VIZHINJAM INTERNATIONAL SEAPORT LIMITED

COMPREHENSIVE ENVIRONMENTAL IMPACT ASSESSMENT FOR VIZHINJAM DEEPWATER PORT







Volume – I Main Report
May 2013

L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

With Contribution From

Asian Consulting Engineers Pvt.Ltd.

COMPLETE SOLUTIONS IN WATER & ENVIRONMENT

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LTR-C1111307-014-L-CVS
May 25, 2013

Vizhinjam International Seaport Ltd.
1st Floor, Vipanchika Tower,
Near Government Guest House,
Thycaud, Thiruvananthapuram - 695 014

Attention: Mr. A. S. Suresh Babu, MD & CEO,

Subject: Submission of Draft Comprehensive EIA for Vizhinjam Port

Reference: (1) Your Work Order: VISL/LTR (II)/2011/881 dated December 08, 2011

Dear Sir,

With reference to the subject project, please find enclosed a soft copy of the Draft Comprehensive Environmental Impact Assessment (EIA) report in Two Volumes for overall Vizhinjam Port including the Road and Rail Connectivity and Ancillary Sites.

Thanking you and assuring you of our best services at all times.

Yours faithfully,
for **L&T-RAMBØLL CONSULTING ENGINEERS LIMITED**

Sundara 25/5/13

C.V. Sundara Rajan
City Office Manager &
Head - Environment Section
Encl: As stated above

Vizhinjam International Seaport Limited
(A Government of Kerala Undertaking)

Undertaking by the Project Proponent

1 Vizhinjam International Sea port Limited (VISL) has carried out and Comprehensive Environmental Impact Assessment (EIA) study for the Proposed Vizhinjam Deepwater Port located at Vizhinjam, In Thiruvananthapuram Corporation Area, Thiruvananthapuram District, Kerala State.

2 As per MoEF office memorandum No.J-11013/41/2006-IA.II (I) dated October 05, 2011, VISL herewith declares the ownership of contents (information and data) of Comprehensive EIA Report.

for **Vizhinjam International Seaport Limited (VISL)**

Name: Mr. A.S. Suresh Babu

Designation: Managing Director & Chief Executive Officer

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L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

Client: **Vizhinjam International Seaport Limited**
Thiruvananthapuram, Kerala

Project: Comprehensive EIA for Vizhinjam Deepwater Port	**Project No.:** C1111307	
Title: Draft CEIA Report	**Document No.:** RP005	**Rev.:** 0

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0	25.05.2013	First Submission	SKF JBF UPK SRL RSD SNV		KRN SAP BRT		CVS	

Declaration by Experts contributing to the Comprehensive Environmental Impact Assessment for Vizhinjam Deepwater Port

I, hereby, certify that I was a part of the Comprehensive EIA team in the following capacity that developed the above Comprehensive EIA.

EIA Coordinator:

Name: C.V. Sundara Rajan



Signature: Date: May 25, 2013

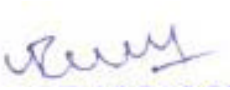
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		Susruta Amirapu	 May 25, 2013	
		With Support From: • Reji Baby Varghese • Shaik Ashraf • P. Balachander • S. Srilatha • Jesse Benjamin Fullonton • Anshul Sanduja		
2.	**WP**	C.V. Sundara Rajan	 May 25, 2013	

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		With Support From: • P. Balachander • Shail Ashraf • Anshul Sanduja		
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S. No.	Functional Areas	Name of the Expert/s	Signature & Date	Involvement (Period & Task*)
11.	**RH**	Susruta Amirapu	 May 25, 2013	
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1. SHW – Experts were accredited for Industrial Solid Waste only and the Application of Experts for Accreditation for Hazardous Waste Management is under process.

Declaration by the Head of the Accredited Consultant Organization

I, C.V. Sundara Rajan, hereby, confirm that the above mentioned experts prepared the EIA for Vizhinjam Deepwater Port. I also confirm that I shall be fully accountable for any misleading information mentioned in this statement.



Signature: Date: May 25, 2013

Name: C.V. Sundara Rajan

Designation: City Office Manager & Head of Environment Section

Name of the EIA Consultant Organization: L&T-RAMBØLL Consulting Engineers Limited

NABET Certificate No. & Issue Date: QCI-NABET Letter dated February 04, 2013

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LIST OF ACRONYMS

AAR	Average Annual Rainfall
ADM	Additional District Magistrate
AECOM	Architecture, Engineering, Consultation, Operation & Maintenance
ALARP	As Low as Reasonably Practicable
ACE	Asian Consulting Engineers
AIW	Assigned Importance Weightage
ASCI	Administrative Staff College of India
ASI	Archaeological Survey of India
BAM	Balarampuram
BDL	Below Detectable Limits
BG	Broad Guage
BMT	British Maritime Technology
BoQ	Bill of Quantities
BOT	Build Operate Transfer
BW	Breakwater
CEIA	Comprehensive Environmental Impact Assessment
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CEPT	Centre for Environmental Planning and Technology
CESS	Centre for Earth Science Studies
CD	Cross Drainage
CEO	Chief Executive Officer
CFE	Consent For Establishment
CFO	Consent For Operation
CGWB	Central Groundwater Board
CMFRI	Central Marine Fisheries Research Institute
CO	Carbon monoxide
CoI	Corridor of Impact
COO	Chief Operating Officer
CCTV	Closed Circuit Television
CPCB	Central Pollution Control Board
CPUE	Catch per Unit Effort
CRZ	Coastal Regulation Zone
CSD	Cutter Suction Dredger
CSR	Corporate Social Responsibility
CTE	Consent to Establish
CZMA	Coastal Zone Management Authority
Db	Decibels
DBT	Dibutyl Tin
DG	Diesel Generator
DLPC	District Land Purchase Committee
DMP	Disaster Management Plan
DO	Dissolved Oxygen
DPR	Detailed Project Report
DTTL	Deloitte Touche Tohamatsu Limited
DWT	Dead Weight Tonnage
EA	Environmental Assessment
EAC	Environmental Appraisal Committee
EC	Environmental Clearance
ECHS	Empty Container Handlers
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMC	Environmental Management Cell
EMP	Environmental Management Plan
EPC	Engineering Procurement Construction
EPZ	Export Processing Zone
E-RTGC	Electronic Rubber Tyre Gantry Cranes
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Mitigation Framework

ESMP	Environmental and Social Management Plan
ESRO	European Seaports Organisation
ETM	Enhanced Thematic Mapper
FCC	False Colour Composite
FL	Flood Level
Fy	Financial Year
FSI	Financial Services Industry
GFLS	General Finite Line Source
G.O.	Government Order
GIS	Geographical Information System
GSI	Geological Survey of India
GL	Ground Level
GoI	Government of India
GoK	Government of Kerala
GPS	Global Positioning System
Ha	Hectares
HC	Hydrocarbons
Hg	Mercury
HED	Harbour Engineering Department
HT	High Tension
HTL	High Tide line
H_2S	Hydrogen Sulphide
HMV	Heavy Motor Vehicles
ICAR	Indian Council Of Agricultural Research
ID	Identification
IEC	International Electro technical System
IFC	International Finance Corporation
IMD	Indian Meteorological Department
INCOIS	Indian National Centre for Oceanographic Information System
In	Indian Navy
INR	Indian Rupee
IR	Indian Railways
IRS	Indian Remote Sensing
IS	Indian Standards
ISO	International Organisation for Standardisation
ISPS	International Ship and Port Facility Security Code
ISSC	International Ship Security Certification
IST	Indian Standard Time
ITV	Internal Transfer Vehicle
IUCN	International Union for Conservation of Nature
IVI	Important Value Indices
KFRI	Kerala Forest Research Institute
KKB	Kerala Khondalite Belt
KLD	Kilo litres per Day
Km	Kilometre
Kmph	Kilometre per hour
kPa	Kilopascals
KSEB	Kerala State Electricity Board
KSCZMA	Kerala State Coastal Zone Management Authority
KSPCB	Kerala State Pollution Control Board
KSRTC	Kerala State Road Transport Corporation
KSTP	Kerala State Transport Project
KV	Kilovolt
KWA	Kerala Water Authority
LA	Land Acquisition
LBH	Land Borehole
LC	Level Crossing
LHS	Left Hand Side
LHPP	Local Hiring and Purchase Plan
LTL	Low Tide Line

LTM	Landsat Thematic Mapper
LSG	Local Self-Help Groups
LTR	L&T-RAMBØLL Consulting Engineers Limited
m	Metre
MAP	Management Action Plan
MCM	Million Cubic Metre
MDR	Major District Road
MLD	Million Litres per Day
MMT	Million Metric Tonne
MoEF	Ministry of Environment & Forests
MoM	Minutes of Meeting
MSL	Mean Sea Level
MSDS	Material Safety Data Sheet
MTPA	Million Tonnes per Annum
NAAQ	National Ambient Air Quality
NABET	National Accreditation Board for Education and Training
NANQ	National Ambient Noise Quality
NATPAC	National Transportation Planning & Research Centre
NCJ	Nagerkovil Junction
NCSCM	National Centre for Sustainable Coastal Management
NE	Northeast
NEM	Nemom
NGO	Non Government Organization
NP	Net Present Value
NH	National Highway
NHAI	National Highways Authority of India
NHDP	National Highways Development Project
NIO	National Institute of Oceanography
NIOT	National Institute of Oceanography and Technology
NRI	Non Residents of India
NRSC	National Remote Sensing Centre
nT	Nano Tesla
NW	Northwest
NYY	Neyyanttinkara
O & M	Operation and Maintenance
OBM	Out Board Motors
PA	Particle Analysis
PAF	Port Annex Facility
PAHs	Project Affected Houses
PAPs	Project Affected Persons
PCB	Polychlorinated Biphenyls
PDPs	Project Displaced Persons
PFSO	Port Facility Security Officer
PIA	Project Influenced Area
PID	Project Influence District
PM	Particulate Matter
POL	Petroleum Oil and Lubricants
PPE	Personal Protective Equipment
PPP	Private Public Partnership
PS	Performance Standards
PSIA	Pound per Square Inch Absolute
PUC	Pollution Under Control
PWD	Public Works Department
QCI	Quality Council of India
R&R	Resettlement and Rehabilitation
RA	Risk Assessment
RAP	Resettlement Action Plan
RCC	Reinforced Cement Concrete
RHS	Right Hand Side
RITES	Rail India Technical and Economic Services

RMQC	Rail Mounted Quay Cranes
RoB	Road over Bridge
RoW	Right of Way
R & R	Resettlement and Rehabilitation
RSO	Recognised Security Organisation
RTGC	Rubber Tyre Gantry Cranes
RuB	Road under Bridge
RVNL	Rail Vikas Nigam Limited
SBI Cap	State Bank of India Capital
SCR	Shoreline Changes Rate
SE	Southeast
SEL	Sound Exposure Level
SEZ	Special Economic Zone
SH	State Highway
SHG	Self Help Groups
SIA	Social Impact Assessment
SIC	Site Incident Controller
SMC	Site Main Controller
SMU	Social Management Unit
SMU	State Management Unit
SoI	Survey of India
SOLAS	Safety of Life at Sea
SPCB	State Pollution Control Board
SPV	Special Purpose Vehicle
SSA	Ship Security Assessment
SSP	Ship Security Plan
STD's	Sexually Transmitted Diseases
STP	Sewage Treatment Plant
T	Tonne
TEU's	Twenty foot Equivalent Units
TGS	Total Ground Slots
ToR	Terms of Reference
TUA	Thiruvananthapuram Urban Area
TVC	Thiruvananthapuram Central
UK	United Kingdom
USEPA	United States Environment Protection Agency
VFH	Vizhinjam Fishing Harbour
VOC	Volatile Organic Compound
VC	Vertical Clearance
VIDMS	Vizhinjam International Deepwater Multipurpose Seaport
VISL	Vizhinjam International Seaport Limited
VTMIS	Vessel Traffic Management Information System
WCIP	West Coast India Pilot
WHO	World Health Organisation
WBG	World Bank Group

Chapter 1
Introduction

Chapter 1 Introduction

The Government of Kerala (GoK) is gearing up to develop various port projects for the overall improvement of the economy of the State. Although the State of Kerala is endowed with a coastline of approximately 580 km length, at present, there is only one major port in this coastal stretch; which is Kochi (Cochin) Port. The major port at Kochi with its recently added containment transhipment facility is under the Ministry of Shipping, Government of India (GoI). This report is prepared in regards to the proposal of developing a major port located in Thiruvananthapuram district at Vizhinjam; which is already declared as a minor port under GoK. This is a Comprehensive Environmental Impact Assessment (CEIA) report is prepared for the proposed **Vizhinjam International Deepwater Multipurpose Seaport** herein after referred to as '**Vizhinjam port**' or simply **'The Deepwater Port'**. The port is envisaged to be developed through Public Private Partnership (PPP) with VISL as a Landlord of the port, in which the construction and operation of the port terminal will be on Build, Operate and Transfer (BOT) basis.

This CEIA report is prepared in two volumes pertaining to all components of the project. The first volume is CEIA report itself and the second volume is all the appendices and A3 size maps for a detailed illustration. This is perhaps the only port project in India that has completed all required studies comprehensively to address all issues and impacts concerning the project with a high level of stakeholder participation. It can be categorically stated that for the first time in India a port project is being taken up with several large scale focussed studies coupled with formal and informal stakeholder consultations to fine tune the project development with the complete knowledge and acceptance of the local communities.

Over a period of time, the Vizhinjam port project has become a dream project for the people of Kerala and therefore the entire GoK machinery is overwhelmingly supporting the project. By default due to its strategic location facing the Indian Ocean and its proximity to Tamil Nadu and Sri Lanka together give it a special stature making it a 'National project' rather than a 'State project'.

1.1 Proposed Vizhinjam Port Infrastructure

Existing Vizhinjam harbour is a natural harbour, which is located close (10 nautical miles) to the international shipping route which connects the United Kingdom, West Asia and the Far East. This includes Middle East Far East route and International Suez- Far East[1] Trade route. As a minor port other than the fishing harbour nearby, no other port infrastructure is currently available at the proposed Vizhinjam port location.

The bathymetric studies conducted at Vizhinjam have shown that around 22 m draft is available at 2.0 km from seashore; hence, this port can handle super tankers and the biggest container mother ships with ease. The container traffic into and out of Indian ports has sharply increased to over 2.5 million units today. The transhipment market is clear and wide open. Buoyant international container trade and growth in container traffic in India at a Compound Annual Growth Rate (CAGR) of 14% during the last decade has led to a trend towards increased vessel sizes on order (Drewry Market Study, 2010). This necessitates the establishment of an International deepwater multipurpose seaport (Vizhinjam port) close to the southern tip of the Indian peninsula and the proposed terminal will be ideal for attracting mother vessels ranging from Post Panamax to Malacca-max, in a phased manner. Detailed traffic assessment study indicates that Vizhinjam port could be configured to meet the transhipment

[1] Cochin port is 75 nautical miles away from this rout but 15 nautical miles to Middle East trade route

requirements of the region. This report is prepared to address all environmental/social impacts and issues associated with the development of the Vizhinjam port infrastructure.

1.2 Applicable Legal and Policy Framework

1.2.1 Government of India (GoI) Requirements

Prior to the implementation of the project Vizhinjam port as a whole, it needs to get environmental clearances/approvals from various regulatory bodies like State level and National level agencies. The most important government departments and institutions responsible for environment protection and management in India are:

- Ministry of Environment & Forests (MoEF)
- Central Pollution Control Board (CPCB)
- Department of Environment (State Level)
- State Pollution Control Board (SPCB)
- Local bodies – Corporations, Municipalities, Gram Panchayats

The EIA for the Vizhinjam port has been carried out conforming to the requirements of September 14, 2006 Notification (as amended) and this is also conforming to the requirement of the Coastal Regulation Zone Notification, 2011 issued by MoEF, Government of India (GoI). The most relevant important acts, rules and notifications for environmental protection in India are provided in the **Table 1-1**. An elaborate legal and policy framework is attached as **Appendix 1.1**.

Table 1-1: Important Acts & Rules for Environmental Protection in India

Legal Requirement	Compliance/Application
The Environment (Protection) Act, 1986	An Act to provide for the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property
The Air (Prevention & Control of Pollution) Act, 1981	An Act to provide for the prevention, control and abatement of air pollution, include the preservation of the quality of air and control of air pollution; relates to the issue of the Consent to Establish (CTO) for the Stack and DG set emissions that are likely to be installed in the project site
The Water (Prevention & Control of Pollution) Act, 1974	An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, relates to the issue of the Consent to Establish (CTO) for the water requirement for the day to day project operations and daily unit wise waste generation
The Public Liability Insurance Act, 1991	An Act to provide for public liability – insurance for the purpose of providing immediate relief to the persons affected – in terms of responsibility and finances
Biological Diversity Act, 2002	Aimed at conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process
Environmental Impact Assessment Notification, 2006 (As amended)	Imposing certain restrictions and prohibitions on new projects or activities, or on the expansion or modernization of existing projects or activities based on their potential environmental impacts, being undertaken in any part of India, unless prior environmental clearance has been accorded in accordance with the objectives of National Environment Policy
Coastal Regulation Zone Notification, 2011	An act to empower the State and the GoI authorities to take measures for protecting and improving the quality of the coastal environment and preventing, abating and controlling environmental pollution in the coastal areas of India
The Noise Pollution (Control & Regulation) Rules, 2000	Deciding the levels of noise at various areas or zones defined as industrial, residential, commercial and silence zone during day and night times

Legal Requirement	Compliance/Application
Solid Waste Management rule, 2000 as amended	Solid waste generation and management
Ancient Monuments and Archaeological site & Remains act, 1958	Act to provide conservation of cultural and historical remains found in India
Land Acquisition Act, 1894 & 1989	Set out rule for acquisition of land by Government. This being a core Social impacts GoI is now formulating a new Land acquisition replacing an Act that is older than 1947, the independent India
National Resettlement and Rehabilitation Policy, 2007	All social issues related to land acquisition, resettlement and rehabilitation

Since the project is being advised by the International Finance Corporation (IFC), Vizhinjam International Seaport Limited (VISL), the nodal agency to develop Vizhinjam port, has incorporated and streamlined the IFC performance standards while carrying out the Environmental and Social Assessment Studies.

1.2.2 IFC Requirements

The IFC requirements are as per the Performance Standards (PS) on Social and Environmental Sustainability dated April 30, 2006 prepared by IFC are given below:

PS 1: Social and Environmental Assessment and Management System
PS 2: Labour and Working Conditions
PS 3: Pollution Prevention and Abatement
PS 4: Community Health, Safety and Security
PS 5: Land Acquisition and Involuntary Resettlement
PS 6: Biodiversity Conservation and Sustainable Natural Resource Management
PS 7: Indigenous People
PS 8: Cultural Heritage

1.3 Brief Description of the Project Area

The Project site is located at Vizhinjam, Thiruvananthapuram District, Kerala. **Exhibit 1-1** and **Exhibit 1-2** are the site photographs of the proposed Vizhinjam port. The port facilities (including quays, terminal area and port buildings) are proposed to be developed entirely on reclaimed land.

As a part of Vizhinjam port development, several infrastructure facilities have to be developed in addition to road and rail connectivity. Most of these infrastructure facilities are to be developed close to the port. Therefore adequate backup area and other land resources have been acquired in the vicinity of proposed port. These are together termed as ancillary sites which will be a part of the overall port infrastructure. These ancillary sites and facilities are for developing (1) warehouse area (2) Port Annex Facility (PAF) zone which includes substation, truck terminal & residential area and (3) port backup areas for administrative and other office requirements. There will be coastguard and defence related infrastructure for coordinating with respective departments. In addition to these, there will be facilities with regards to cruises/tourism, customs, railway terminal offices and other security establishments.

The GoK is supposed to develop the port associated infrastructural facilities like the breakwater, quay wall, dredging, reclamation, utilities (drinking water, power supply to the terminal, etc.) and infrastructure connectivity (rail and road). The port operations and superstructure development are proposed to be the responsibility of the private operator. The flowchart of the Landlord Port Model is given in **Figure 1-1**.



Exhibit 1-1: Nellikkunnu – Northern End of port



Exhibit 1-2: Adimalathura Sothern End of Port

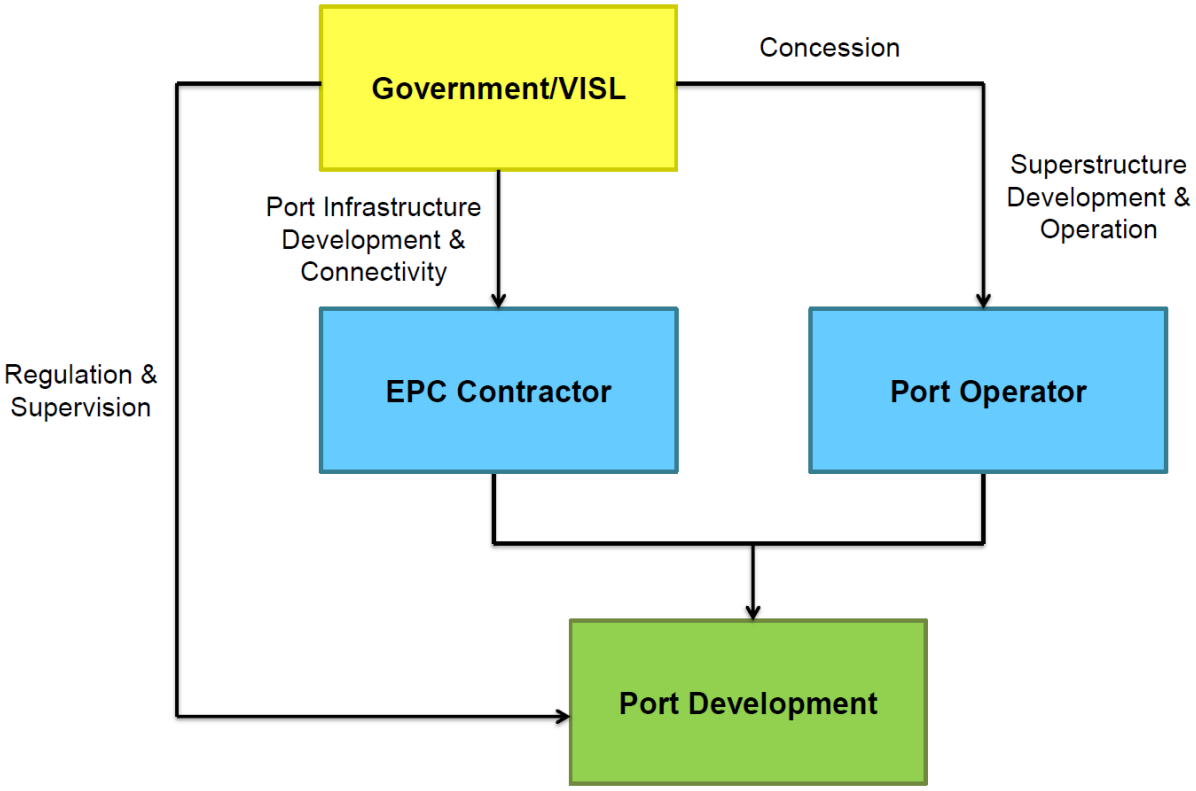


Figure 1-1: The Flowchart of the Landlord Port Model

1.3.1 Project Location, Site and Study Area

The identified shoreline for the proposed port development will be within the proposed port limits. The co-ordinates of the proposed port limits fall within the following geographical coordinates:

Table 1-2: Coordinates of the Proposed Port Limits

S. No.	Easting	Northing	Latitude (N)	Longitude (E)
1	719480.4464	927210.7796	8°22'59.27"	76°59'35.48"
2	716858.078	924289.2303	8°21'24.62"	76°58'9.30"
3	716858.078	921674.8624	8°19'59.54"	76°58'8.87"

S. No.	Easting	Northing	Latitude (N)	Longitude (E)
4	723381.1926	921674.8624	8°19'58.47"	77°1'42.02"
5	721377.6205	924134.1795	8°21'18.84"	77°0'36.96"
6	721798.2834	924465.6649	8°21'29.55"	77°0'50.76"

These port limits are being proposed as the original port limits notified in the G.O. (P) No. 4/F P&D, dated January 22, 2003 (**Appendix 1.2**) are too broad and wide for a realistic view of the port operations. The proposed port limits are shown in **Figure 1-2**.

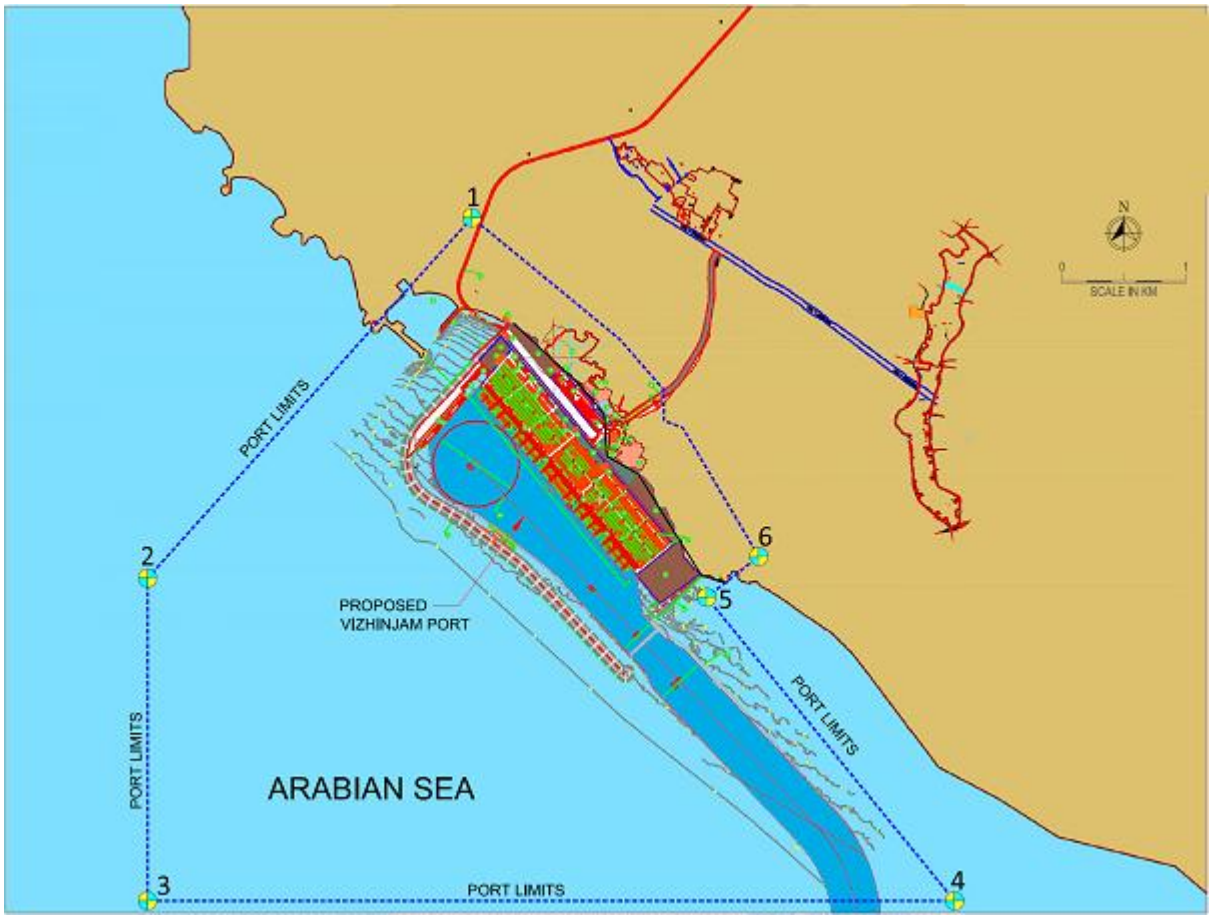


Figure 1-2: Proposed Port Limits for Vizhinjam Port

The proposed project site is located in west coast of India at Vizhinjam (South of Vizhinjam fishing harbour), Thiruvananthapuram District, Kerala. An overview of the project site with all its infrastructure facilities, the project area map and its study area of 10 km radius from the project site are shown in **Figure 1-3 (Ref: Volume 2 - FD0101 for details in A3 size format)**.

The major site specific advantages of the proposed site are:

Availability of 18-20 m contour within one nautical mile from the coast
Proximity to International shipping routes (**Figure 1-4**) approximately 10 nautical miles from proposed project site
Minimal littoral drift along the coast, hardly any maintenance dredging is required.
Links to national/regional road, rail network
Flexibility in design and expansion being a Greenfield project

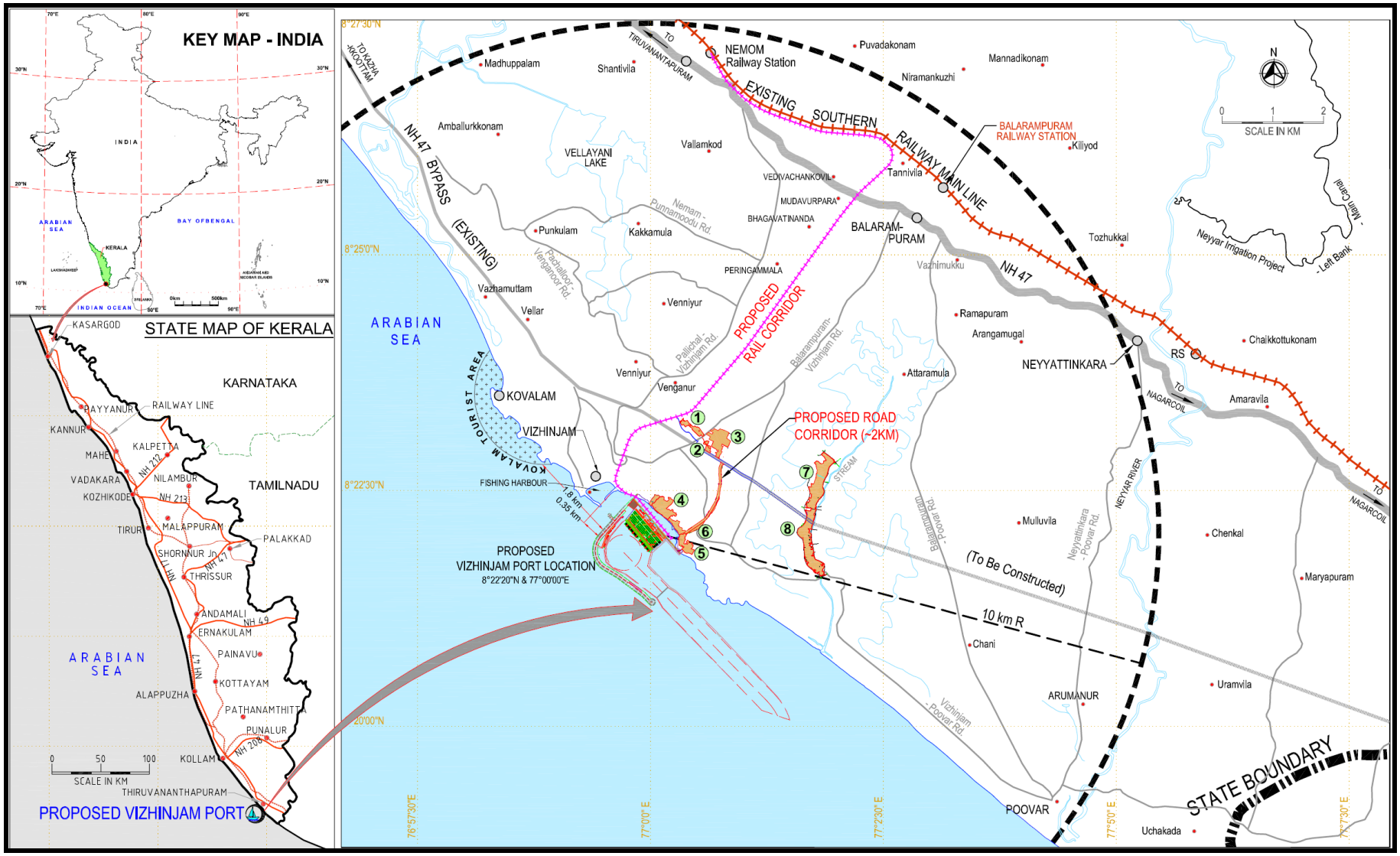


Figure 1-3: Project Location Map



Figure 1-4: Vizhinjam Ports Proximity to International Shipping Route

The project is proposed to be developed in three phases; Phase I, Phase II and Phase III. The total area to be developed in for all three phases (including all port infrastructures) is estimated at 404.91 Ha. The land use plan for Vizhinjam port is given in **FD0102**. In phase-I the requirement is 140.42 Ha in addition to 66.00 Ha reclaimed land. Four kinds of terminals, namely container terminal, multipurpose terminal, and cruise terminal, are proposed to be developed. The annual capacity to be handled by the terminals in each phase is given in **Figure 1-5**.

1.4 Project Status

During the last one decade or so, the GoK has been longing to develop the Vizhinjam port into a full-fledged port. As a part of the long term strategy, GoK has developed the existing facilities for the Vizhinjam fishing harbour for the benefit of the local fisherman during 1968 - 1974. This facility is an important asset for the fisherman and has been upgraded with breakwaters recently during the year 2008. In between, the GoK appointed VISL as the nodal agency to develop a Greenfield port at Vizhinjam near Thiruvananthapuram. There was a serious attempt to develop the port in Private Public Partnership (PPP) mode and all required studies were completed and the selected but the developer unfortunately had been denied approval due to National security related reasons. During that stage there were preliminary levels of environmental studies (Rapid EIA based on 1994 EIA notification) for unravelling any risk involved in order to happen the PPP concessioner agreement. According to this the Concessioner was responsible for conducting detailed studies and also to obtain environmental and Coastal Regulation Zone (CRZ) clearances and approvals. Nevertheless, these studies were very important as it was the basis of current Vizhinjam port site selection and it has the analysis of alternative study resulted in pin pointing the present location of Vizhinjam port.

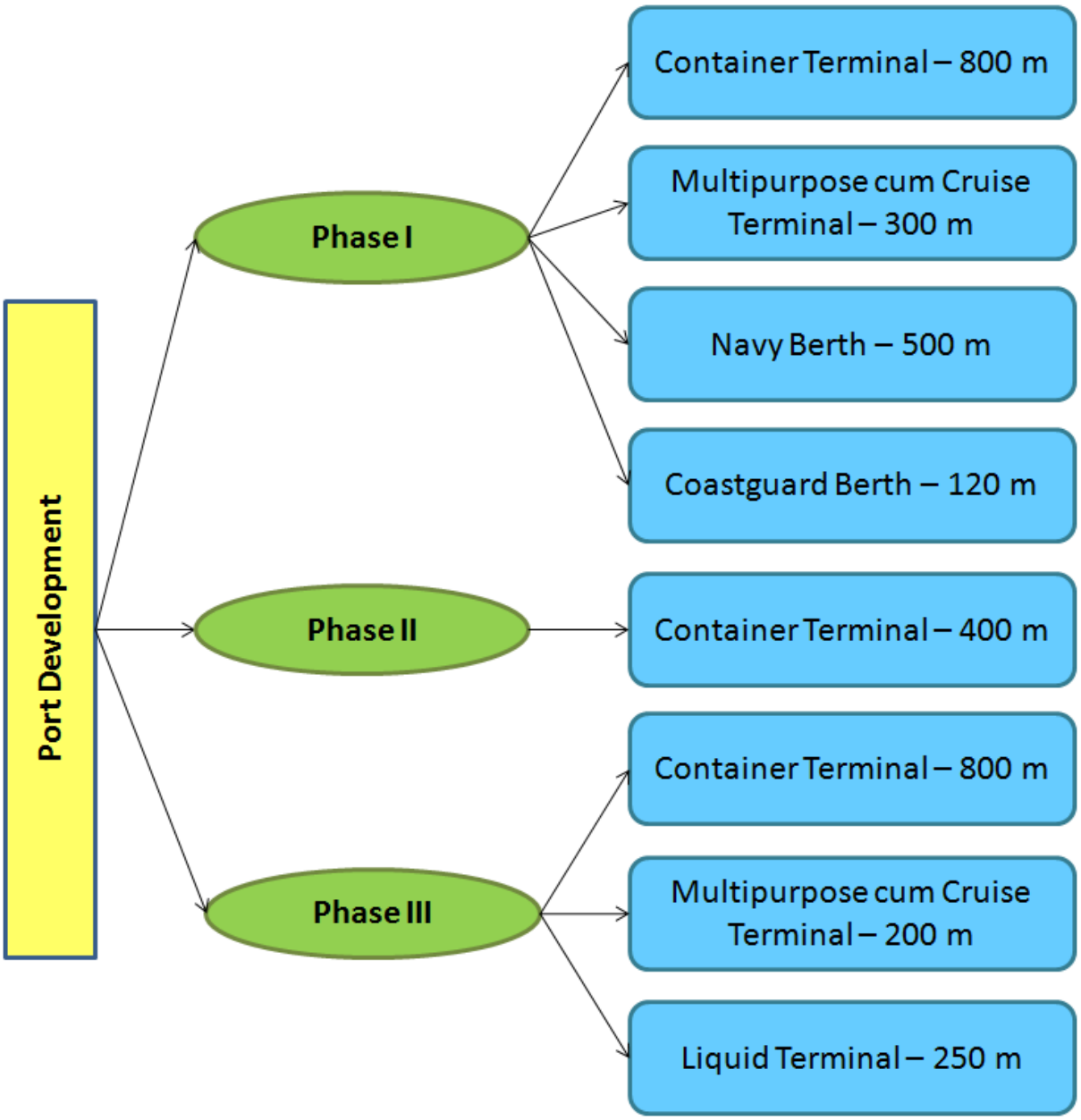


Figure 1-5: Phase-wise Development of the Proposed Port

Further there was renewed effort to develop the port in **'Land Lord Model'** wherein GoK has a major role in developing certain facilities and to obtain all clearances including Environmental Clearance (EC) from the regulatory agencies. In this direction, IFC has been appointed by VISL and Royal Haskoning (RH) was engaged as the engineering consultant for restructuring the project in to viable phasing options. RH on the other hand has appointed the Asian Consulting Engineers (ASE) for the environmental studies for the Vizhinjam port. Later VISL appointed L&T-RAMBØLL Consulting Engineers Limited (LTR) for carrying out few other focussed studies relating to various port infrastructure components that include the road and railway alignment, ancillary sites, mathematical modelling, shoreline changes and also to assist for obtaining regulatory clearances from the National and State level agencies. In this regard, LTR is engaged by VISL for providing technical assistance while obtaining EC/CRZ clearance for the Vizhinjam port. Later, the Vizhinjam port project received Terms of Reference (ToR) approved by Environmental Appraisal Committee (EAC), MoEF on June 23, 2011 with several conditions.

As discussed above the current phase of the project development is on a landlord model wherein VISL/GoK will be the owner of the project. According to this, M/s. Welspun International had won the project bid for operator but failed at the negotiation stage. Mundra Ports who was also finally qualified did not get security clearance from the GoI. Currently GoK is looking at various options as the time for selection of operator is more than adequate with other priorities like Environmental Clearance and Engineering Procurement Construction (EPC) contractor are outweighing as the priorities.

1.4.1 Connectivity Aspects

The National Highway (NH 47) runs close (1.9 km towards west) to the project site connecting Thiruvananthapuram to Kanyakumari. The railway link connects Thiruvananthapuram to Nagerkovil is about 10 km from the proposed deepwater port. The nearest airport is located at Thiruvananthapuram within 15 km from the Vizhinjam project site.

1.5 Need for International Multipurpose Deepwater Vizhinjam Port

Cost of importing/exporting from India is relatively higher than in other developed countries, primarily due to inefficiencies in the logistics chain, lack of deep draft port facilities and capacity constrained hinterland cargo evacuation system. In order to attract mainline vessels with Indian cargo directly to Vizhinjam (away from Colombo, Salalah and Singapore etc.), the port will have to provide world class and efficient service, least disruption in existing voyage route, competitive rates and overall reduction in import/export cost of cargo.

Vizhinjam is strategically located along south of the Kerala coast and is only 10 nautical miles away from the **Middle East-far East route** and **International Suez-far East Trade Route**[2] shipping corridor. Its planned location is endowed with natural deep draft water and is estimated to have minimal maintenance dredging needs. The Greenfield location has enabled for the master plan to be developed to provide world class infrastructure for efficient services and to cater for future development potential of the region.

Vizhinjam has a good potential to capture the transhipment cargo from Colombo and outside of ISC region ports. With these advantages and planned facilities to handle the biggest container vessels (upto 18,000 TEUs), Vizhinjam will be able to attract mainline vessels to call directly instead of trans-shipment at other ports outside of the country. This will result in savings in overall import/export logistics cost for the Indian consumer.

The proposed Vizhinjam port has provision for two world class cruise berths with a total of 500 m berth length and can serve as homeport for multi-day cruises. The international airport is located around an hour's drive away increasing the attractiveness for the cruise passengers. The dedicated cruise terminal and resort area will further increase the tourism profile of the Thiruvananthapuram region.

The need for effective coastal security in the present security scenario is being accommodated at proposed Vizhinjam port by providing a dedicated 120 m berthing space for Coast Guard to enable operation of its ships. The present docking facility available within the existing Vizhinjam harbour is insufficient to cater to the increased needs in the region. The Coast Guard is planning to have station at the proposed port for effective coastal security and monitoring of Sea Lanes of Communication. It

[2]Cochin and Tuticorin ports are 75 and 100 Nautical miles away from this international trade route respectively

will also help to provide enhanced training to Marine Police. It will also drastically reduce the amount of operating cost in coastal patrolling for the Coast Guard.

The proposed port also caters to the security needs of the country considering the strategic location along the south Kerala coast. Indian Navy will be provided a mounting base for loading of amphibious vessels, troops and transports. This has been done in the form of providing a dedicated berth length of 500 m. Navy plans to utilize the berth mainly for loading of amphibious troops, transports and armoured vehicles for joint operation with the Indian Army base at Thiruvananthapuram (where the only amphibian infantry brigade in the Country is stationed) and the Indian Air Force Base at Thiruvananthapuram.

The proposed port will provide additional fish landing berths of 500 m length that will augment the existing Vizhinjam fishing harbour. The existing harbour is currently very congested and does not provide enough berthing area for efficient fishing fleet of the region. In addition, to catering for the existing fleet, the proposed fish landing berths will enable further growth in fishing activities along the Kerala coast.

This is the only candidate project location in India with deep natural water; minimal maintenance dredging and all other important criteria (closeness to International shipping route) are favourable to develop a container transhipment hub that can allow access to the largest vessels.

1.6 Environmental Impact Assessment (EIA)

The development of the proposed Vizhinjam port including road-rail connectivity may result in land and seaside environmental changes through increased traffic and development. Therefore adequate environmental mitigation and management measures are essential for the project. The specific objectives of the Environmental Impact Assessment (EIA) process are:

- To establish the environmental baseline in the study area and to identify any significant environmental aspects
- To assess the project impacts and provide for measures to address the adverse impacts by the provision of the requisite avoidance, mitigation and compensation measures
- To integrate the environmental issues including genuine stake holder concerns in the project planning and design
- To develop appropriate management plans for implementing, monitoring and reporting of the environmental mitigation and enhancement measures suggested during all stages of project cycle

The EIA study has been carried out based on the approved ToR covering both terrestrial and marine environments. The committee approved the ToR vide MoEF *Letter No: 11-122/2010-IA.III, dated June 10, 2011 and 11-122/2011-IA.III, dated July 01, 2011*. A copy of the letters are enclosed as **Appendix 1.3** for reference. There is no separate ToR for the road and rail connectivity component of the port. Compliance to MoEF suggestions on ToR is enclosed as **Appendix 1.4**. The current volume is:

- **Volume-1:** Comprehensive EIA/EMP for Vizhinjam port Infrastructure (that include road, rail connectivity, backup areas and other ancillary site developments)
- **Volume-2:** Appendices to EIA Report including Detailed A3 size maps

1.6.1 Objective of EIA for Vizhinjam Port

This document is the Comprehensive EIA (CEIA) that will be submitted to the Kerala State Pollution Control Board (KSPCB) as the draft CEIA to carry out public hearing. Later, the draft EIA will be updated with all inputs including those from the public hearing to prepare a final CEIA for Vizhinjam

International Deepwater Multipurpose Seaport. The final CEIA will be used for obtaining other State and Central clearances.

The objective of CEIA for Vizhinjam port is to carry out a CEIA and an Environmental Management Plan (EMP) including a monitoring plan for the proposed Vizhinjam port and to obtain EC from statutory authorities. The CEIA and EMP will enable the effective application of all country laws to minimise, mitigate and to avoid project environmental impacts. This is to ensure, enhance and optimise the targeted overall project benefits. In addition, the project has to take all valid stakeholder concerns to address them suitably.

The CEIA report has been prepared by taking into account various EIA and SIA reports prepared separately for the purpose of the port, road/rail connectivity and the ancillary sites. The relationship of these reports and their respective action plans is provided in **Table 1-3**.

Table 1-3: Details and Contents of Integrated Comprehensive EIA and EMP

Volume	EIA and SIA Reports	Action Plans	Combined EIA Report for EC from MoEF
1.	Road & Rail Environmental Impact Assessment (EIA)	Environmental Monitoring and Management Plan	CEIA for Vizhinjam International Deepwater Multipurpose Seaport
2.	Road & Rail Social Impact Assessment (SIA)	Resettlement Action Plan (RAP)	
3.	EIA study for the Ancillary Sites*	EMP for Ancillary Sites	
4.	SIA for Ancillary Sites	RAP for Ancillary Sites	
5.	Port Environmental and Social Impact Assessment (ESIA)	Environmental Monitoring & Management Plan	

*Where the Ancillary sites include backup areas, warehouse area, PAF zone, etc.

1.6.2 Scope of the Study

The scope of EIA study includes:

Assessment of baseline environmental conditions for terrestrial environment within the study area based on field studies and review of literature
Identification and prediction of significant impacts due to proposed expansion on various environmental and social attributes
Environmental impact evaluation
Preparation of EMP and Environmental monitoring plans

1.7 Approach and Methodology

The EIA study was carried out as per the guidelines of MoEF and consistent with the principles of the IFC Performance Standards. The approach to the EIA study involved establishing of the environmental and social baseline conditions of the study area (including the 10 km general study area). The next step was the identification of both negative and positive potential impacts. After identification of environmental and social impacts, the respective impact mitigation and avoidance framework is proposed to mitigate the adverse environmental impacts and to enhance the positive impacts.

1.7.1 Project Influenced Area (PIA)/General Study Area

As per the norms laid out by MoEF an area within 10 km radius with the Vizhinjam port site as a centre has been earmarked for the study as the *general study area*. The PIA/general study area map is given

as **Figure FD0103**. Nevertheless, this study as a special case considered the *core study area* is the acquired project area with a two kilometre radius from the centre of the port site.

Thiruvananthapuram district is the only PIA district and Vizhinjam and Neyyattinkara are the PIA talukas. There are two PIA blocks under which the PIA panchayats are listed; they are Athiyannoor block and Nemom block. Under these blocks the PIA gram panchayats are Athiyannoor, Kottukal, Kanjiramkulam, Karumkulam, Venganoor, Maranalloor, Pallichal, Malayinkeezhu, Vilappil, Vilavoorkal, Kalliyoor, Balarampuram and Vizhinjam. Due to the very high density of population after the last census in 2011, the Vizhinjam has become the part of Thiruvananthapuram Urban Area (TUA).

1.7.2 Baseline Environmental Studies

The baseline of the environmental and social-economic status/conditions of the study area has been established through review, compilation and analysis of existing published secondary data/literature/information and primary data generated/collected through field study, surveys and monitoring.

1.7.3 Study Period

The baseline terrestrial environmental surveys were carried out for three seasons i.e. during June, 2011 - June 2012 after the receipt of ToR. The collected secondary data has been supplemented and validated by conducting the necessary primary data generation/collection through three seasonal field study/monitoring (pre-monsoon, monsoon and winter season/post-monsoon). The field monitoring and analysis of parameters with respect to ambient air, noise, water and soil was carried out by NABL, accredited **Eko Pro Engineers Pvt. Ltd. Ghaziabad**. The marine monitoring was undertaken by Central Marine Fisheries Research Institute (CMFRI), Indian Council of Agricultural Research (ICAR), Kochi, Kerala. The following subcomponents constitute the baseline condition of the study area:

1.7.4 Methodology

The CEIA for the proposed port has been carried out both for construction as well as operational phases. In each phase, the anticipated impacts due to the proposed project on terrestrial and marine environmental components have been addressed. The methodology adopted for the study is discussed.

1.7.4.1 Analysis of Alternatives

The detailed analysis of site selection for the proposed Vizhinjam port location has been described in the chapter for three scenarios. This includes the latest scenario, the ToR scenario and the original studied scenario of 2004. As per the ToR specification the marking has been adjusted to 0-100 scale for better clarity.

To ensure sustainable development under the given conditions, the analysis of alternatives considered for the site identification rail and road layout selection has been discussed in detail and presented in the **Chapter 3**. In this, there were several options for the start location or take-off point and also for the end location or terminal at the Vizhinjam port site.

1.7.4.2 Baseline Environmental Conditions

The baseline environmental status of the study area was established by carrying out the field surveys covering terrestrial environmental components. In addition, authenticated secondary data was also collected, reviewed and presented.

Terrestrial Environment: The baseline environmental data for terrestrial environment was collected within the study area for following attributes.

- Meteorology
- Ambient Air Quality (PM_{10}, $PM_{2.5}$, SO_2, NO_X and CO)
- Noise
- Water Quality
- Soil
- Ecology
- Land use and Land Cover Mapping
- Topography

The baseline terrestrial environmental conditions are described in **Chapter 4**.

Marine Environment:

Marine Water Quality: Marine water samples were collected from six locations by Niskin sampler. Relevant physico-chemical parameters were analysed.

Sediment Quality: Sediment samples from six locations were collected by Van Veen Grab sampling method and were analysed for different physico-chemical parameters.

Marine Ecology: Sampling for planktons and benthos was carried out at six locations. The analysed data of planktons was used to calculate the Shannon Wiener Diversity Index. Investigation for fish fauna in the Project stretch was conducted by using hook and line and through sample netting. In addition to this, secondary data on fish species and fisheries was collected from Department of Fisheries, Government of Kerala.

Socio-Economic Aspects:

In addition to the primary surveys and stake holder consultations on the Project affected area for land acquisition, data on population, literacy, occupation, amenities, and medical facilities was collected from District Statistical Handbook of Thiruvananthapuram and Primary Census Abstract (Census of India), 2001.

Socio-economic data was collected from the respective panchayat office, Block Development Office and Village Heads. Data on demography of the area was collected from the Census of India (2001), and CMFRI (2010). These data were analysed to prepare the socio-economic impact of the proposed Project. A socio-economic survey was conducted in Thiruvananthapuram Corporation areas and Neyyatinkara Taluk area and 10 Panchayats within 10 km study area of the proposed project site. Focussed Group Discussions (FGD) were held in 12 fishermen villages within 15 km distance of the project site and near two quarry sites namely Thukalay and Kadavila to enlighten the people about the project and to highlight their apprehensions in this report.

The fishing harbour in Vizhinjam, which is about 300 m north from the proposed port site, falls within the port limits and influence. The socio-economic data with respect to the fishing harbour (including fisheries and fish landing data) was obtained from the Department of Fisheries/Central Marine Fisheries Research Institute (CMFRI), Thiruvananthapuram. The baseline environmental condition has been delineated based on the field survey and monitoring. The Tourist resort owners established in

the region are another group of stakeholders; specific attention has been paid to them as well. Particularly important are the Ayurvedic resorts situated along the coast near the project site.

As a part of this CEIA study, a Social Impact Assessment (SIA) was also carried out for both rail and road connectivity. Further, a Resettlement Action Plan (RAP) is also being prepared.

1.7.4.3 Anticipated Environmental Impacts and Avoidance/Mitigation Measures

Based on the environmental as well as socio-economic baseline conditions, impacts are identified with respect to air, noise, water, land, biological, marine and the socio-economic environment. Following the impact identification, based on the severity of the impacts a mitigation framework is proposed. The proposed mitigation framework also addresses opportunities to enhance the positive impacts in for instance the fisheries and tourist industry.

The environmental and social impacts which are likely to arise due to the proposed port, road and rail connectivity and ancillary sites (as an integral part of port project) during the construction as well as operational phases have been studied in detail with respect to the facilities being proposed. Further, the impacts have been assessed taking into consideration the existing baseline status of the terrestrial environment. The mitigation measures are proposed to minimise/avoid each of the likely impacts. These are presented in **Chapter 5**.

1.7.4.4 Environmental Management Plan

An Environmental Management Plan is key to ensuring a sustainable development. For now, it basically comprises of all the mitigation measures, which have been proposed for the identified potential impacts. Finally, a budget is presented for the implementation of the proposed Environmental and Social Mitigation Framework. The details of management plans to be developed by VISL is given in **Table 1-4**.

Table 1-4: Detailed Management Plans to be developed by VISL[3]

Environmental Impact Mitigation		Social Impact Mitigation
• Quarry management plan. • Dredged material management plan. • Occupational health and safety management plan. • Contract labour and labour camp management plan. • Marine traffic management plan. • Pollution control/prevention plan. • Biodiversity conservation and management plan. • Green belt development.	• Risk analysis and hazardous materials management plan. • Port security and security personnel management plan. • Emergency preparedness and response plan. • Oil spill contingency plan.	• Community grievance redress plan. • Stakeholder Engagement Plan. • Livelihood restoration plan.

[3]These plans will be developed as appropriate in the further design and construction phase.

1.7.4.5 Environmental Monitoring Programme

Post project environmental monitoring programme has been formulated for the port and road and rail connectivity and presented in the **Chapter 6** of this report. The environmental monitoring programme covers the technical and network design of monitoring, as well as the effectiveness of mitigation measures (including measurement methodologies, frequency, location, etc., and detailed budget).

1.7.4.6 Additional Studies

Stakeholder and Community Consultation: This project has consulted all stakeholders both institutional as well as community stakeholders. Details of such stakeholder/community engagements have been compiled and provided in a section in **Chapter 7**. Most of such interactions have been video recorded for the best interest of the project implementation. In addition, this chapter also provides an idea of the elements to be included in the Corporate Social Responsibility (CSR). A Resettlement and Rehabilitation (R&R) Plan is also included.

Risk Assessment (RA) and Disaster Management Plan (DMP): Preliminary Risk analysis (RA) covering the hazard identification is carried out. Based on this, preventive measures and Disaster Management Plan (DMP) were prepared outlining various measures to combat accidents including oil spills and natural disasters. Also measures to guard against fire hazards have been provided in **Chapter 7**.

1.7.4.7 Project Benefits

The project benefits in terms of improvements in the physical infrastructures and social infrastructure, employment potential and other tangible benefits are presented in **Chapter 8**.

1.7.4.8 Environmental Cost Benefit Analysis

The **chapter 9** covers the environmental cost benefit analysis of the project. Although not recommended by the Expert Appraisal Committee (EAC) at the scoping stage, this has been include as a feed back to the extensive stake holder consultations carried out for the project including the subprojects.

1.7.4.9 Environmental Management Plan (EMP)

An EMP was prepared based on the mitigation measures for the impacts during construction and operational phases and necessary environmental monitoring programme proposed. The institutional mechanism responsible for the implementation of the mitigation measures and greenbelt development is presented in **Chapter 10**.

1.8 Details of the Project Proponent

GoK through its special purpose vehicle (SPV) government company VISL is developing a Deepwater Multipurpose Greenfield Port at Vizhinjam through Public Private Partnership (PPP) mode on a Build Operate Transfer (BOT) basis. VISL has been formed as a nodal agency for implementing the Greenfield port at Vizhinjam in Thiruvananthapuram, capital city of Kerala. The SPV is fully owned by GoK. The contact details of the authorized person at VISL are provided below:

Managing Director & CEO,
Vizhinjam International Seaport Ltd
New No. 84, Old No. 50, 1st Floor, Vipanchika Tower,
Near Government Guest House,
Thycaud, Thiruvananthapuram - 695 014
e-mail: ceo@vizhinjamport.in

1.9 Consultants Engaged

GoK has engaged the International Finance Corporation (IFC), a part of The World Bank Group as the Lead PPP Transaction Advisor. IFC is assisting GoK in structuring and implementing the PPP Project.

IFC has appointed Royal Haskoning Netherlands (RH) and Drewry Shipping Consultants, U.K. as the Technical and Market Consultants. RH and the NABET accredited sub–consultants Asian Consulting Engineers Pvt. Ltd. (ACE), and Eko Pro, New Delhi are responsible for the Environmental and Social Impact Assessment (ESIA) study for the port (accreditation details of these firms are included in **Appendix 1.5**).

VISL has appointed AECOM as the technical consultant for EPC contract and L&T-RAMBØLL Consulting Engineers Limited (LTR) as the EIA consultant for rail and road connectivity and preparation of the integrated EIA report (Port EIA & external infrastructure EIA) for obtaining environmental clearance for the port project (accreditation details for LTR are also included in **Appendix 1.5**). The State Bank of India Capital (SBI Cap) is the financial advisor of VISL. The list of agencies involved along with their role is given in **Table 1-5**.

Table 1-5: List of Agencies Engaged in this Project and their Role

S. No.	Agency	Role/Study
1.	International Finance Corporation (IFC)	Transaction Advisor
2.	Royal Haskoning (RH)	Technical Consultant Hired by IFC
3.	AECOM	Technical Consultant for EPC contract/ Master Planning and DPR
4.	Royal Haskoning/Asian Consulting Engineers Pvt. Ltd. (ACE)	ESIA Consultant for the Port, contracted by IFC
5.	L&T-RAMBØLL Consulting Engineers Ltd. (LTR)	ESIA for Road & Rail Connectivity, other infrastructural facilities, associated studies, consolidating the ESIA report for obtaining the EC from MoEF, GoI
		(1) hydrodynamics study, (2) wave transformation study, (3) wave disturbance study within the fishing harbour, (4) sediment transport study to assess the changes and (5) dredge spoil disposal study to evaluate the impact of dredge spoil dumping
6.	Indian National centre for Ocean information system (INCOIS), GoI	Shoreline Change studies
7.	Centre for Earth Science Studies (CESS), GoK	HTL/LTL demarcation studies as per CRZ Notification 2011
8.	Public Works Department Government of Kerala	Road component – Engineering and construction

S. No.	Agency	Role/Study
9.	Drewry Shipping Pvt. Ltd.	Market Study and Marine Traffic Study
10.	Fugro Geotech Pvt. Ltd.	Geo Technical Study
11.	Allen Overy and Trilegal	Legal Consultant
12.	SBI (State Bank of India) Capital	Financial Advisor
13.	EGS Survey Pvt. Ltd.	Oceanographic surveys
14.	CEPT (Centre for Environmental Planning and Training) University Ahmedabad	Area Development Plan
15.	Deloitte	Economic Viability and EIRR
16.	BMT (British Maritime Technology)	Ship navigational studies
17.	RVNL (Rail Vikas Nigam Limited)	DPR for railway connectivity and Report on the Alternative Railway Alignment for Vizhinjam Railway connectivity
18.	RITES (Rail India Technical and Economic Services)	Feasibility for Vizhinjam Port railway connectivity
19.	IL&FS (Infrastructure Leasing and Financial Services) & LTR	Techno-commercial feasibility report
20.	CMFRI (Central Marine Fisheries Research Institute)	Marine/Fisheries Studies

1.10 Compendium of Studies Carried Out

From 2004 onwards various studies have been conducted to check the feasibility of this project. This report is based on various engineering studies and other carried out by different agencies. The specific details of these studies which were prepared for the development of Vizhinjam port were reviewed and analysed as part of the CEIA are provided in the **Figure 1-6**.

All analysis and studies carried out are based on the above studies for identifying impacts and mitigation measures. In addition several National and State government prestigious institutions such as CMFRI, INCOIS etc were also involved.

1.11 Structure of EIA Report

The report is structured as per Appendix III of EIA Notification, 2006 and also EIA guidance manual for Ports and Harbours, February 2010, released by the MoEF.

- Chapter 1 : Introduction
- Chapter 2 : Project Description
- Chapter 3 : Analysis of Alternatives
- Chapter 4 : Description of Baseline Environment
- Chapter 5 : Anticipated Environmental Impacts and Mitigation Measures
- Chapter 6 : Environmental Monitoring Programme
- Chapter 7 : Additional Studies
- Chapter 8 : Project Benefits
- Chapter 9 : Environmental Cost Benefit Analysis
- Chapter 10 : Environment Management Plan
- Chapter 11 : Summary and Conclusion
- Chapter 12 : Disclosure of Consultants Engaged

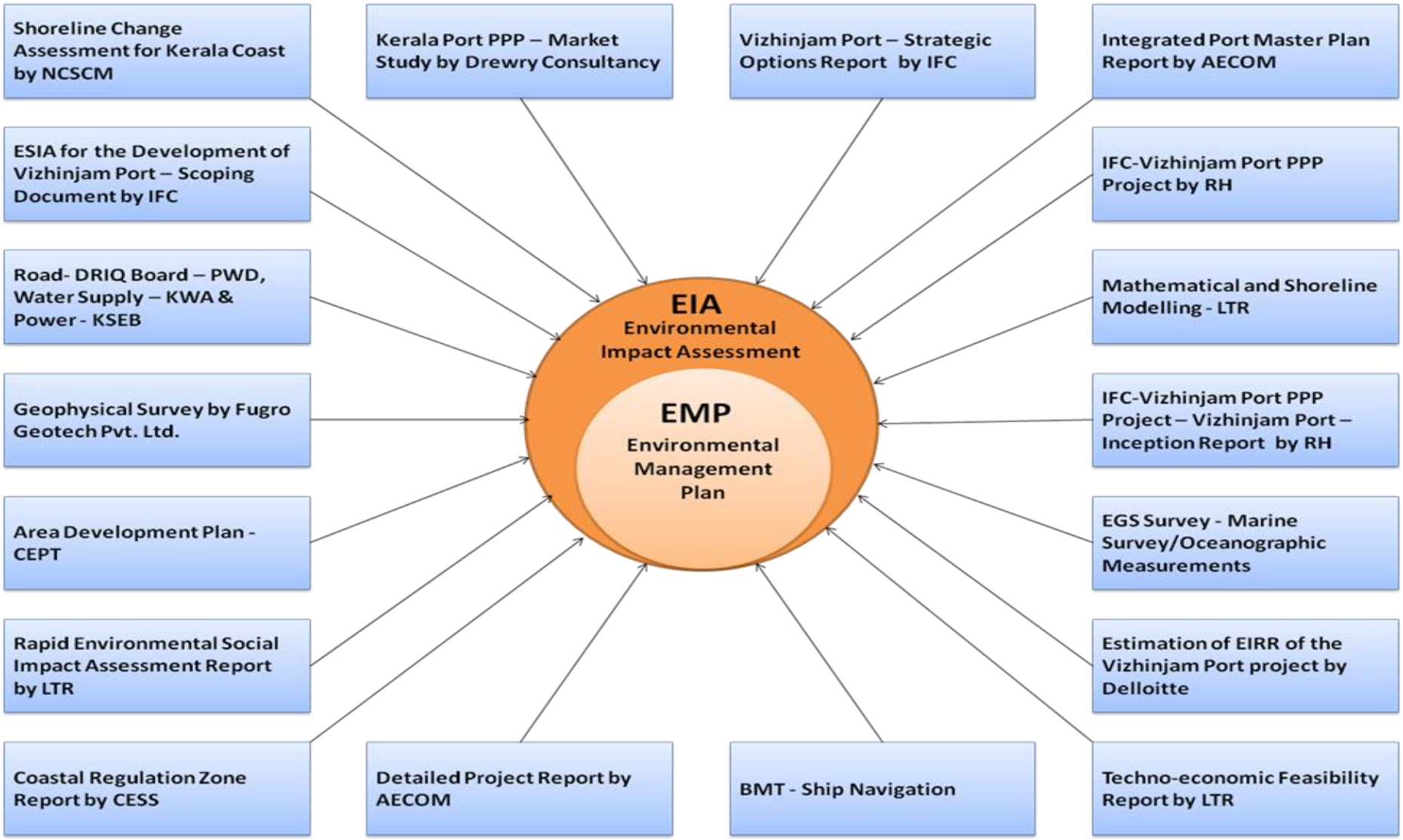


Figure 1-6: Compendium of Reports

Chapter 2
Project Description

Chapter 2 Project Description

2.1 General

The proposed Vizhinjam port will be developed in three phases (Phase-I, Phase-II and Phase-III). This comprehensive EIA is prepared for obtaining the Environmental Clearance (EC) and CRZ clearance for phase-I only, as the other phases are to be developed after 10 and 20 years from the commencement of construction of the first phase based on the project phasing provided in the DPR (AECOM; May, 2013), and Port master plan (AECOM; May, 2013). Accordingly in this chapter, the phase-I development plan for the proposed Vizhinjam port is presented; summarising the details of location, land availability, expected traffic, field surveys to ensure the suitability of port development, etc. This chapter also provides the details of phase-I development such as port, utilities and services, road and rail connectivity, ancillary site facilities, estimated cost for the development of project, environmental protection works, project implementation schedule and overall suitability of the site and the proposed activity with respect to existing environmental regulations, including CRZ notifications.

The fishing community being the most important stakeholders of the project, an additional fishing harbour is also included in phase-I. This could double the capacity of the existing fishing harbour berthing facility and will be developed towards fulfilling the Corporate Social Responsibility (CSR). The design for this is additional fishing harbour is also part of phase-I development. Cruise terminal is also planned for overall benefit of the tourism industry in the locality, State and the Country.

2.2 Project Location

The proposed port at Vizhinjam (Lat 8° 22’ 20”N, Long 77° 0’ E) is located in the State of Kerala, 16 km south of the State capital city, Thiruvananthapuram, and is also about 10 nautical miles (18 km) from the international East-West shipping route. The location map of the port is as shown in **FD0101**.

2.2.1 Port Development

All the port facilities are proposed to be developed entirely on reclaimed land whereas all the infrastructure facilities like back up areas, warehouse, truck terminal areas, administrative buildings, etc. are planned to be developed on the landward side in area of 140.42 Ha, part of which i.e. around 48.2 Ha is owned by VISL. The port facilities which are planned to develop on reclaimed land comprises an area of approximately 66.00 Ha. The proposed land use plan details of Vizhinjam port is given in **Table 2-1**. Breakup of the total land required for phase-I is given in **Table 2-2**.

Table 2-1: Proposed Land Use of Vizhinjam Port

S. No.	Land Use Plan	S. No.	Land Use Plan
1.	Administrative Building	2.	Railway Station Master Building
3.	Entry/Exit Gate Canopy	4.	Future Expansion Area
5.	Security Gate Guard Booth	6.	Provisional Coast Guard Area
7.	Customs building	8.	Fire Station
9.	Gate Staff Building	10.	Bund
11.	Container Storage Area	12.	Indian Navy Loading Berth With Ramp of 200 m
13.	Port Parking Area		

Table 2-2: Breakup of Land Required for Phase-I

Port Infrastructure	Area (Ha)	Reclaimed Area/Available Land
Berth and Container Storage	36.00	Reclaimed
Rail Terminal and others within Port Boundary	30.00	Reclaimed
Ancillary Sites and Road/Rail Connectivity (Spilt up given in **Table 2-33**)	140.42	Available Landward side Area
Total	**206.42**	

2.2.2 Road/Rail Corridor Development

A dedicated rail/road corridor is planned for Vizhinjam port to cater the port traffic. The connectivity aspects of the rail/road corridor development are given in **Table 2-3**. Details of road and rail corridor with respect to inventory, alignments, features along the alignment, etc., are described in Section 2.22.

Table 2-3: Connectivity Aspects of Vizhinjam Port

S. No.	New Connectivity Details	Length (km)	Width (m)	Area (Ha)	Other Details
1.	Road up to NH 47 bypass, start at port and end at NH bypass	1.964	45	9.96	Joins at with NH bypass
2.	Rail connectivity to Nemom Railway station ending at port	14.725	31	45.68	10 km new alignment & 4.725 km parallel to the existing alignment
			Total Area	**55.64**	

2.2.3 Ancillary Sites

As a part of Vizhinjam port development, several infrastructure facilities have to be developed in addition to road and rail connectivity. Most of these infrastructure facilities are to be developed close to the port. Therefore adequate backup area and other land resources have been acquired in the vicinity of proposed port. These are together termed as ancillary sites which will be a part of the overall port infrastructure. These ancillary sites and facilities are for developing (1) warehouse area (2) Port Annex Facility (PAF) zone which includes (a) truck terminal, a 220/66 KV sub-station & (b) port operator's colony and (c) port backup areas for administrative and other utility requirements for phase-I/II/III for the operators & VISL, backup area for navy & coast guard with dedicated road, cruise service area with dedicated road, 66/11KV substation, water harvesting area, greenbelt, etc.

Table 2-4: Land Required for Ancillary Sites

Ancillary Site	Hectares (Ha)
Backup Areas	23.36
Truck Terminal (PAF zone)/220/66 KV Substation/Port Operators colony	19.88
Warehouse/VISL Colony/Navy/Coast Guard	41.53
Total	**84.77**

2.3 Traffic Projections for Vizhinjam Port

A traffic forecast study was carried out by Drewry Shipping Consultant Ltd. to assess the expected traffic for various commodities and a strategy for capturing potential container and bulk traffic over the

forecast period at proposed Vizhinjam port. The phase-I cargo traffic forecast expected to be handled at Vizhinjam port is given in **Table 2-5**.

Table 2-5: Expected Traffic during Phase-I of Vizhinjam Port Development

Terminal	Commodity	Unit	Phase-I
			FY14-17
Container Terminal	Gateway Container Traffic	TEU	138,459
	Transhipment Container Traffic	TEU	683,798
	Total	**TEU**	**822,256**
	Vessel calls - main liners	**No.**	**156**
	Vessel calls - feeders	**No.**	**260**
Multi-purpose Terminal	Timber	T	44,000
	Raw cashew (break-bulk)	T	63,000
	Total	**T**	**107,000**
	Vessel calls	**No.**	**NA**
Cruise Terminal	**Vessel calls**	**No.**	**30**

(Source: IFC/Drewry-Market Study, November 2010)

2.3.1 Traffic along Two International Shipping Routes

This traffic analysis includes the major cargo vessels plying the International Suez-Far East Trade Route and the Middle East-Far East Route as shown in **Table 2-6**. On an average, 90 ships per day are moving everyday in these routes. The contribution of phase wise Vizhinjam traffic to the international shipping route is provided in the same table. In addition, there will be many other vessel movements such navy, tugs, barges, etc. which have not been estimated.

Table 2-6: No. of Vessel Movements along the Two International Shipping Routes

Route: International Suez-Far East Trade Route	Phase-I	Phase-II (2024)	Phase-III (2034)
Estimated Container Vessel movements per Day	21	23	31
Other vessels	43	47	63
Total Vessels on the Route	64	70	94
Addition in movements because of Vizhinjam Port per Day	1.9	2.8	4.1
Percent Increase	**3%**	**4%**	**4%**
Route: Middle East – Far East Route			
Estimated Container Vessel movements per Day	10	11	16
Other vessels	19	21	32
Total Vessels on the Route	29	32	48
Addition in movements from of Vizhinjam Port per Day	0.8	1.2	1.8
Percent Increase	**3%**	**4%**	**4%**

(Source: http://www.worldshipping.org/)

2.4 Field Surveys and Investigations

Field surveys and investigations were carried out to collect seabed surveys, oceanographic measurements and marine geotechnical investigations of project site. Detailed investigations that included seabed surveys (viz. bathymetry, shallow seismic profiling), Oceanographic measurements

(wave measurements, current meter observations) and seabed sediment/marine borehole sampling were carried for the planning and design of the proposed facilities at Vizhinjam port. Geotechnical investigations and surveys were carried out by Fugro Geotech Private Limited; Mumbai and Oceanographic surveys were carried out by EGS Survey Pvt. Ltd.

2.4.1 Bathymetry

The bathymetric survey covered an area extending up to 21 m contour into the sea which is at a distance of approximately 1.5 km from the shoreline and 5.0 km along the shore. Water depths within the survey area were ranging between a minimum of 0.0 m (at the northern extreme of the survey area, near to shore line) and a maximum of 22.5 m (at the southern extreme of the survey area). The recorded depths within the survey area were reduced to chart datum using predicted tides.

In general, the seabed within the survey area was gently sloping down towards south west. The seabed between the shoreline and 10 m depth contour in the project site has a slope of 1:36 (1.59°) is comparatively steeper than the seabed between 10 m and 15 m depth contours and these contours run parallel to the shoreline. Consequently the reverse trend is conspicuous in the deeper water i.e., along the seabed between 10 m and 15 m depth contours which has slope of 1:110 (0.5°) which continues with the similar trend in the region beyond 15 m depth in the study region. The surveyed bathymetry is shown in **Figure 2-1**.

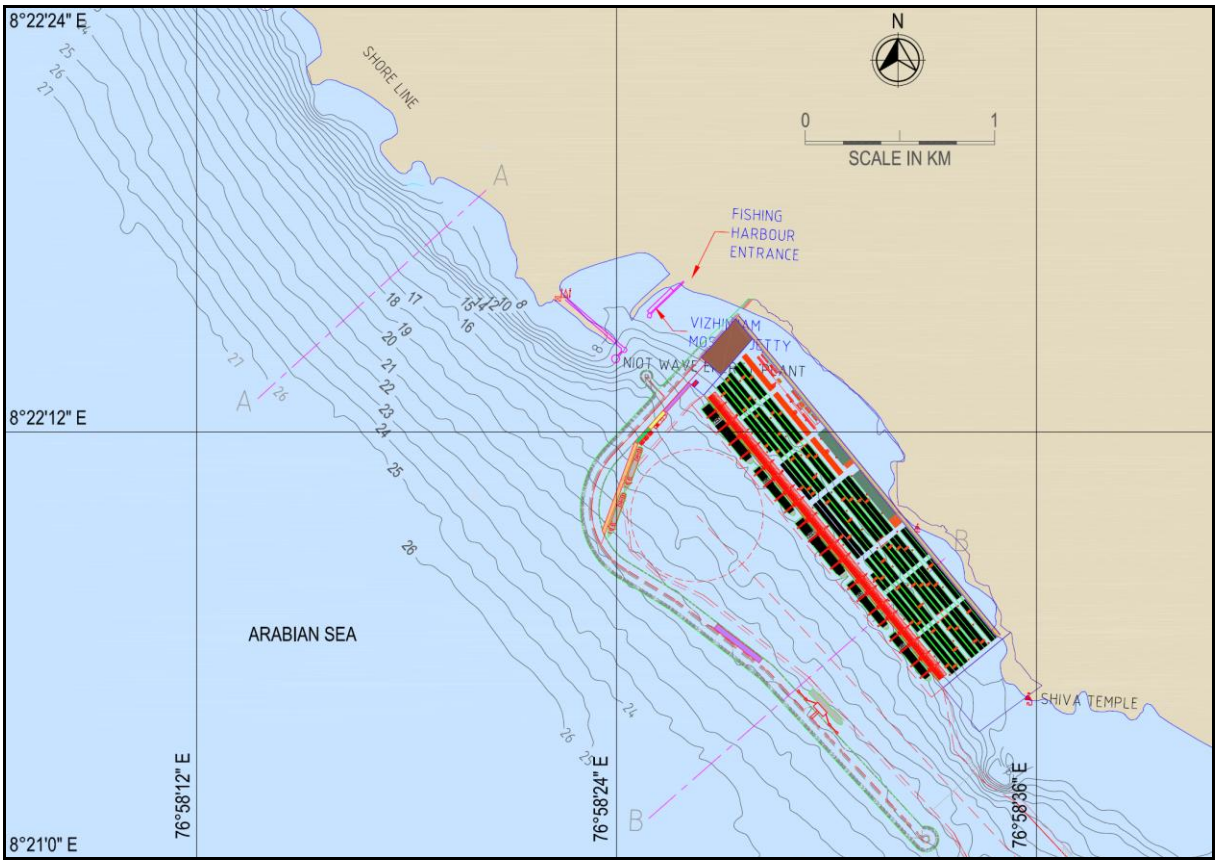


Figure 2-1: Bathymetry of the Proposed Vizhinjam Port Location

2.4.2 Side Scan Sonar Survey

Odom Echotrac MK II dual frequency single beam echo sounder, with transducer operating at 33 kHz and 210 kHz frequencies was used for measuring water depths. R2 Sonic 2024 multi beam echo sounder system was used for acquiring swath bathymetric data within the survey area to study the extent and bed profile of rock outcrop within the survey area. Prior to commencing survey works the echo sounder was calibrated against a 'Bar Check'

This survey reveals the sea bed features and any obstruction to the navigational operations. Geo-Acoustics Side Scan Sonar System SS941 Trans receiver159 DF with Tow fish 100/410 kHz transducers, soft and FUGRO's proprietary GLog/GPlot geophysical digital data acquisition system were used for acquisition of side scan sonar data within the area. Seabed sediments within the survey area was classified into following types based on the acoustic reflectivity observed on the side scan sonar records.

- Type 1: Low to medium reflective seabed interpreted as Clayey/Silty Fine SAND
- Type 2: Medium reflective seabed interpreted as fine to medium SAND
- Type 3: High reflective seabed interpreted as Rock Outcrops

In general, Type 1 and Type 2 sediments were predominant within the survey area and were randomly distributed over the survey area. Rocky outcrops (Type 3) were predominant in areas close to the shoreline. Distribution of various seabed types within the survey area is depicted. Total Five (5) sonar contacts were recorded within the survey area. All the sonar contacts were found without any measurable height and were classified as hard contacts. No significant seabed features were identified within the survey area other than the breakwater recorded in areas close to the Vizhinjam harbour mouth. No existing pipelines/cables were identified on the survey records within the survey area.

2.4.2.1 Shallow Seismic Survey

This survey is essential in order to assess the compactness of the seabed which could affect the dredging and/or navigation. Geo-Acoustics 5430A sub-bottom profiler (pinger) system was deployed to obtain the sub-seabed shallow geological information within the survey area. Boomer system was deployed for collecting the sub-seabed shallow geological information within the survey area. An Applied Acoustic Engineering CSP-1500 with Boomer Plate was used as the seismic energy source and the returning seismic signal was received by a Geo-pulse eight element hydrophone array. The penetration of acoustic waves primarily depends on the type of instruments, the frequency used and the geology of the surveyed area.

The compactness of the sediment derived from the seismic records, is presented in the form of isopach map. Isopachs are contours connecting points of equal thickness. Isopachs are true stratigraphic thicknesses; i.e. perpendicular to bedding surfaces. For example, the isopach contour of 9.0 m implies that the sediment column is present for at least 9.0 m thickness without presence of any hard strata in between.

The investigation area covered an extent of approximately 5.0 km of waterfront parallel to the shore extending up to 21 m contour (bathymetric) into the sea. The area was distinguished in view of the necessary developments for the proposed port. All sedimentary units defined in the map are based on an assessment of the recorded acoustic characteristics of the seabed and sub-seabed nature of sediments.

The sub-seabed acoustic signal penetration achieved was variable within the survey area and the maximum penetration achieved was approximately 40 m below seabed. Scattering of the acoustic signals due to the thick layers of sand and high acoustic impedance offered by the weathered rock layers were the limitations in achieving better acoustic signal penetration within the survey area. The nature of the seabed sediments within the survey area was classified primarily based on the reflectivity pattern of the seabed. Appropriate references from single beam & multi-beam echo sounder data, sub-bottom profiler data and soil samples taken by Grab Sampler were taken as and when required. From the sub-bottom profiler records, the stratigraphic sequence within the surveyed area can be broadly classified into two major sedimentary units – topmost Sandy unit underlain by weathered rock unit. However, the topmost Sandy unit was further classified into different sub-units based on the acoustic reflectors identified from the sub-bottom profiler records due to the variation in density / compaction of the sediments with depth.

Loose to medium dense Silty Sand unit was the topmost geological unit throughout the survey area except in areas wherever rock out crops was recorded. The thickness of this unit was varying between <1.0 m and 9.0 m within the survey area. Sedimentary unit underlying the topmost unit was interpreted as medium dense Sand. The intermittent parallel/sub-parallel internal reflectors within this unit can be attributed to presence of thin layers of silt/clay within this unit. This unit was present throughout the survey area except at the rock outcropping areas. The very dense firm sand unit was found underlying the medium dense Sand unit and was identified mainly in the seaward side of the survey area. The weathered rock layer unit was overlain by the Sand unit throughout the survey area except at the outcropping locations. The outcropping areas were mainly close to the shore line. The top of the weathered rock was identified from the records due to the high seismic impedance offered by this unit to the seismic energies and little acoustic signal penetration beyond this unit.

2.4.2.2 Magnetic Anomalies

In geophysics, a magnetic anomaly is a local variation in the Earth's magnetic field resulting from variations in the chemistry or magnetism of the rocks. Mapping of variation over an area is valuable in detecting structures obscured by overlying material. Marine Magnetics SeaSPY Marine Magnetometer was deployed for the magnetometer survey for identifying the magnetic anomalies within the survey limits. The system is an Overhauser magnetometer system which measures the ambient magnetic field using ‘Nuclear Magnetic Resonance Technology’.

A value greater than 5 nano Tesla (nT) against the background magnetic intensity was used as the criteria to detect possible anomalous magnetic objects. The value of the magnetic anomalies depends on several factors such as distance from the source causing the anomaly, direction of magnetisation of the source with respect to the earth’s field, ferrous content of the object, ambient magnetic noise etc. No conclusions could be drawn from the value of the magnetic anomaly alone regarding the nature or type of the source causing the anomaly. The positional accuracy of the interpreted magnetic anomalies depends on a combination of the vessel positioning, layback calculations for the tow fish relative to the vessel.

Total of thirty five (35) spots of magnetic anomalies, were identified by FUGRO within the survey area. As per the conclusion made by FUGRO, three anomalies were possibly associated with the electricity generator installed close to the wharf/breakwater and eight were attributed to rock outcrops. The rest could not be correlated to any specific source.

2.4.3 Geotechnical Investigation

As part of the site selection and techno-feasibility during early stage of the study in May 2004, L&T-RAMBØLL (LTR) conducted borehole investigations in the area of Vizhinjam port development. The following is the summary of sub soil strata based on these borehole investigations:

- Top soil is a layer of relatively loose to dense sand with shell fragments with varying thickness in the offshore region, followed with the layer of weathered rock or hard Khondolite.
- A layer of clay sandwiched between dense sand and rock was found in certain patch of the area of approximate thickness of 1.2 m.
- Rock was usually found beyond the depth of 12 m below existing bed level in deepwater. Boreholes were terminated once rock was found or 24 m below seabed level.

Geotechnical investigations were also carried out by Fugro Geotech Private Limited during November 2003 and subsequently during February to March 2011.

Three land boreholes and three marine (total six boreholes) were explored during November 2003 along the coastline of the project area. From the land borehole profiles, it was found that the soil strata at land borehole (LBH-1) is of medium to dense sand up to a depth of 1.36 m followed by the granite rock, whereas in case of the LBH- 2, it was found to be medium to dense sand to a depth of 4.05 m followed by granite rock. The soil profile at LBH-3 consists of medium to dense sand to a depth of 7.80 m followed by weathered rock. In case of marine borehole profiles, the soil encountered is predominantly sandy in nature. Sand or silty sand is observed in all boreholes down to the weathered rock/hard rock level. Sand content is found to be more than 80% and the remaining 20% consists of silt and clay content. Hard rock is encountered in all boreholes at varying depths. The subsurface stratification in offshore region generally consists of dense sand with varying thickness, followed by hard rock. Borehole data collected during February to March 2011, by Fugro inside the proposed harbour and the approach channel is to identify the existing soil strata. It was observed that the top layer mostly consists of dense sand.

2.4.4 Oceanographic Investigations

M/s. EGS carried out the oceanographic measurements and investigations in Feb 2013. The site specific oceanographic conditions such as Tide, wave, Current, Bathymetry etc, and meteorological conditions such as Climate, Temperature, Relative Humidity, Rain fall, Wind, Visibility, Cyclone, etc. are discussed in detail in Chapter 4.

2.4.5 Ship Simulation Studies

Real time ship navigation simulation studies were done by BMT CI (Mumbai) in December 2012. The results and conclusions of the trial simulation runs have been summarized in this section. The objectives of the study were:

- To test the outer approach channel alignment for environmental conditions
- To test the ports navigability based on channel width, depth and alignment
- Carrying out berthing and turning circle manoeuvres and suggesting any layout changes, if required

2.4.5.1 Methodology for Ship Simulation Study

BMT utilized Vizhinjam Port's phase wise layout (from Integrated Master Plan Report, November, 2012 by AECOM). Based on the phase wise master plan layout BMT prepared the electronic navigation chart and modelled the port facilities like approach channel, breakwaters, berths, etc.

As per the Master plan report suggested design vessels and using BMT's in house library of ship hull forms, ship models were finalized for the simulation runs. Met ocean conditions (Wind, Wave, Currents) were obtained from LTR. Apart from the met ocean data given to BMT by LTR, BMT also referred data available in public domains such as West Coast India Pilot (WCIP) and NHO charts and compared it with the data provided by LTR. A run matrix was created with varying wave, wind and current parameters to carry out the navigation simulations.

2.4.5.2 Conceptual Design of Navigation Facilities

The analysis of the navigational facilities was done in two stages, conceptual design (theoretical assessment of navigation facilities based on international guidelines like PIANC) and final detailed design (based on navigation simulation trial runs)

The remarks made by BMT based on conceptual design of the outer channel are as follows:

- **Channel Width:** The channel width initially proposed (300 m) for 12,500 TEU vessels were found to be sufficient for one way traffic.
- **Bend Radius and Width:** A bend is present at the entrance of the channel. As the channel entrance location has a deep natural water depth of 21 m, there will not be any restriction on the final approach of the ship towards the channel. As per BMT's conclusion, ships can safely navigate to align with channel at the final approach towards the port.
- **Turning Circle and Basin:** As per BMT analysis, the turning circle of 700 m diameter was found to be adequate. Conditions inside the harbour were found calm and tugs can be used so a 390 m vessel could be swung in the available turning circle.
- **Stopping Distance:** At Vizhinjam the stopping distance for phase-I is around 1200 m. The adequacy of stopping distance for various vessels has been checked with the simulation runs as the stopping distance varies considerably depending on the type of ship, the type and number of tugs used and the ship speed at entrance breakwater.
- **Channel Depths:** The depths were found to be suitable provided that channel wave heights are limited to 2.5 m and ship transit speed in the channel was 8 knots on an average.

2.4.5.3 Trial Simulations

For the preliminary analysis, initial runs were carried out to check the alignment of the channel. The trial runs (seven) were carried out from the entrance of the channel till the harbour entrance. Ship manoeuvring of design vessels at the approach of the channel and its transit through the channel was simulated in these trials. The following conclusions were provided from these trial runs.

- **Channel Alignment:** From the trial simulations the channel alignment was found to be ok. The effect of wind and current was found to be more than the effect of beam waves.
- **Stopping Distance:** Stopping distance available for the phase-I layout (about 1200 m) was found to be adequate in the trial runs. However a tug had to be made attached at the stern of the vessel.
- **Channel Width:** The channel width of 300 m was found just sufficient but not generous for the 390 m vessel transit. In view of sufficient depth available on the sea side of the channel it was

recommended that channel width should be increased to 400 m. The channel width can then gradually taper down to 300 m till the breakwater entrance.

- **Channel Bend Width:** The channel width at the bend was found to be inadequate for turning the vessel. It was advised that either the bend be made more gradual with its width increased to 400 m or the vessel be aligned with the outer channel before entering the channel itself.
- **Turning Circle:** Turning circle diameter (700 m) was found adequate for the biggest design vessel (390 m long container vessel). Minor recommendations were provided for the basin boundary around the turning circle to provide more manoeuvring space within the breakwater alignment.
- **Depths:** Depths in channel, basin and turning circle were found adequate.
- **Requirement of Tugs:** Based on theoretical calculations of bollard pull required (considering forces due to wind, wave, current and gust factor), power utilization of tug (80% of maximum rated power) BMT used the following tug suite for trial simulations:
  - 390 m Container: 3 × 70T tugs and 1 × 40T tug
  - 300 m Container vessel: 3 × 70T tugs
  - 268 m cruise: 3 × 70T tugs
  - 244 m tanker: 1 × 70T and 1 × 40T tug
- The tug suite was found adequate for tanker and cruise liner. However berthing of 300 m and 390 m vessel using the above tug suite against a NE wind of 25 knots was found difficult but doable. Vizhinjam port may seldom experience winds of 25 knots. Additional runs will be carried out with a wind speed of 20 knots.

2.4.5.4 Feasibility Simulations

In order to ascertain the initial feasibility of the layout, additional runs were performed and graded by BMT as per the parameters shown in **Table 2-7**.

Table 2-7: Run Matrix Grading based on Parameters



Run	Vessel type	Wind (speed x direction)	Current	Waves (ht. x dir.)	Tugs (no. x bollard pull)	Remark
8	300m Container	25 knots x 260 N	SE current	2.5 m x 225	3 x 70t	Phase1 layout; **Not Demanding**
9	390m Container	25 knots x 300 N	SE current	2.5 m x 225	3 x 70t +1 x 40t	Phase1 layout; **Challenging**
10	390m Container (with extended basin)	25 knots x 300 N	SE current	2.5 m x 225	3 x 70t + 1 x 40t	Phase1 layout; **Not Easy**
11	390m Container	25 knots x 045 N	NW current	2.5 m x 180	3 x 70t + 1 x 40t	Final Phase; **Not Easy**
12	268m Cruise	25 knots x 300 N	SE current	2.5 m x 225	3 x 70t	Final Phase; **Not Demanding**
13	268m Cruise	25 knots x 045 N	NW current	2.5 m x 180	3 x 70t	Final Phase; **Not Demanding**
14	244m tanker	25 knots x 045 N	NW current	2.5 m x 180	1 x 70t + 1 x 40t	Final Phase; **Comfortable**
15	244m tanker	25 knots x 300 N	SE current	2.5 m x 225	1 x 70t + 1 x 40t	Final Phase; **Comfortable**

(Source: Ship Simulation Study for Vizhinjam Port, BMT)

Based on the simulation runs the operational limits can be summarized in Table 2-8.

Table 2-8: Manoeuvring Operational Limits

S. No	Parameter	Description
1	Wind	Up to 25 knots (For maneuvers in excess of 20 knots a proper risk assessment needs to be carried out)
2	Current	Movements is peak flood and ebb can be carried out (based on data provided by VISL)
3	Waves	2.5 m
4	Visibility	Up to 3 nm

[Source: Ship Simulation Study for Vizhinjam Port, BMT]

2.4.5.5 Conclusions

It was concluded that ship navigation runs validate the safety aspects of the NW-SE channel alignment direction. The navigational parameters such as channel width, depths, turning circle diameter were found to be adequate and minor recommendations were provided in the navigational parameters by BMT.

2.5 Mathematical Model Studies

As per MoEF suggestion, model studies were carried out for the existing fishing harbour and for the proposed port development along with the proposed fishing harbour. These model studies include the following:

- Hydrodynamics study
- Wave tranquillity, transformation and wave disturbance study
- Sediment transport study
- Dredge spoil disposal study
- Shoreline changes study

2.5.1 Mathematical Model Studies for Fishing Harbour and Proposed Port

LTR has carried out Mathematical model studies like (1) hydrodynamics study, (2) wave transformation study, (3) wave disturbance study within the fishing harbour, (4) sediment transport study to assess the changes and (5) dredge spoil disposal study to evaluate the impact of dredge spoil dumping. The summary of the findings are described in the following sections.

2.5.2 Near Shore Wave Climate

The characteristics of waves often changes when the waves propagate from offshore to near shore shallow water regions. The knowledge about the wave characteristics in the near shore region is necessary for various coastal engineering studies. In the present study the near shore wave climate was estimated by transforming offshore waves to near shore using SWAN model.

Near Shore Wave Model

SWAN (4) is a third-generation wave model for obtaining realistic estimates of wave parameters. The simulations were carried out for a total of 382 annual wave events from BMO data. The results from the near shore wave transformation indicate the change in wave direction is due to refraction. The waves acting from SE direction in offshore region is observed to undergo refraction and reach the near shore from S direction. Similarly, the wave-fronts acting from different directions undergo refraction and tend to become parallel to the contours as it reaches the shallow water. The significant wave

height is less than 1.5 m on an average for more than 80% of the waves in a year. Waves are generally higher during the SW monsoon months that is from May to September. It is observed that the waves approach predominantly from two sectors, S to SSW and W to WSW. It can also be observed that the waves approach the near shore mainly from S to W during months of May to October that is during the SW monsoon season and from S and SSW during NE monsoon and non monsoon periods for the rest of the period of the year. In general, when the waves approach the near shore, they suffer reduction in the wave heights due to bottom dissipation and other processes. The estimated wave heights show a maximum reduction of 57% compared to the incident wave height.

The results from the near shore wave analysis will serve as the inputs for studying the wave tranquillity inside a harbour which will help in calculating the number of operable days and the sedimentation as well.

2.5.3 Wave Disturbance Study within the Existing Fishing Harbour

Waves travel from offshore to shallower coastal waters; they are modified by the process of depth-induced refraction and shoaling. As the waves propagate further into the harbour, diffraction around the breakwaters and reflection from various harbour structures and other adjacent structures become important and affect the tranquillity within the harbour. The shallow water process of seabed friction, bed diffraction and wave breaking will also modify the wave conditions.

The comparative study of the wave tranquillity inside and at the approach to the Vizhinjam fishing harbour with and without the proposed port has been done using an ARTEMIS model (5), which is part of the TELEMAC finite element hydraulic modelling systems.

2.5.4 Wave Tranquillity Modelling within the Existing Fishing Harbour

Wave tranquillity is a measure of disturbance free condition from wave. Wave disturbance pattern inside the harbour were simulated for monochromatic waves approaching from different directions for a series of wave periods ranging from 4 to 20 seconds. Input wave heights were given as 1.0 m. The simulations were done by giving various reflective index values at the boundaries considering the reflections from the natural and man-made structures. By using the spectrum and wave height coefficients from the ARTEMIS results, wave height distribution inside the harbour was estimated.

Based on the analysis, it is observed that the proposed port located 300 m south of the existing fishing harbour, does not imply significant changes to the fishing harbour. In addition, it gives additional tranquillity inside the fishing harbour. It is also observed that the proposed port gives an additional protection to the fishing harbour mainly from the waves propagating from the directions SSW to S which constitutes more than 55% of the waves throughout the year. Only during the SW monsoon, the waves propagate from W and WSW which is about 30% towards the fishing harbour.

2.5.5 Dredge Spoil Disposal Study

The dredge spoil disposal study was carried out to assess the impact of dredge spoil dumping and to identify suitable location. Particle Analysis (PA) module of MIKE was used to assess the fate of dredged spoil after disposal. The sediment plume was found to be confined to the deepwater. From the simulated results it is observed that there is no impact to the fishing harbour due to dumping operation. The details of dredge disposal study are discussed in **Chapter 5**.

2.5.6 Sediment Transport Study

Sediment transport is a complex coastal process that results from the combination of interaction within the waves, current and wind. The sediment particle are transported by currents (tide driven, wave driven or wind driven), wave motions and combinations of the two. To predict the sediment transport patterns in the vicinity of coastal projects and to assess its impacts like the amount of annual maintenance dredging or the behaviour shoreline etc., numerical modelling tools have been used in this study. SISYPHE (9) is the sediment transport module for the TELEMAC system. The details of Sediment Transport Study are summarised in **Chapter 5**.

2.5.7 Shoreline Changes Study

Shoreline is defined as the physical line of contact between the land and the water body. In some context, this may also be referred as mean high water line or coastline. The aim of this study is to assess the shoreline evolution due to the proposed port development. GENESIS shoreline evolution model was setup to study the existing scenario and to study the long-term change due to the proposed port development. A shoreline stretch of 25 km evenly distributed near the vicinity of the proposed port has been studied. A grid resolution of 30 m × 30 m was used for the simulation of shoreline evolution using GENESIS model. The simulated results in existing condition without the port were compared/co-related with the analysed data from Google Earth imagery, and are found to have similar trend.

Based on the analysis of the results of existing condition, it was observed that shoreline evolution with the proposed port indicates the average rate of accretion adjacent to the south-eastern structure (revetment) is 21.6 m/year in the first year of the phase I construction which gradually reduces to 0.5 m/year by end of tenth year. This indicates the stabilising trend of shoreline over the years. No significant change in the shoreline pattern is observed towards NW side of fishing harbour. The detail study of shoreline changes is discussed in **Chapter 5**.

2.6 Phase-I Development of Vizhinjam Port

The various aspects considered during the planning of the port layout are:

- Depth of water and type of seabed at the proposed site
- Wave incidence and tranquillity condition within the fishing harbour and port area
- Wind and current condition in the vicinity and in the fishing harbour and port area
- Littoral drift and sediment transport at the project site.
- Traffic volume
- Hinterland connectivity
- Port operational requirements
- Stages of port development

Detailed analysis of alternative layouts has been discussed in **Chapter 3**. The port facility requirements are outlined in the following paragraphs.

2.7 Port Layout (Phase-I)

The salient features of port layout are given in:

- Breakwater of total length 3,180 (original breakwater 3,040 m with 140 m extension for fish landing harbour) to be developed in phase-I.

- Container berth length of 800 m.
- Container yard commensurate with the quay development
- Port craft berth of 100 m and coast guard berth of 120 m length.
- Fish landing centre with a total berth length of 500 m.
- Cruise cum multipurpose cargo berth of 300 m.
- Berthing and storage/operation facilities for Indian Navy with berth length 500 m.

The port is designed to primarily cater to the container transhipment business with provision for a cruise terminal and general/multipurpose cargo area. A drawing showing the layout of the port facilities for the phase-I are given as **Figure FD0201** and the port master plan layout is given in **Figure FD0202**.

2.8 Cargo Handling Capacity

The cargo planned to be handled at Vizhinjam port during phase-I is given in **Table 2-9**.

Table 2-9: Cargo Handling Capacity

Type of Cargo		Units	Phase-I
Container terminal	Gateway container	TEUs*	138,459
	Transhipment container		683,798
General Cargo	Timber	Tonnes	44,000
	Raw Cashew (break-bulk)		63,000
Cruise terminal	-	Passenger	1200

***TEUs: Twenty Foot Equivalent Units**

2.9 Design Vessels

The size of ships calling at the port will also have a bearing on the facilities available at the ports of origin/destination. Detailed vessel size analysis was carried out to estimate the vessel sizes, which is an important factor in planning of port.

The size of ships that would call at Vizhinjam port will be governed by the following aspects:

- Trading route and distance between Vizhinjam port and origin/destination ports.
- Facilities available at the loading/unloading port including the draft.
- Availability of a suitable ship in the market.
- Future availability of vessel on the market including 'trickle down' effects from mainline routes to secondary routes.
- Volume of annual traffic to be handled and the likely parcel size.
- Balance between capital costs for Vizhinjam port development and freight transport costs.

The design vessel sizes considered for planning of port facilities are given in the **Table 2-10**.

Table 2-10: Design Vessel Sizes and Dimensions

S. No	Commodity	Average Parcel Size		Design Ship Size			Overall Length (m)	Beam (m)	Loaded Draft (m)
		TEU	DWT	TEU		DWT			
1.	Transhipment Containers	2,500	23,000	Min	9,000	82,500	350	46.0	14.5
				Max	18,000	165,000	400	59.0	16.0
2.	Import/Export	1,200	11,000	Min	1,000	9,200	175	27.0	10.0

S. No	Commodity	Average Parcel Size		Design Ship Size			Overall Length (m)	Beam (m)	Loaded Draft (m)
		TEU	DWT	TEU		DWT			
	Containers			Max	6,000	55,000	300	43.0	13.5
3.	Multipurpose Cargo vessels	-	30,000	Min	-	25,000	178	26.4	10.7
				Max	-	40,000	190	28.0	11.3
4.	Cruise	-	55,000	Min	-	40,000	212	32	8.0
				Max	-	70,000	268	32	8.0

2.10 Cargo Berths

2.10.1 Container Handling

2.10.1.1 Berth Capacity

With two berths of total quay length of 800 m in phase-I of Vizhinjam port can handle approximately 900,000 TEU over the berths in a year. It is estimated that if bigger vessels are calling at the port (such as 18,000 TEU vessels) with higher parcel size per vessel call, additional throughput can be handled from the proposed port. This additional throughput will depend on the actual mix of different vessels calling at the port.

2.10.1.2 Berth Length

The berth length needs to be sufficient to accommodate the length of the vessel plus an allowance at either end for mooring and clearances between vessels. The amount of clearance required at either end of the vessel depends upon the vessel size. Minimum single berth length for the design vessels are shown in **Table 2-11**.

Table 2-11: Minimum Berth Lengths

S. No	Berth Type	Design Ship Size	Phase-I (m)
1.	Container Berths	12,500 TEU	360 – 400
2.	Cruise/Multipurpose Berth	70,000 DWT	300

2.10.1.2.1 Berth Length for Support Facilities

The **Table 2-12** below provides the summary of the support facilities required for phase-I development of Vizhinjam port.

Table 2-12: Summary of Berth Length for Support Facilities

S. No	Type	Berth Length (m)
1.	Cruise cum Multipurpose Cargo Berth	300
2.	Port Craft Berth	100
3.	Coast Guard Berth	120
4.	Navy Berth	500

2.10.1.3 Cruise cum Multipurpose Cargo Berth

The cruise demand based on Drewry report is estimated that the size of the cruise vessel will be 1200 passengers with 30 number of calls per annum in Phase-I The long term demand for general/break bulk cargo was provided by Drewry to be in the range of 0.1 MTPA in the phase-I. The forecast of these cargoes is not significant that would require a dedicated berth and equipments in Phase-I. These commodities can be handled at the proposed cruise berth using the ship's gears until more dedicated need for bulk cargo is identified. It is proposed to provide one berth of 300 m to carry out the cruise and multipurpose cargo handling operations.

2.10.1.4 Coast Guard Berth

The coast guard requested a dedicated berthing space at Vizhinjam port to enable operation of its ships. Presently, the coast guard has minimum provision to berth ships calling at Vizhinjam. The coast guard is planning to have a station at Vizhinjam port for effective coastal security and monitoring of Sea Lanes of Communication which is located at 10 nautical miles off the SW coast of Thiruvananthapuram. It will also help to provide enhanced training to Marine Police. The coast guard at Vizhinjam requested for a dedicated berth having a minimum berthing space of 120 m and alongside a depth of 8.0 m.

2.10.1.5 Navy Berth

Taking the advantage of the strategic location of the port, the Indian Navy (IN) has shown the interest in the port proposing the requirement of a navy berth and the associated storage facility. The requirement is basically to provide a mounting base for loading of amphibious vessels, troops and transport tanks. This would require a contiguous berth of 500 m (200 m near the container yard end and 300 m near the breakwater side) with a loading ramp of width 20 m to enable loading of vehicles through the bow ramps of Indian Naval Ships. This has very high significance as the Indian army has only one amphibian troop based in Thiruvananthapuram and this is currently operating with an extremely tedious operational plan. As per this plan, the nearest place they can load their ships is at Karwar in Karnataka which means they will have to transport the entire troupe to Karwar by road. The navy berth at Vizhinjam port having road and rail connectivity with the National network will decrease the transportation time and distance because of its proximity to Thiruvananthapuram. It also envisages developing an Amphibious Training Centre/School and other operational facilities, so as to have combined operations by the Navy, Army, Air force and Coast Guard stationed at Thiruvananthapuram.

2.10.1.6 Port Crafts

The ship navigation study has recommended a minimum requirement of four tugs i.e. three tugs with 70T bollard pull capacity and one tug with 40T bollard pull capacity to assist the navigation of ships visiting the port, three mooring launches and one pilot launch. It is recommended that a back-up tug be procured for the port. The characteristics of these support crafts are given hereunder in **Table 2-13**. A total of 100 m of berth length is provided at the port for the port crafts mentioned above.

Table 2-13: Characteristics of Port Crafts

S. No.	Type of Craft	LOA	Beam	Draft	Freeboard
		(m)			
1.	Tugs	30.0	9.0	2.5	1.5

S. No.	Type of Craft	LOA	Beam	Draft	Freeboard
		(m)			
2.	Pilot Launch	19.5	4.8	1.8	1.1
3.	Mooring Launch	10.3	3.2	1.2	0.8

(Source: DPR AECOM, May 2013)

2.10.1.7 Fish Landing Centre

The existing Vizhinjam fishing harbour has the berthing facility of 500 m and is being utilized to its peak causing the congestion in the harbour. During SW monsoon the congestion in the entire facility is actually doubled and therefore substantial development for the fishing harbour is required. Apart from this, the harbour requires up gradation in terms of ancillary facilities. In order to ease the congestion in the existing fishing harbour and provide additional facilities for the local population, VISL has proposed to provide fishing berths along the sea side of northern breakwater of the proposed Vizhinjam port as a part of Corporate Social Responsibility (CSR). The details of facilities provided are given in **Table 2-14**. It is proposed to provide 500 m Landing, Outfitting Quay and berthing quay/ jetty for the fishing trawlers and country boats.

Table 2-14: Facilities to be provided for Fish Landing Centre

Waterside Facilities	Landside Facilities
• Proper access to the landing area from the sea • Landing, Outfitting Quay and berthing quay/ jetty • Navigational Aids, etc.	• Auction hall • Administrative building • Vehicle parking area • Access roads • Electric & Water Supply, etc.

2.11 Storage Requirements

2.11.1 Container Yard Capacity

Container yard capacity is defined as the potential maximum throughput of containers handled inside the container yard (measured in twenty-foot equivalent units or TEU). With available number of Total Ground Slots (TGS) in phase-I development, the Vizhinjam port will be able to handle the berth throughput from the planned container yard. The container yard capacity provided is higher than the berth capacity so, with higher utilization of berth capacity, additional throughput will be also possible from the container yard. The TGS is split into the following as indicated in **Table 2-15** to accommodate the empties and reefer storage to cater the required capacities.

Table 2-15: Container Yard Storage Split

S. No.	Container Storage	Total Ground Slots (TGS)
1.	RTG Storage	
	– Non Reefer Storage	4,270
	– Reefer Storage	300
2.	Empty Storage	1,140
	Total	**5,710**

(Source: DPR AECOM, May 2013)

2.11.2 Receipt and Evacuation of Cargo

2.11.2.1 Rail Throughput Capacity

In order to meet the traffic forecast, one working track will be required in phase-I development. Only one working track will provide almost twice the capacity than the overall requirement. It should be noted that if the rail yard can be operated 24/7 then additional capacity can be achieved to handle even non-containerized cargo from the rail yard area. Containers will be stacked at the container yard and brought to the railway siding by Internal Transfer Vehicles (ITV). Reach stackers will load/unload them on the railway track.

2.11.2.2 Gate Capacity

Gate capacity analysis is essential feature to get essence of seamless inward and outward traffic movement including major share of trucks having containers. For phase-I development 8 hour gate shift is assumed. The gate working hours will be increased if additional demand for gateway traffic is experienced at the port and for future phases. The details of capacity required for seamless container truck traffic movement through the gate during phase-I are given in **Table 2-12**.

Table 2-16: Gate Capacity Analysis

Phase-I	Gate Capacity
600,000	Vessel moves/year [a] (from Berth Capacity calculations)
12%	% of Total Container Traffic via Truck [b]
69,395	Total throughput moved through Gate [c = a*b]
1,335	Moves per mean week [d = c/52]
1.2	Peak/mean week ratio [e]
1,601	Peak week moves [f = d*e]
7	Days per week operation [g]
229	Mean day moves [h = f/g]
1.3	Peak/mean day ratio [i]
297	Peak day moves [j = i*h]
8	Hours worked per day [k]
37	Moves per mean hour on a peak day [l = j/k]
1.5	Peak/mean hour factor [m]
56	Peak hour on a peak day moves [n = l*m]
1.1	Moves per truck visit [o]
51	Peak hour truck entries [p = n/o]
100%	Fraction of entries that have a container [q]
51	Trucks per hour at RPM [r = p*q]
30	RPM process including truck replacement (sec) [s]
120	RPM capacity per hour [t = 3600/s]
1.0	**RPM lanes required [u = r/t]**
180	Entry pedestal process time (sec) [v]
20	Gate capacity per hour [w = 3600/v]
3.0	**Gate entry lanes required [x = p/w]**
180	Exit process time (sec) [y]
20	Exit capacity per lane [z = 3600/y]
3.0	**Exit lanes required [a1 = p/z]**

2.11.2.3 Container Terminal Capacity

The container terminal has been sized to meet the market demand predicted by IFC/Drewry in 2010. The **Table 2-17** summarizes the development needs of berths, gate, yard and rail elements for the Vizhinjam port. The phase-I plan has been prepared to meet this development needs. **Table 2-18** shows a summary of the estimated traffic and the planned capacity for the Vizhinjam port based on the port components planned for phase-I development. As evident from the table, the phase-I development will provide optimum capacity for handling the projected traffic for phase-I.

Table 2-17: Terminal Development Summary for Vizhinjam Port

S. No.	Port Components	Phase-I
1	Berths (400 m each)	2
2	Container yard storage (TGS)	5,710
3	Rail sidings (800 m each)	1
4	Entry/Exit Gate (lanes each)	5

(Source: DPR AECOM, May 2013)

Table 2-18: Terminal Development Capacity Summary for Phase-I Development

Description	Total	Transhipment Traffic	Gateway Traffic	
			Truck	Rail
	TEU			
Phase-I - Container Traffic Forecast	8,22,256	6,83,798	96,921	41,538

(Source: DPR AECOM, May 2013)

2.12 Breakwaters

For carrying out cargo handling operations at the berths, there is a limiting wave conditions at the berths to ensure that there are no excessive movements of the ships that will hamper the loading/unloading operations. This limit varies with the handling system for the different types of cargo. Hence, the breakwater configuration and the overall port layout should ensure adequate tranquillity at the berths so that cargo handling may continue even when the offshore wave climate exceeds the limit for ships' movement in and out of the harbour. The maximum acceptable wave conditions for cargo handling operations at the berth are dependent on ship size, the type and method of cargo handling, and the direction of the wave attack. Beam waves cause the vessel to roll and affect the cargo handling operations more than head waves. The limiting wave heights (Hs) for different wave directions for cargo handling operations are summarized in **Table 2-19**. These numbers are based on IAPH4 guidelines and apply to the worst wave periods for each direction.

Table 2-19: Limiting Wave Heights for Cargo Handling

S. No	Type of Ship	Limiting Wave Height (H_s)	
		Head or Stern (0°) (m)	Quadrant (45° - 90°) (m)
1.	Container Vessels	0.5	0.3
2.	Multipurpose Vessels	1.0	0.8

The breakwater alignment for phase-I development have been chosen to maximize the operations time by effectively blocking all of the bigger SW monsoon waves and providing enough protection against rest of the year waves. Breakwater optimization will be further done during later design stages in order to maximize the tranquillity and provide a balance with capital cost. The breakwater alignment

[4]International Association for Ports and Harbours

consists of breakwater that is 3,180 m long. The deepest depth contour for breakwater is around -20 m CD.

2.13 Approach Channel

The port approach channel consists of the two parts:

- Outer approach channel which is the section of the channel outside the breakwaters area; and
- Inner approach channel, which is the section of the channel from the head of the breakwaters area to the vessel turning area.

The outer approach channel would be unprotected with vessels in transit along this section sailing under their own power without tug assistance. The inner entrance channel would be protected and should be fairly sheltered from wave attacks. Tugs will be able to meet and fasten to the vessel at the port entrance and starts to manoeuvre towards the allocated berth. The vessels will start slowing down after tugs are attached in the inner approach channel. As per PIANC[5] (1997) guidelines, sheltered inner approach channel should have around 4-5 times length of the design ship. However, considering the capital cost of longer breakwater, it is expected that breakwaters will provide an effective length of 3-4 times the design vessel length overall for phase-I operations which is deemed adequate. As per the design inner and outer approach channel length is 1.2 km and 2.8 km, respectively. The vessel navigation study has further confirmed the inner approach channel length adequacy for the vessel operations for phase-I.

2.14 Dredged Depth at Port

The Vizhinjam port location has a very favourable bathymetry and natural depth. Water depth in the channel region is around 15 to 18 m depth below CD. This will minimize the initial capital dredging cost involved. The dredged depths at the port entrance channel and manoeuvring areas will be governed by the fully loaded draft of the design ship. Based on PIANC guidelines, the following dredged depths (after rounding off) are provided at different parts of the harbour for the design ships.

Table 2-20: Dredge Depths

Ship Size	Approach Channel Outside Breakwater	Inner Channel and Manoeuvring Area	Depth at Container Berths
	(Loaded draft+30%)	(Loaded draft+15%)	(Loaded draft+15%)
18,000 TEU (16.0 m draft)	20.8	18.4	18.4

Thus the outer approach channel which will be unsheltered will have a minimum dredging depth of 20.8 m CD, whereas in the inner approach channel area, turning circle and harbour basin, a water depth of 18.4 m CD will be provided. Berthing pockets will have a dredged depth of 18.4 m CD.

2.15 Turning Circle Diameter

As per the PIANC guidelines, diameter of the sheltered turning circle with tug assistance should be 1.75 times length of the design ship. The design ship length is taken as 400 m so the turning circle diameter required would be 1.75 times 400 m which is 700 m. The vessel navigation study has further confirmed the adequacy of the turning circle diameter and location.

[5]Permanent International Association for Navigation Congresses; an international body establishing design guidelines for maritime

2.16 Width of Harbour Entrance

The width of the single lane approach channel has been estimated considering the design ship beam of 59 m. The various factors considering the base width of the channel have been taken from PIANC guidelines. A suitable factor for each parameter is taken and it is multiplied with design ship beam to get the total base width of the channel. Channel width calculations are shown in **Table 2-21**.

Table 2-21: Approach Channel Width Estimation

Factor Description	Outer Approach	Inner Approach
Basic Width (m)	1.5	1.5
Vessel Speed (m/s)	0.0	0.0
Prevailing Wind	0.4	0.4
Prevailing Cross Currents	0.7	0.7
Prevailing Long. Currents	0.1	0.1
Sig. Wave Height & Wavelengths	1.5	1.0
Aid to Navigation	0.0	0.0
Bottom Surface	0.1	0.1
Depth of Waterway	0.1	0.1
Cargo Hazard	0.0	0.0
Bank Clearance 1	0.3	0.3
Bank Clearance 2	0.3	0.3
Total Factor (One-Way Channel)	**5.0**	**4.5**
Beam of Design Vessel (m)	59.0	59.0
Channel Width	**295 m (=59*5.0)**	**266 m (=56*4.5)**

From the above table, it can be concluded that as per PIANC guidelines outer approach channel (unsheltered) and inner approach channel (sheltered) will need approximately 295 m and 266 m of base width respectively. The **Ship Navigation Simulation Study** has recommended that the outer approach channel be widened to 400 m and inner approach channel be maintained at 300 m. For phase-I development, outer approach channel width is sized as 400 m gradually reducing at the breakwater mouth to an inner approach channel width of 300 m.

2.17 Navigational Aids

Navigation aids for the port are required to ensure safe and efficient navigation of ships entering and leaving the port through the approach channel as well as berthing/un-berthing requirements inside the docks. It is envisaged that navigation will be carried out throughout the year, by day and night, except during cyclonic weather. These aids will assist the captains and pilots in determining the position of vessel while transiting the navigational channel and manoeuvring inside the port. The approach channel stretching from the breakwaters head to 21.0 m contour has a width of 400 m. The channel has a total length of about 2.8 km. From the deepwater initially the channel is oriented 343°, it takes a turn at a radius of 1200 m before approaching straight into the harbour at an orientation of 317° N.

These aids as listed below are proposed to be installed on land or in water for guidance to all vessels for safe and regulated navigation in channels, basin, berths and docks.

- Fairway buoys, port and starboard buoys
- Leading/transit lights
- BEACONS and

- Vessel Traffic Management Information System (VTMIS)

2.18 Dredging and Reclamation

2.18.1 Dredging

The proposed port site is characterized by naturally available deepwater depths with 20 m contour located at a distance of less than 800 m from the shore. This substantially reduces the dredging cost and hence enables the port to provide berthing ability for the largest container vessels (up to 18,000 TEU). The port intends to utilize reclaimed land for most of the onshore port facilities. The dredging operations are expected to meet most of the demand for reclamation material. The calculated dredging volumes are given for phase-I are given in **Table 2-22**.

Table 2-22: Dredge Areas for the Vizhinjam Port

S. No.	Dredge Area	Dredge Depth (wrt CD)	Dredge Volume (m^3)
1.	Approach Channel	Outer channel - 20.8 m Inner channel - 18.4 m	3,254,953
2.	Turning Circle	18.4 m	904,300
3.	Berths and Harbour Basin	18.4 m	883,320
		Total	**5,042,573**

Whereas, for reclaimed area in phase-I it is required to dredge 6.9 million m^3. To meet this quantity, 7.6 million m^3 of dredged material is required. As per the engineering design mentioned in the above table, 5.04 million m^3 dredged material is available. Hence, additional 2.56 million m^3 is to be procured from approach channel by excess dredging.

***Cutter Suction Dredging (CSD)*:** The CSD will be deployed for dredging and pumping materials directly into the reclamation area. The pipeline may consist of a combination of floating, submerged and shore lines. In this particular situation, the CSD is connected directly to a shore connection point by means of a floating pipelines where required in combination with a submerged line and there off to the reclamation area, by means of a shore pipeline. As the reclamation progresses, the shoreline will be extended. Depending on the layer thickness to be dredged and the characteristic of the materials, the CSD will cut and dredge the material in one and more layers. On an average 0.5 m vertical over depth will be dredged by the CSD. The dredging will be carried out by using the box-cut method and slopes will be allowed to fall to natural angle of repose.

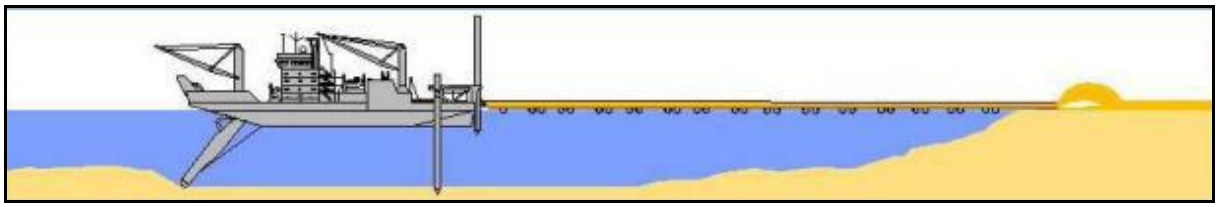


Figure 2-2: CSD Discharging Onshore through Floating Pipe

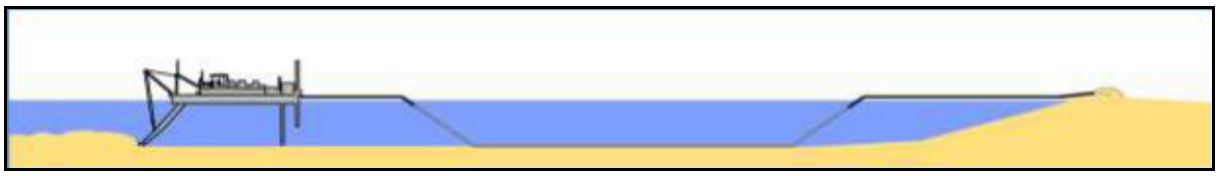


Figure 2-3: CSD Discharging Onshore through Submerged Pipe

2.18.2 Reclamation

The proposed port of Vizhinjam is planned to be constructed on reclaimed land adjacent to the existing coastline 0.3 km south of the existing fishing harbour. The preliminary reclamation level is at + 4.2 m CD. It is estimated that around 6.9 million m^3 of material will be required for reclamation. This would require total dredging to be of the order of around 7.6 million m^3. So the additional dredging quantity of 2.56 million m^3 may be obtained from over dredging the navigation channel. From the mathematical model studies, it is evident that maintenance dredging is also negligible during phase-I.

2.19 Multipurpose Cargo Handling System

The multipurpose cargoes at Vizhinjam port comprise of Timber and Raw Cashew. The forecast of these cargoes is not significant that would require a dedicated berth and equipments. These commodities can be handled at container berth using the ship's gears. The flow diagram for the multipurpose cargo handling system is presented in **Figure 2-4** below.

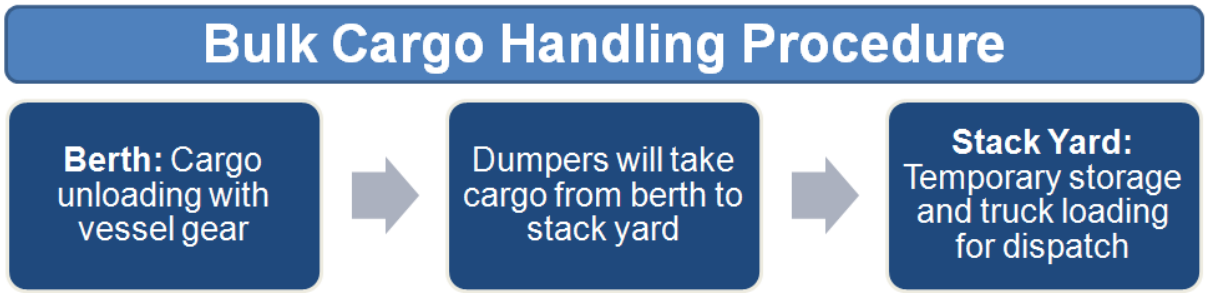


Figure 2-4: Flow Diagram for Multipurpose Cargo Handling System

2.20 Container Terminal Equipments

2.20.1 Ship-to-Shore Handling Facility (Rail Mounted Quay Cranes - RMQCs)

These are rail mounted travelling cranes on quay provided as a ship-to-shore handling facility. They will have a front outreach of up to 65 m for handling 18,000 TEUs vessels. It is not envisaged to stack any containers on the quay except in emergency situations. The cranes will be provided with telescopic twin lift spreaders.



Exhibit 2-1: Typical RMQCs Operating at Berth

2.20.2 RTGs (Rubber Tired Gantry Cranes)

RTG cranes have long been the most common mode of operating worldwide in a container yard. As the name implies, these machines operate on rubber tires and can roam anywhere in the container yard. They typically run on reinforced concrete runways to minimize the rutting that can take place along the RTG travel paths. Although RTGs have traditionally been diesel powered, there is a major trend in the container handling industry to shift to electrically powered RTGs. RTGs can be powered from a cable reel but the most common electrical solution is an above ground bus bar power system.

Taking due care of the green nature of the proposed port, spatial provisions are provided in the planned development for E-RTGs (Electric RTGs) for container yard handling. It will run with zero emission compared to a diesel-powered RTG, a greenhouse gas emission free container yard operation and saving in energy costs on long run. Local NO_X, PM, CO emissions can be reduced at greater level with use of E-RTGs. **Exhibit 2-2** shows an E-RTG in operation.



Exhibit 2-2: Typical E-RTG for Yard Operation

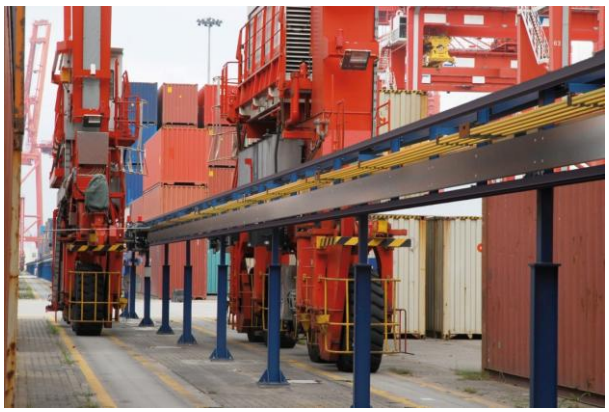


Exhibit 2-3: Typical Details of Electric Buss Bar Arrangement for E-RTG

2.20.3 Reefer Load Container Storage

Refrigerated loaded containers (reefers) are envisioned to be stored at the south end of the middle RTG stack rows. The reefers will be stored for access via multi-level reefer racks, stacked to a maximum of five containers high. The racks will provide power and maintenance access. Reefers will be delivered and retrieved by ITVs.



Exhibit 2-4: Typical Reefer Stacks



Exhibit 2-5: Another View of Reefer Stacks

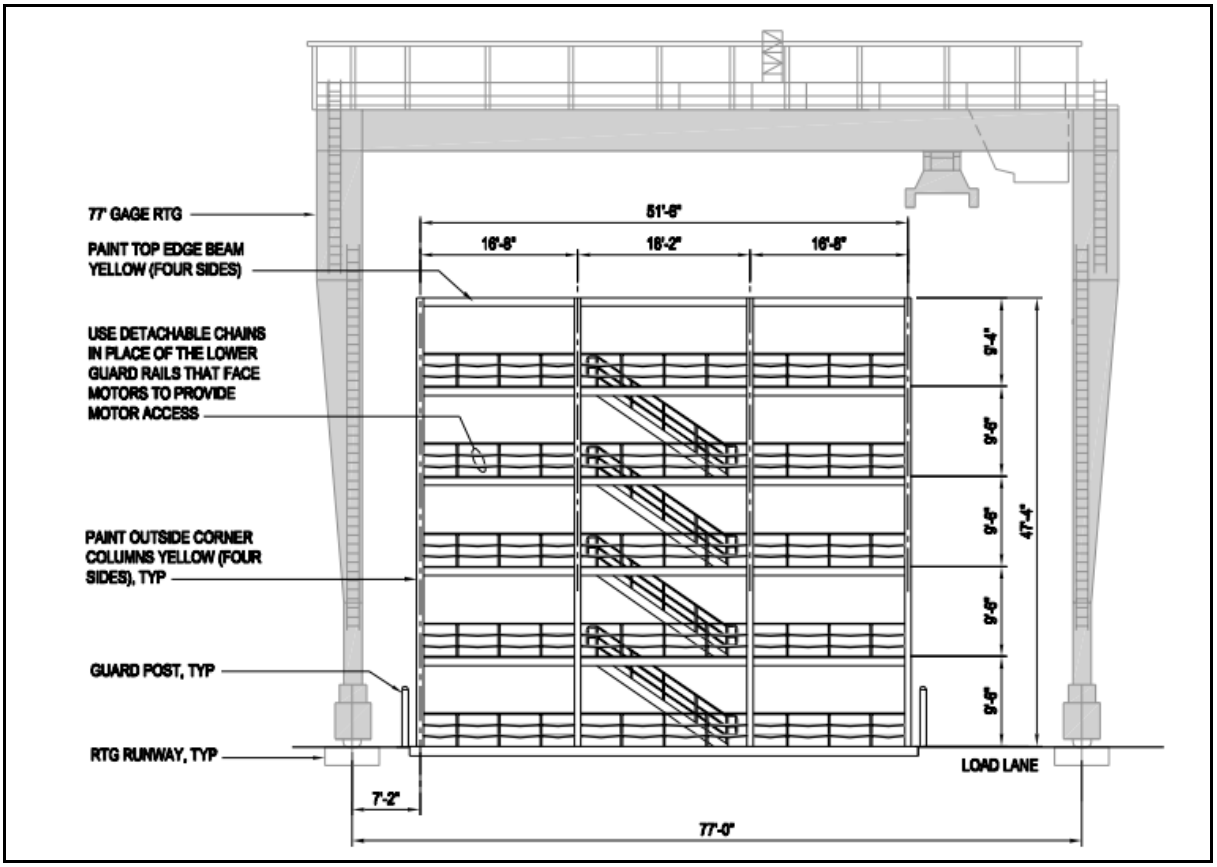


Figure 2-5: Typical Arrangement Details of Reefer Stacks

Reefer racks provide grounded storage for reefers. Multi-level reefer racks are provided to allow mechanics access to plug and unplug units, to check reefer machinery status, and to perform low level maintenance and repair. Refrigerated loads are plugged into power receptacles, located on the reefer racks, to maintain temperature while stored in the container yard. Empty reefer containers can be stored in designated areas of the empty storage area and/or the RTG container storage rows. Empty reefers are plugged in and tested (pre-tripped) to confirm their operating condition. Pre-tripping can be done in the grounded reefer stacks.

2.20.4 Empty Container Handlers

Empty containers will be block-stowed in grounded rows with containers stacked up to eleven-wide by six to seven high. Empty Container Handlers (ECHs) will service these rows. ECHs may include, at the discretion of the concessionaire:

- Medium-duty forklift trucks
- Side-pick cranes
- Top-pick cranes
- Reach-stacker cranes

Side-Pick empty container handlers are recommended as the primary equipment for ECH operations. See image below. Should the concessionaire elect to do twin-picking of twenty-foot boxes, a twin-pick reach-stacker can be used in the proposed layout.



Exhibit 2-6: Snapshot of Typical Side-pick Handling



Exhibit 2-7: Snapshot of Typical Reach Stacker Handling



Exhibit 2-8: Typical ITV for Handling Containers



Exhibit 2-9: Another Typical ITV for Handling Containers

The dedicated empty storage area is provided at the eastern end of the container terminal between the RTG rows and the container terminal main access road. ECHs may transport empty containers over short distances to or from the container repair shop or reefer washout area. Containers will be transported between the quay and the empty storage areas by ITVs. Traffic through the ECH storage rows can be either unidirectional or bidirectional based on the preference of the operator.

2.20.5 Reach Stackers

Reach stacker is the equipment used for handling containers within container yard and intermodal operation of the containers. It is able to transport containers for short distances and stack them in various rows depending on its access. In small to mid-size ports reach stackers are also used in the yard operation for stacking containers. Reach stacker has gained ground in container handling in rail yard because of its flexibility and ability to stack across rail tracks. Considering the throughput of the import export containers of gateway traffic, it is proposed to provide two numbers of reach stackers for train loading/unloading.

2.20.6 Internal Transfer Vehicles (ITVs)

These are the vehicles used for cargo movement within the terminal area from berth to storage area and storage area to rail yard or vice-versa. Generally trucks with a forty feet long trailer are used for container handling and dumper trucks are used for bulk cargo. The battery operated ITVs are also in practice in place of diesel based ITVs in upcoming terminals developing on green and eco friendly mechanisms. ITVs requirement for container handling has been identified as 55 nos. for phase-I development of Vizhinjam port. The actual requirement and classification of the ITV procurement will be decided by the awarded terminal operator.

2.20.7 Phase-I Container Terminal Equipment Requirement

Table 2-23 provides a summary of estimated requirements for various container terminal equipments for the phase-I associated attributes including quantity and productivity rate. This is just an estimate based on industry practice and general operating procedures. Terminal operator will finally decide on the requirements based on his operational requirements and actual container throughput.

Table 2-23: Estimated Container Terminal Equipment Requirements

S. No	Container Terminal Equipment	Quantity (Nos.)	Productivity (moves per hour)
1.	Rail Mounted Quay Cranes (RMQC)	8	25
2.	Rubber Tired Gantry Cranes	24	15 to 20
3.	Reach Stackers	2	12
4.	Empty Container Handlers	6	15 to 20
5.	Internal Transfer Vehicles	55	4 to 6

2.21 Utilities and Services

2.21.1 Water Requirements

Based on the requirements of berths over the master plan horizon, it is expected that the water demand at the port is estimated to be 0.5 MLD in the Phase-I development. Out of this, the potable water demand for the port personnel, township is 0.35 MLD with the balance being raw water. The total water demand over the master plan horizon is expected to go up to 1.0 MLD which would comprise 0.7 MLD of potable water with balance being raw water. Kerala Water Authority (KWA) has sanctioned 1.0 MLD of potable water for Vizhinjam Port use. The water requirement for phase-I is given in **Table 2-24**.

Table 2-24: Estimated Water Demand

S. No.	Consumer	Demand (KL /day)
		Phase-I
A.	**Raw Water**	
	Greenery and Landscape	120
	Reefer Wash and Misc	24
	Total Raw Water (A)	**144**
B.	**Potable Water**	
	Port Personnel, Users & Misc.	64
	Township	250

S. No.	Consumer	Demand (KL /day)
		Phase-I
	Cruise Terminal	40
	Ship Supply	-
	Total Potable Water (B)	**354**
	Total (A + B)	**498**

(Source: Detailed Project Report, AECOM 2013)

2.21.1.1 Source of Water Supply

The source of water shall mainly be from Vellayani Lake. The plan is for drawing 3.30 MLD of water from Vellayani Lake and to treat the same at a treatment plant located at Vizhinjam in the land available with the Harbour Engineering Department (HED). As per the report, 3.00 MLD of water will be available after treatment with a net availability of 2.49 MLD. As part of the port development a total of 2.49 MLD of potable water have been allotted to cater to the port requirements, of which 1.49 MLD of water from the proposed water supply scheme of Vizhinjam Port shall be distributed to the locality as part of initiation of the implementation of Corporate Social Responsibility (CSR) activities of VISL. The proposed fresh water mains will mainly serve the purpose of potable water supply to the usage points. Since the raw water quality is a crucial parameter while deciding any treatment process, it is recommended to get the quantity and quality of available water analyzed. The water treatment plant must ensure that it produces water of acceptable quality as per the provisions of IS 10500:1991.

2.21.1.2 Storage of Water

The treated water supplied by the KWA will be collected in an underground sump at a point near the proposed cruise terminal area and resort complex development near the eastern boundary of the port. The capacity of the treated water sump will be 1200 cum, which is equivalent to about two days consumption. It is proposed to provide a supplementary sump for raw water of 400 cum capacity (165 cum for greenery & landscape and 35 cum for reefer wash and other miscellaneous requirements and rest being the provisional storage to suit any additional requirement) adjacent to potable water sump. The potable water is pumped into an overhead tank of 200 cum capacity provided near the sump, from where, the water is pumped into port operational area through gravity. Separate individual water tanks are proposed for the port buildings such as administration, canteen, etc. and the details of the same as indicated below.

Table 2-25: Separate Storage for Terminal Operation Buildings

S. No	Area	Tank Capacity (cum)
1.	Administration	3.0
2.	Resource	6.0
3.	Canteen	4.5
4.	Workshop	4.0
5.	RTGC Service Building etc.	4.0
	Total	**19.5**

The wash water after treatment amounting to about 0.5-0.8 MLD, now being drained unused shall be stored and used for green belting/street washing/which in turn will recharge the groundwater regime.

2.21.1.3 Distribution System

The treated water from KWA connection will be brought into the underground storage tank of 1200 cum capacity. The treated water from the potable water sump near the proposed resort complex shall be pumped through pumps and pipeline of 200 mm diameter supply to the overhead tank of 200 cum capacity located near the storage sump tank. The overhead tank is provided with the pipeline of two separate pipelines of 100 mm diameter through which water is supplied to all port usage points and the proposed residential colony area by gravity. The water from raw water sump shall be pumped to the secondary storage to facilitate reefer wash and other miscellaneous requirements through two separate pumps and a separate pipeline of 150 mm diameter line

2.21.2 Power Requirements

The total power required for the initial construction phase is 33.3 MVA. The required power will be supplied by Kerala State Electricity Board (KSEB) by upgrading the 66 KV line to the existing Vizhinjam substation to 110/220 KV, along with a dedicated GIS substation planned to VISL at the land adjoining the truck terminal at Kadrarakkuzhy It is required to run a new receiving line to the port main receiving substation to draw the power load requirement for the port development activities. Backup power will be with generators. The total power required will constitute for the following electrical services also:

- Electrical system consisting of a Main power supply and several sub-stations
- Lighting towers or masts,
- Security Systems such as fencing and CCTV cameras

A detailed split up of the power requirement for phase-I is given in Table 2-26.

Table 2-26: Power Requirement for Phase-I

S. No	Equipment Description	Qty	Installed Load		Diversity Factor	Demand
		Nos.	KW/ Equip	Total		KW
1.	RMQC	8	2,400	19,200	0.8	15,360
2.	RTG	24	500	12,000	0.8	9,600
3.	Reefer Points	476	3	1,428	0.8	1,142
4.	Lighting Towers - Jetty, Container Yard and Rail Yard	27	15	300	0.8	324
5.	Operation Office, Gate complex, other utilities	1	400	400	0.8	320
	Total Demand of Container Terminal in KW					**26,746**
	Power Factor					0.85
	Demand in KVA					**31,466**
1.	Fire Fighting	1	475	475	0.5	237.5
2.	Sump Pumps	1	40	40	0.5	20
3.	Water Supply	1	400	400	0.5	200
4.	Office Buildings, Port Area Lighting	1	375	375	0.5	187.5
5.	Support Services	1	1,000	1,000	0.5	500

S. No	Equipment Description	Qty	Installed Load		Diversity Factor	Demand
		Nos.	KW/ Equip	Total		KW
6.	Illumination of Approach roads/service roads	1	800	800	0.5	400
	Total load in KW					1,545
	Power Factor					0.85
	Demand in KVA					**1,818**

(Source: Detailed Project Report, AECOM 2013)

2.21.3 Buildings

The phase-I development of port has identified the conceptual footprint and location for various terminal buildings required for the functional port operations as provided **Table 2-27**.

Table 2-27: Typical buildings and other buildings common to a Container Terminal

Typical Building	Other Functional Building Required for the Port Operations
• Administration Building; • Entry/Exit Gate Inspection Canopy; • Security Guard Booths; • Pre-gate and Customs Building; • Maintenance Workshop and Repair Building; • Quay Crane Maintenance and Marine Operations Building • Rail Master Building	• VISL port administration building for functioning of VISL in managing the port operations. • Substation buildings to house the transformers and other electrical equipment as per the load requirements in the different parts of the port area. • Fire Station building to house fire fighting equipment, fire tenders, etc. • Dispensary building to be located near the operational areas and provide minimum facilities required for the first aid. • Other miscellaneous utility sheds as per requirements of a particular terminal • Canteen buildings to provide space for catering staff, messing facilities for the terminal personnel and for utilities. • Rail master building required to provide for functioning of rail operations within the terminal.

A provisional location for these buildings is shown on the plan with flexibility for future expansion.

2.21.3.1 Building Requirement Summary

Most of the port buildings are low rise buildings and it is expected that these can be safely founded on shallow foundation comprising of a combination of strip and isolated footing. The estimated building areas required for the phase-I development are provided in **Table 2-28**.

Table 2-28: Vizhinjam Port Buildings

S. No.	Particulars	Floor Area (m^2)
1.	Administrative Buildings	
	– VISL Administrative Building	800
	– Private Operator Administrative Building	800
2.	Port Marine Operations Building	630
3.	Yard Operations Building	300
4.	Crane Maintenance Building	830

S. No.	Particulars	Floor Area (m^2)
5.	Maintenance & Repair Building	3,400
6.	Trouble Kiosk & Restrooms	60
7.	Longshoremen Restrooms	60
8.	Reefer Shop	330
9.	Canteen	100
10.	Fire station	100
11.	Utility Building	400
12.	Electrical Sub Stations	400
13.	Security Booth - Entry Gate	30
14.	Security Booth - Exit Gate	30
15.	Other Misc. Buildings	200
16.	Rail Administration Building	200
	Total	**8,670**

2.21.4 Communications

A communication system comprising telephones, fax machines, wireless sets computers, etc. and a public address system will be provided at all port operational areas.

An efficient and effective operation of a port terminal requires the provision of reliable and adequate communication facilities. Communication is usually required between the outside world and the port, between and within the terminals as well as other locations where port staff, customs officials etc. are located. To meet these requirements, a communication system comprising telephones, fax machines, wireless sets, computers, etc. and a public address system will have to be provided. These are broadly described below.

2.21.4.1 Telephone System

An electronic (digital) automatic PBX exchange will be provided for the port. Adequate connections will be taken to all required places within the port's limits. A telephone system in open and in high sound areas will be provided with adequate weather and sound proof arrangements. Telephone connections will also be provided for each berth for use by vessels moored alongside.

2.21.4.2 Radio Communications

The efficiency of port terminal operations depends on a speedy flow of information between the key personnel who are directly involved in the handling of cargo.

A radio communications system will be developed in order to handle the flow of information which passes between the personnel engaged in the following operations:

- Ship working duties
- Quay crane and mobile equipment operations
- Shore side duties
- Control office
- Terminal engineering services
- Operations management
- Supervision

- Port Security

In order to ensure an effective radio communication network the port operations have been divided into the following four organizational segments each of which requires a dedicated radio channel(s):

- Ship work
- Quay and Storage work
- Control (base station)
- Port Security/Customs

The system will need to reflect the importance of establishing and maintaining contact between the following areas of operation:

- Ship and crane
- Ship and quay/stacking yard/storage area(s)
- Ship and base station
- Base station and engineers
- Engineers and supervisors
- Supervisors and all foremen, ship and quay/stacking yard/storage area(s)
- Base station and supervisors
- Management and supervisors
- Port security staff and customs officials

In planning the radio communication system, it is essential that the installations provided in Initial scenario can be readily expanded in response to the future growth of the port.

2.21.4.3 Public Address System

The public address system will supplement the above two systems. The central control for the system will be kept with the control room.

The public address system would provide a comprehensive paging system for oral communication and announcement by loud speakers covering all working areas of the port terminal. The loud speakers would be mounted on purpose built supports provided on permanent structures. The exterior speakers would be weather-proof.

2.21.5 Fire Fighting Facilities

The fire fighting system is to be designed to be capable of both controlling and extinguishing fires. There will be two types of systems i.e. sea water system and fresh water system. The sea water system would broadly consist of a fire water intake to draw water from the sea, pump house with pumps, nozzles for water curtains along the front side of operating platform, hydrants and distribution networks. The container and car carrier berths will also be covered under the sea water system.

A centralized fire station will be provided for attending to all calls which will house 2 mobile fire tenders. One fire tender will be provided with snorkel attachment.

Fire Alarm Bells will be located on permanent structures at strategic locations that can be heard by the terminal operators. Buildings where the hazard of fire and the occupancy are high will be provided with alarm bells (e.g. the workshop, administration building etc.). The fire alarm system will be activated by push buttons located at strategic places within the terminal areas and around the port's perimeter.

2.21.6 Bunkering Facilities

To meet the bunkering requirements of ships (HFO and Marine Diesel), a provision for laying a 350 mm diameter pipeline will be made in the berths. The bunkering tank farm will also serve fuel to port crafts and port vehicles/equipments. However, bunkering facilities are not planned in phase-I but vessels are supplied bunker fuel through mobile fuel tankers/trucks bringing the fuel from outside the terminal and directly feeding the vessels in phase-I.

2.22 Road/Rail Corridor for Vizhinjam Port

As described in the Section 2.3.2, the proposed road and rail corridors are an integral part of the Vizhinjam port infrastructure. The **Figure 2-6** shows the combined map of road and rail connectivity to the planned port infrastructure. The proposed NH (bypassing Thiruvananthapuram city) alignment at the point of joining location is 8.0 m above ground level.

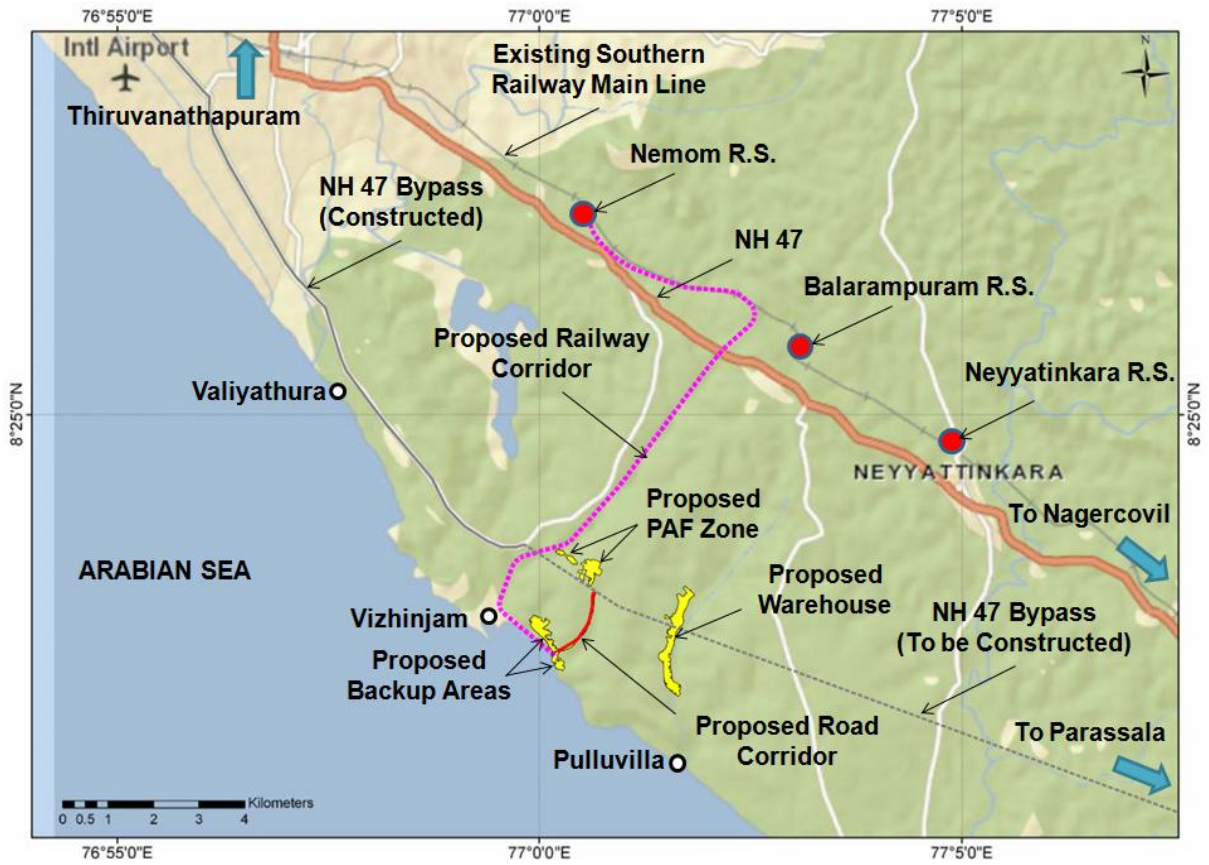


Figure 2-6: Road/Rail Connectivity to Vizhinjam Port

2.22.1 The Road/Railway Traffic

Cargo traffic that would be dealt with at the proposed Vizhinjam port consists generally the following categories:

General traffic from hinterland in view of development of industries
Attracted regional traffic from neighbouring ports due to their expansion and capacity constraints
Container transhipment traffic

Cruise vessels – related traffic for the movement of tourists

All the above factors are relevant during the operational period but during the construction phase most of the required quantities of construction materials could be transported by sea using barges for the construction of breakwater and all other port infrastructure. But all other construction materials and part quarry materials for port as well as for road and rail connectivity will be transported by road. Therefore, road connectivity needs to be prioritised against all other infra components to avoid major issues for transportation of construction materials; especially part quarry materials. All the above factors make it necessary to have dedicated transport connectivity to the port site.

2.22.2 Hinterland

Traditionally the hinterland of a port infrastructure is that area from where export cargo traffic is moved to the port and import traffic back, based on a cost benefit approach (commodity wise); keeping in view the transportation facilities, costs and time taken for transportation, etc. Taking into consideration the operational characteristics and marketing strategies, the hinterlands of different ports situated in the same coastal belt overlaps each other, as is the case of the proposed port at Vizhinjam, the existing Kochi container transhipment terminal (Cochin port) situated in the same coastal belt and Tuticorin port in the Eastern coastal area of the country but lies in the southern peninsula. Traffic for Vizhinjam from its hinterland consists of the following two components: generated cargo and attracted cargo. Dedicated road/railway connectivity is planned for Vizhinjam port to cater the traffic. Cargo likely to get generated in the hinterland and its use for transportation needs is the main contributor for a successful operation of a port.

2.22.3 Road Connectivity

Adequate field surveys were undertaken to appreciate the projects' critical issues for plan, design, final survey and investigations including survey locations and to identify social and environmental hot spots.



Exhibit 2-10: Start Road Connectivity at Sea



Exhibit 2-11: End of Road Alignment at NH 47

2.22.3.1 Road Inventory

The proposed road connectivity, of approximately 2.0 km, is a completely new link connecting the Vizhinjam port to NH 47 bypass that is being constructed. This NH 47 bypass is an ongoing project of National Highways Authority of India (NHAI) with half of the NH 47 bypass (up to Kovalam) already

under operational stage. At this location, construction of bypass is at an early stage with only the land acquisition process completed. This Vizhinjam port road alignment almost completely traverses through agricultural land, disturbing a few structures and meets the NH 47 bypass that is being constructed. The start chainage of the Vizhinjam port connectivity road is shown in **Exhibit 2-10**. **Exhibit 2-11** is the end chainage and the intersection point (bottom point of valley) of the proposed Vizhinjam road and the NH 47 bypass that is yet to be constructed at 8.0 m above ground level.

During the field surveys, the proposed Right of Way (RoW) boundary markings were observed. In the proposed alignment there are some existing structures like private buildings, two temple ponds and agricultural fields (Tapioca, Banana, and Coconut) which will be impacted due to proposed road connectivity. The project road will be integrated with the service road of the NH with necessary changes to accommodate the additional container traffic. The Vizhinjam road is also required to be constructed to link to the proposed truck parking area on the other (Eastern) side of the road with an underpass.

2.22.3.2 Proposed Road Carriageway

The proposed road is 4-lane with a divided carriageway. The proposed design cross-section for the road alignment is given in **Figure 2-7**.

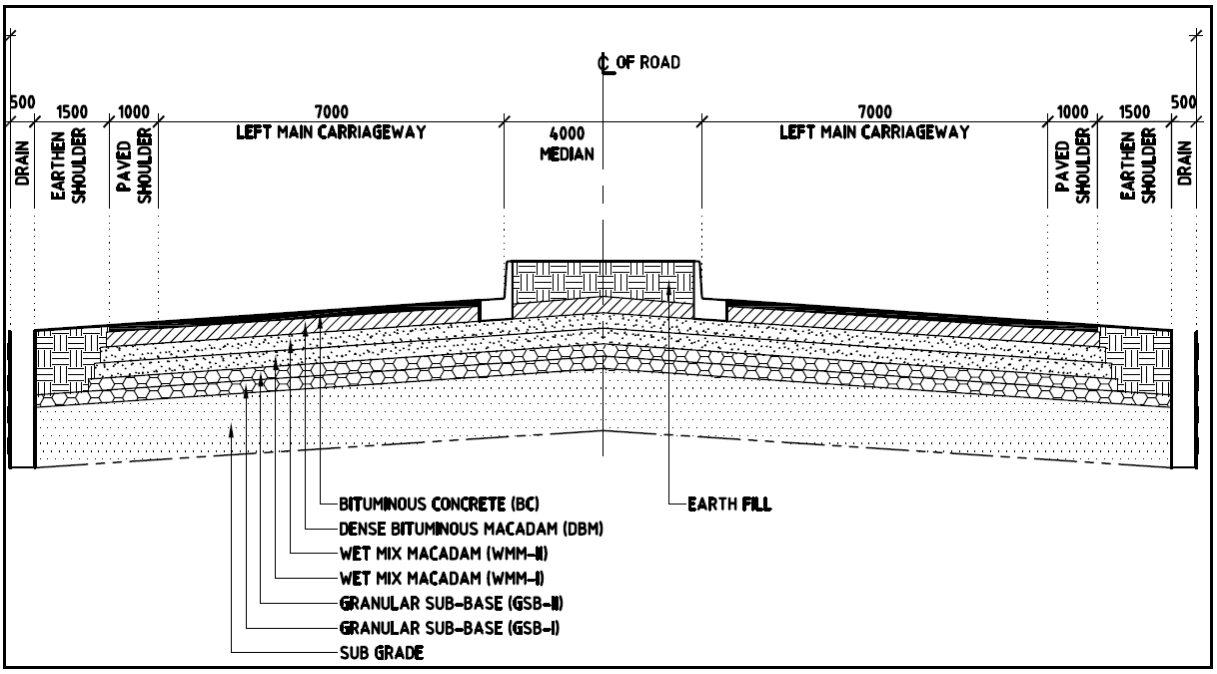


Figure 2-7: Typical Cross-Section for Four Lane with Divided Carriageway

As illustrated in the design cross-section, this road is a four lane road with a median width of 4.0 m. In addition, there will be a 1.0 m paved shoulder and 1.5 m unpaved earthen shoulder. Main features of the road are the following:

- **Total length** - 1.964 km starting from port (0.00 km) side to NH 47 bypass
- **Total width** - 45.0 m for four lane configuration
- **Median width** - 4.0 m (considering a scope for future widening)
- **Carriageway** - Four lane (7.0 m on either side) for a total of 14.0 m
- **Paved shoulders** - 1.0 m paved shoulder on both sides

- **Earthen shoulder** - 1.5 m earthen shoulder
- **Main traffic expected** - Multi axial trucks loaded with containers
- **Embankment height** - 0.5 to 2.0 m raised embankment along ground level
- **Access road** - One main road crossing - to construct Road over Bridge (RoB)
- **Drainage** - 0.5 m to accommodate both longitudinal and cross drainage features wherever necessary
- **Greenbelt -** Additional land area available on the Right Hand Side (RHS) of the road corridor; a total of 1.17 Ha will be used as greenbelt development along with
- **Strip plantation** - 10.5 m wide space on both sides plus the
- **Barbed wire fencing** - In all areas avoiding access to building and properties

2.22.3.3 Proposed Junctions

Along the proposed road alignment there are three access roads and one main road but other than the junction at NH and also along the Poovar road no other major junction are involved. This Poovar road is proposed to be a RoB across the Vizhinjam project road.

2.22.4 Railway Line Connectivity

The railway line is also a completely new link connecting Vizhinjam with Nemom railway station (NEM). Geographically, the proposed Vizhinjam port is situated on the west of the present railway line running from Thiruvananthapuram Central station (TVC) to Nagerkovil junction (NCJ) of Thiruvananthapuram division of Southern Railway. The dedicated freight rail alignment identified for Vizhinjam port is proposed to take off from NEM station (situated at km 227.70 between TVC and NCJ - single line non electrified section (electrification work is nearing completion)) and it ends at Vizhinjam port, which is 14.725 km away from NEM station. It is proposed to construct a major transit station yard at Nemom. In addition railway terminal at Vizhinjam port which is planned at about 4.2 m above mean sea level (MSL). **Exhibit 2-12** and **Exhibit 2-13** are the start and end chainage of the railway connectivity alignment respectively.

2.22.4.1 Location and Alignment

The order of relevant stations including relationship in terms of chainages in the railway network is given in **Table 2-29**.

Table 2-29: Relationship between Railway Mainline and Vizhinjam Rail Corridor

S. No.	Stations	Existing Mainline Chainage (km)	Port Railway Alignment (km)
1.	Thiruvananthapuram	219.800	NA
2.	Nemom	227.700	0.925
3.	Balarampuram	233.210	6.435
4.	Neyyattinkara	237.080	0.000
5.	Nagerkovil	291.100	NA
6.	Vizhinjam Port Area	Not in Main Line	14.725

(Source: Rail Vikas Nigam Limited - 2012)

The proposed rail connectivity starts from the existing NEM station (0.925 km) in the Thiruvananthapuram division of Southern Railway. There is a reduction of 0.925 km length in the case of NEM start chainage. This adjustment was found necessary to avoid complications for the already finalized DPR for the rest of the rail alignment with several other studies. This railway line runs parallel to the existing main line at a centre to centre distance of 7.5 m up to chainage 5.000 km from where it

deviates with a curve towards Vizhinjam, crossing through deep cutting, the existing NH crossing, medium and low built up areas in between chainages 5.000 km to 14.725 km, and through Madavurpaara, Ithiyur, Panayarakunnu, Mangalathukonam, Puthoorkaanam, Puthukulathinkal, Vayalooram, Chennakkal, Mukkoola to Vizhinjam. At the Vizhinjam end, is the medium built up area consisting of fisherman villages, harbour offices, fishing harbour, KSRTC depot, other government and private buildings, a church and mosque. The proposed Vizhinjam terminal station chainage starts at km 14.725 and ends at km 15.650.



Exhibit 2-12: Start Chainage Rail Connectivity at Nemom (km 0.925)



Exhibit 2-13: End of Rail Connectivity along the Beach (km 14.725)

2.22.4.2 Studies Carried Out

Feasibility Study:

The government agency, Rail India Technical and Economic Services (RITES) prepared a feasibility study for the railway connectivity/alignment;

- To identify the most suitable point for the takeoff from existing Thiruvananthapuram and Nagarkovil railway line.
- To study the alternatives and identification of most suitable location for setting up of railway transit yard for storage, handling and loading/unloading of containers and cargo initially and also for integrating the same with the dedicated railway line subsequently.
- To study the most suitable rail alignment between Vizhinjam port and the point of connection with Southern Railway in consultation with Southern Railway.

Detailed Project Report (DPR):

Another government agency, Rail Vikas Nigam Limited (RVNL) conducted a study and submitted a DPR for the rail connectivity to the proposed Vizhinjam port by exploring the alignment. The DPR describes the salient features of the rail connectivity from NEM to Vizhinjam. Technical details including the civil engineering, signal engineering and electrical engineering and other technical aspects of the project are also described. Cost estimates giving the detailed estimate of the project (Separate estimate for Civil, Electrical and Signal are worked out) and a comparative study of the RITES report and the DPR are also provided in the RVNL report.

RVNL has studied different alternative routes for railway alignment connecting port to nearest SCR line. And these details are discussed in chapter 3. The Nemom option is the finally selected option.

The complete details and analysis of all the alternatives for both road and rail is provided in Chapter 3. Exchange Transit yard at Vizhinjam is the point where trains are exchanged between the main railway line and the port connected line. Facilities for reception and dispatch of trains are arranged here. The schematic phase-I layout of rail yard within port boundary is as shown in **Figure 2-8**.

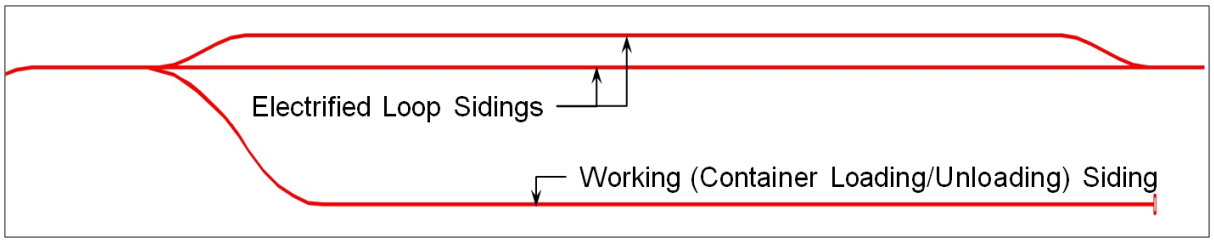


Figure 2-8: Schematic Layout of Rail Yard within Port Boundary

2.22.4.3 List of Major and Minor Bridges

There are three existing major bridges proposed to be rebuilt to accommodate the new alignment and two new additional Road over Bridges (RoBs) which will have to be constructed. The details of which are given below:

1. Bridge No. 35 is a major RoB at km 228.450 along the mainline chainage having and existing 3 x 9 m span aqueduct which carries water from Neyyar dam to the hinterlands. It is just outside the NEM station top point (to BAM side) and the existing vertical clearance is only 4.89 m. As this is an aqueduct (gravity flow) and since it is near to the NEM station, it can be rebuilt as four spans of 9.0 m aqueduct with the same vertical clearance (with condonation).
2. At chainage km 1.560, along km 228.500 in the mainline chainage, there is an existing RoB (Bridge No. 36) with 2.0 x 12.05 m span RCC slab - which connects the NH at Nemom to Kattaakada and hence is important. This is just outside the NEM station limits (km 227.70). As the gradient of the proposed track follows the same gradient from NEM station to chainage km 2.175 toward Vizhinjam, the existing RoB can be rebuilt and extended with 6.575 m Vertical Clearance (VC) now 5.59 m only to suit three tracks (existing line + new line + future doubling).
3. At chainage km 4.566 (km 231.522 km in the mainline chainage), there is an existing RoB (No. 47) with 2.0 spans of 12.05 m girder and slab and a vertical clearance of 10.87 m. The proposed new alignment comes to the western side of the existing track (i.e. to the left of the track). Ground Level (GL) = 57.481 and the proposed Flood Level (FL) = 49.244 (cutting of 8.237 m) and hence proposed to be extended as 3.0 spans of 12.05 m (existing line + new line + future doubling).
4. At chainage km 5.900 a new RoB will be constructed over a pond and a village road. GL= 57.636 and proposed FL= 56.827 (0.809 m cutting). RoB 20 m I girder (as proposed in the DPR). In the DPR alignment, the cutting was for 3.492 m and now it is favorably reduced to 0.809 m.
5. A new RoB will be built at chainage km 5.600 (Cutting) in the DPR alignment where there was maximum cutting of 14.678 m. It is located at village road connecting Madavurpaara and Balaramapuram. GL= 66.422 and proposed FL= 55.827 (cutting of 10.595 m). In the DPR alignment, the cutting was for 14.678 m and now it is reduced to 10.595 m. Proposed RoB of 40 m I girder as in the original DPR.

The details of existing and new minor bridges are given in the **Table 2-30** and **Table 2-31** respectively.

Table 2-30: List of Existing Minor Bridges

S. No.	Bridge No.	Mainline Chainage (km)	Chainages (km)	Span (m)	Type	RCC Box Proposal (m)
1.	37	228.910	2.015	1.83 X 1	RCC slab	1.0 x 2.0
2.	38	229.130	2.160	1.20 X 1	Pipe	1.0 x 1.5
3.	39	229.630	2.656			
4.	40	229.642	2.680	1.83 X 1	RCC slab	1.0 x 2.0
5.	41	229.962	3.034			
6.	42	230.325	3.385	1.20 X 1	Pipe	1.0 X 1.5
7.	43	230.513	3.570	1.83 X 1	RCC slab	1.0 x 2.0
8.	44	230.672	3.720		Box Culvert	
9.	45	231.135	4.230	1.00 X 1	Pipe	1.0 x 1.5
10.	46	231.300	4.345	3.66 X 1	Box Cul (Syphon)	1.0 x 3.66
11.	48	231.640	4.682	1.20 X 1	Pipe	1 x 1.5

(Source: RVNL - 2011 & 12)

Table 2-31: List of New Minor Bridges

S. No.	Bridge No.	Chainage (km)	Span & Type Proposed	Reduce Level	Flood Level
1.	VM*-5	6.170	1.0 X 3.00 X 2.50 RCC Box	56.969	56.294
2.	VM-7	6.815		57.769	57.094
3.	VM-8	7.115		54.769	54.094
4.	VM-9	7.370		52.219	51.544
5.	VM-11	7.840		47.519	46.844
6.	VM-16	9.475		37.543	36.868
7.	VM-17	9.915		34.776	34.101
8.	VM-19	10.323		32.442	31.767
9.	VM-20	10.625		31.500	30.825
10.	VM-21	11.005		30.316	29.641
11.	VM-22	11.405		29.070	28.395
12.	VM-24	11.760		26.993	26.318
13.	VM-25	12.465		20.522	19.847
14.	VM-26	12.825		17.217	16.542
15.	VM-27	13.232		13.481	12.806

Where VM stands for Vizhinjam** ***(Source: RVNL - 2011 & 12)

2.22.4.4 List of Road under Bridges (RuBs)

List of RuBs to be newly built are given **Table 2-32**.

Table 2-32: List of Road under Bridges (RuB)

S. No.	Bridge No.	Chainage (km)	Span Proposed (m)	Proposal (m)	Ground Level	Reduce Level	Flood Level
1.	VM-6	6.475	6 x 40	PSC	49.644	59.419	58.744
2.	VM-10	7.600	1 x 20	I girder	36.310	49.919	49.244
3.	VM-12	8.150	4 x 20	I girder	35.047	44.419	43.744
4.	VM-13	8.575	1 x 20	I girder	32.357	40.169	39.494
5.	VM-14	8.875			34.161	41.669	40.994
6.	VM-15	9.175			31.959	39.430	38.755
7.	VM-18	10.250			25.227	32.669	31.994
8.	VM-23	11.625			20.647	27.787	27.112

(Source: RVNL - 2011& 12)

2.22.4.5 Major Features along the Proposed Railway Alignment

1. At Chainage km 5.375 (km 232.3 along existing route) there is a 66 KV High Tension (HT) Line crossing the existing track. The alignment chainage is about 162 m to the western side of the existing track. The GL= 47.156 m and the proposed FL = 55.077 m above mean sea level (7.921 m above the GL) and hence an elevated structure is proposed. The HTS line will have to be raised to more than 12 m at this chainage.
2. At chainage km 5.050 (between km 231.9 and 232.2 in the existing track) is a tunnel of 204 m long. Due to the infringement in the tunnel, there is a permanent speed restriction of 15 km/hr for passenger trains and 30 km/hr for goods train. The new alignment is proposed to be taken 30 m away from the tunnel to the western side and the proposal is given in the **Figure 2-9**. The GL is 67.137 m and the proposed FL is 53.994 (cutting of 13.143 m) and hence a box culvert is proposed with leading and trailing cutting to this box.
3. At chainage km 4.650 km, to the side of 231.6 km in the existing track, there is a small private temple (kaavu kshetram or Sacred Grove), located about 18.2 m away from the track. This private temple is located in the proposed alignment and hence needs to be shifted.
4. At chainage km 2.800 is an unmanned Level Crossing (LC) No. 5 between 229.7 km and 229.8 km used by private vehicles. The GL at this location is 27.457 m and the proposed FL at this location is 31.494 m (4.037 m high) and hence a box is proposed. As the proposed track will be above the road on box, the vehicles in the box culvert will have low visibility while crossing the existing track. So it is proposed to man this LC at this projects expense.

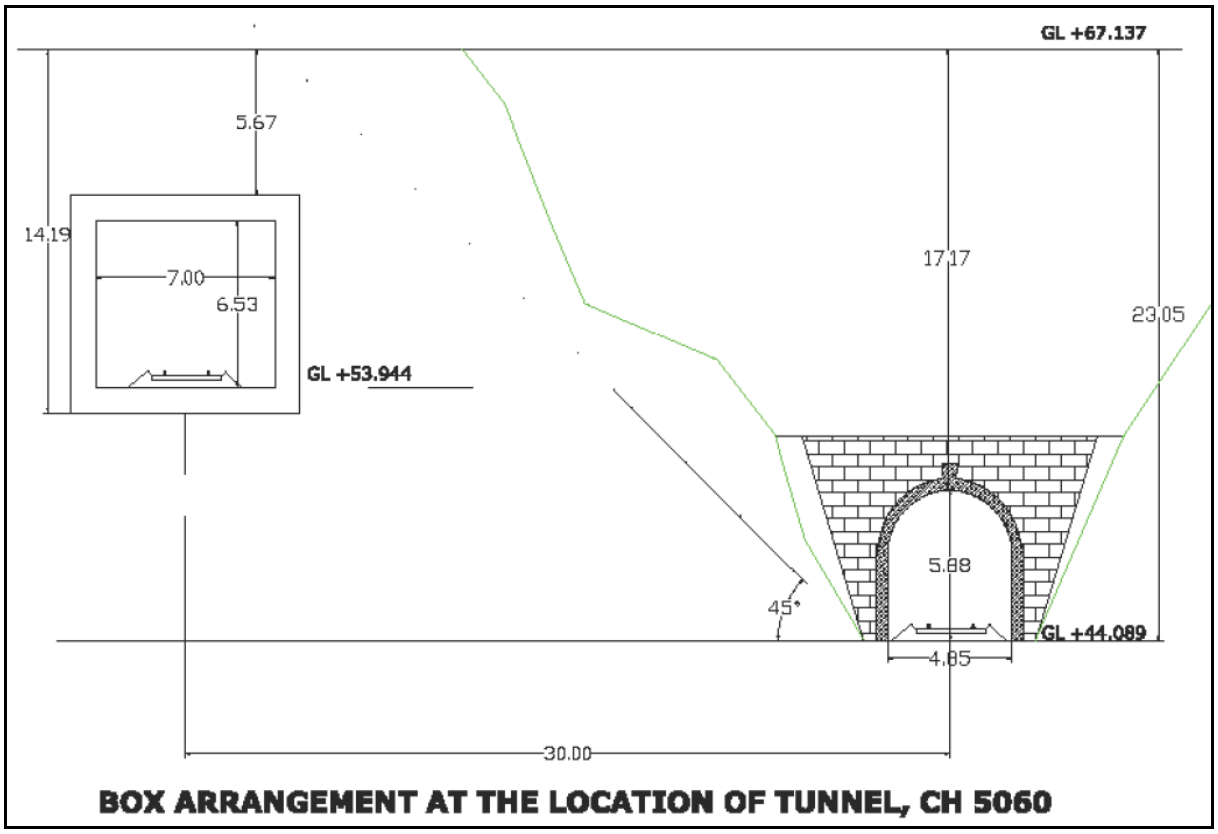


Figure 2-9: Proposal at the Side of the Existing Tunnel

2.23 Ancillary Sites of Vizhinjam Port

The ancillary sites and facilities are for developing (1) warehouse area (2) Port Annex Facility (PAF) zone which includes truck terminal & residential area and (3) port backup areas for administrative and

other office requirements. An ESIA was carried out by LTR for these three ancillary sites. In order to get focus for these geographically isolated pieces of development, each ancillary site was treated individually. The details provided here are derived from the EIA report prepared specifically for the ancillary sites. A Google imagery showing the ancillary sites is given in and **Figure 2-10** and the ancillary sites on a topographic map are given in **Figure 2-11**. The land procured, notified and to be notified is given in **Table 2-33**.

Table 2-33: Land Procured, Notified and to be Notified

S. No.	Location	Land Procured/Notified		Land to be Notified & Procured		Total	
		(Acres)	(Ha)	(Acres)	(Ha)	(Acres)	(Ha)
1.	Backup Area	44.39	17.97	13.31	5.39	57.70	23.36
2.	Road	18.63	7.54	5.99	2.43	24.62	9.96
3.	PAF zone	49.10	19.88	0	0	49.10	19.87
4.	Warehouse	102.58	41.53	0	0	102.58	41.53
5.	Railway	0	0	112.83	45.68	112.83	45.68
Total		**214.70**	**86.92**	**132.13**	**53.49**	**346.83**	**140.42**

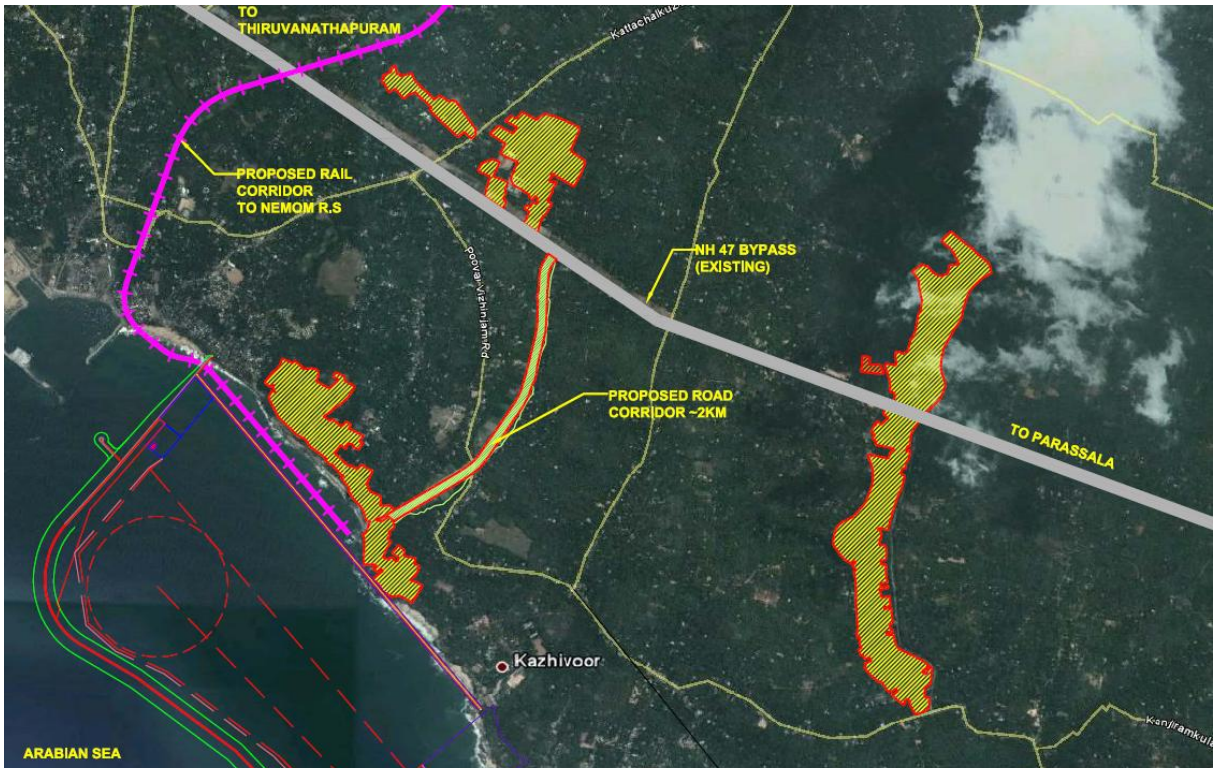


Figure 2-10: Google Imagery showing Ancillary Sites of proposed Vizhinjam Port

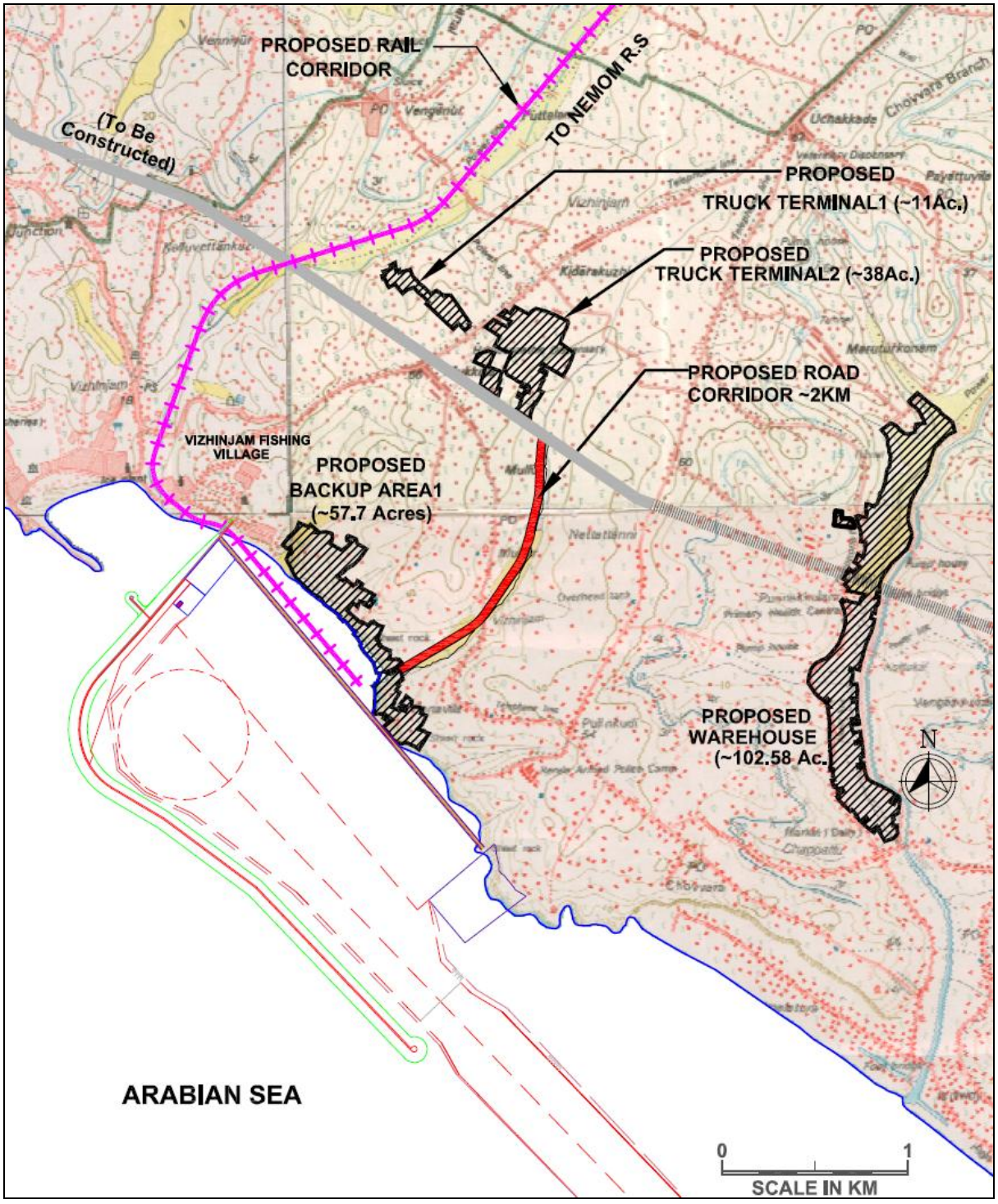


Figure 2-11: Topographic Map with all Ancillary Sites of Proposed Vizhinjam Port

2.24 Pollution Control Aspects

One of the essential regulatory functions of a port authority is to ensure that the port waters are free from pollution. The main sources of pollution in the port are:

- Discharge of oil by ships/crafts.
- Discharge of bilge by ships/crafts.
- Discharge of dirty/contaminated ballast by ships.
- Discharge of cargo overboard.
- Spillage of cargo during unloading/loading operations.
- Discharge of garbage, sweepings, sewage, etc.
- Discharge of industrial effluents.
- Municipal sewage and drainage.
- Smoke from ships, vehicles.
- Noise from vehicles, machinery.

Containers being low hazardous cargo, no specific pollution control facilities are required for a container terminal. The following steps will be taken for pollution control at the port:

- For containment and cleaning of oil spillage from fuel stations, a special drainage system will be planned for the area which can separate oils from drain water. The reefer wash down area will also be provided with an oil-sediment separator unit as part of the drainage system.
- For containment and cleaning of oil spillage from vessels, a portable inflatable type oil spill containment booms and oil skimmer is proposed.
- High mast lights with shielding arrangements will be used at the terminal to minimize light pollution.

The port is envisaged as a green port and usage of eRTGs and hybrid ITVs is proposed amongst other measures to reduce the environmental impact of the port. In addition, the port is planned as a world-class facility with efficient systems that minimize processing times which reduce fuel consumption and air pollution, thus positively impacting the environment.

2.24.1 Drainage and Sewerage System

2.24.1.1 Drainage System

The drainage system needs to be designed to minimize the potential pollution in the port basin. The rainy season persists during the Southwest and the northeast monsoon. May to November is the wettest months of the year with an average rainfall in excess of 220 mm per month, with a maximum of 356 mm in June. The average annual rainfall is around 1800 mm. The average number of rainy days per year is 132 days. The maximum rainfall intensity has been taken as 30 mm/hr.

It is proposed to lay the trench drain parallel to the proposed internal road. These drains are connected through various cross drains bringing the water from the different areas of the terminals covering the port operational buildings. All the drains will be of Random Rubble (RR) stone pitched and grouted with cement mortar of 1:4.

A drainage system will be provided below the stacking area, with buried perforated drain lines. An impervious layer will be placed in the ground below these transverse drain lines. The storm water runoff from the yard area and adjacent roads will be collected, via trenches and buried pipelines. The **Figure 2-12** shows a typical arrangement for drainage system over gravel bed container pavement.

The wastewater from the administrative offices, transit sheds and all other buildings will also be connected to the storm water drain. The waste water collected from the workshop will be treated in an oil skimmer before disposing off to the storm water drain.

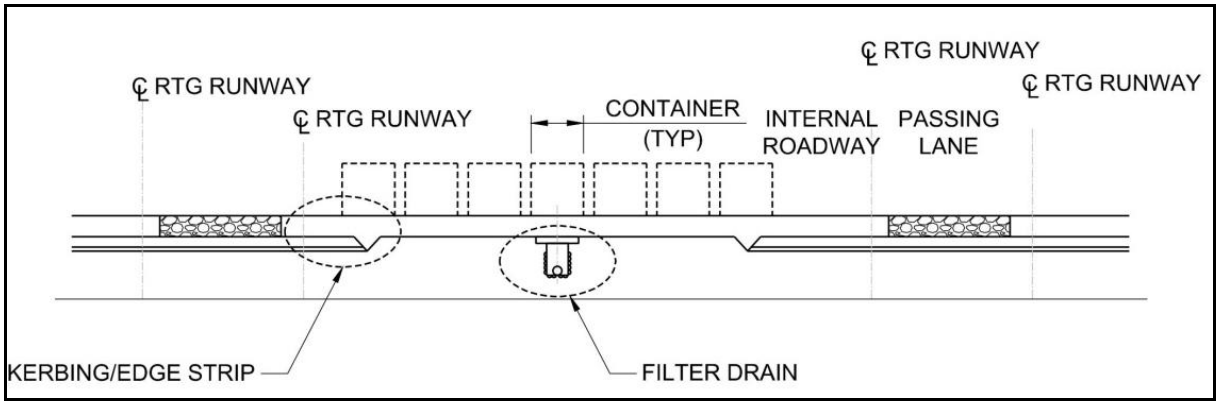


Figure 2-12: Typical Representation of Drainage for Gravel Bed Pavement in Container Yard

2.24.1.2 Sewerage System

The sewerage system is limited to the areas wherever office buildings, canteens, and other operational buildings are constructed. For the isolated buildings where the quantity is negligible, it is proposed to construct septic tanks with soak pits for disposal. For port buildings and township, it is proposed to provide a Sewage Treatment Plant (STP) of 100 KLD and 350 KLD respectively. The treated sewage shall be used for green belt development. During monsoon months, the sludge will be stored separately in a storage structure with adequate capacity. The treated water will be discharged into the main drainage system of the port. The sludge from the treatment plant will be processed and converted into Biomass used as manure.

The ships will not be allowed to discharge their sewage in the port complex. As per MARPOL convention, the ships are now required to have a Sewage Treatment Plant (STP) on board. In the initial phase of development, no STP has been planned in the port complex.

2.24.2 Solid Waste Management

The solid waste generation will be basically from 2 sources – cargo handling and the garbage/ human waste. The cargo envisaged at the port is primarily container cargo. The garbage and human waste generation will be minimal and is proposed to be disposed using the normal measures. The solid waste generated by humans during the initial phase is expected to be of the order of 1000 kg/day the garbage will be carried through covered trucks and disposed at the designated dumping grounds proposed by VISL for compost/landfill in the locality.

2.24.3 Green Areas and Greenbelt Development

A Greenbelt Development Plan will be implemented around the various project components of Vizhinjam port. This will help to achieve environmental protection and mitigation of pollution levels in the area. Both road length of 2.0 km and rail alignment of 15 km will be planted with strip plantation on both sides. The road sides will be mostly planted with flowering trees such as Kanikonna (yellow flowers) and Arali (red flowers) trees. The periphery will include Ashoka of coniferous category. This is mainly because the strip plantation area may be required for future expansion programs, if any.

2.25 Coastal Regulation Zone (CRZ) Compatibility

The Centre for Earth Science Studies (CESS), Thiruvananthapuram has carried out demarcation of High Tide Line (HTL), Low Tide Line (LTL) and Coastal Regulation Zone (CRZ) for the project site. Field investigations were carried out in which geomorphic and other signatures such as berm crests, seawalls, embankments and intertidal zone have been used to identify the HTL. The distances to the identified HTL was measured with respect to known points such as survey plot boundaries and transferred to the base map. Existing land use and landform in the project area have been used for the identification of CRZ categories.

The project area does not have any sensitive ecosystems such as mangroves, sand dunes, corals, etc eligible to be categorized as CRZ IA. As per the CZMP of the State the land part adjacent to the project site belong to CRZ I and CRZ III. Vizhinjam panchayat has now become part of Thiruvananthapuram Corporation. Hence the developed areas in the erstwhile Vizhinjam panchayat may be categorized as CRZ II when CZMP (2011) is implemented. Port development is a permissible activity in the CRZ except in CRZ IA. The site proposed for port development does not have any CRZ IA area. The Area of Outstanding Natural Beauty and the 50 m zone adjoining the lateritic cliff edge, categorized as CRZ I in CZMP (1995), is not relevant for CRZ (2011) and has not been considered for CRZ I categorization.

The project area does not have any sensitive ecosystems such as mangroves. The proposed construction of breakwaters and port development are permissible in CRZ subject to conditions as per the CRZ Notification 2011 as it requires waterfront and foreshore facilities.

The project layout superimposed on HTL, LTL and CRZ setbacks is given as **Figure FD0203**.

2.26 Project Cost

The Vizhinjam port will be developed in a phased manner. The capital cost estimate for development of Phase-I of the port is estimated at **₹ 5,187 Crores**. The breakup is provided in **Table 2-34**.

Table 2-34: Capital Cost for Phase-I Development

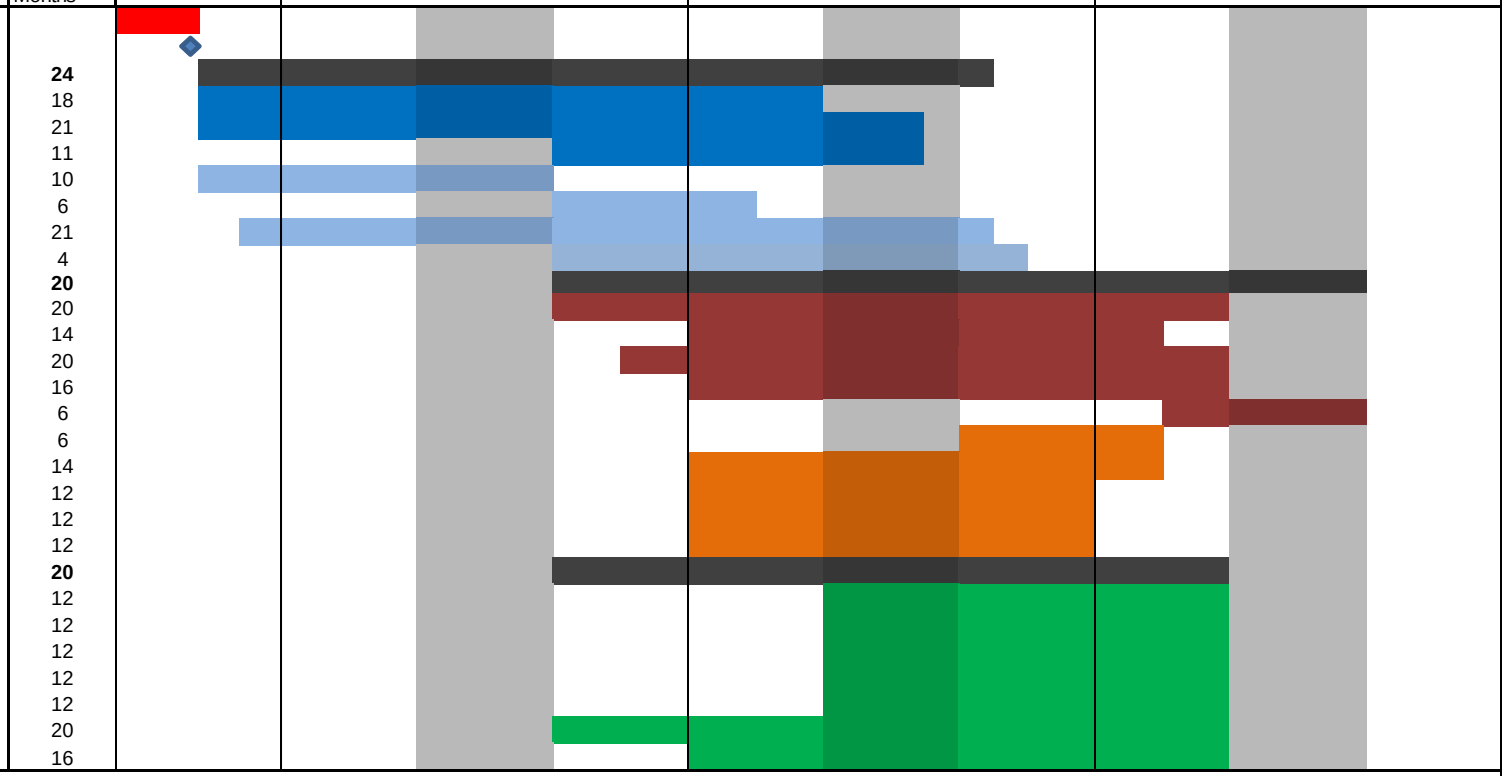
S. No.	Description	Phase-I (in ₹ Crores)
1.	Port Facilities (VISL + Private Operator)	3640 (2332 + 1308)
2.	Road	60
3.	Rail	350
4.	Power	50
5.	Water	10
6.	CSR & EMP Costs (5% of 2332 crores plus 5% of VISL portion of phase-I port costs i.e. 470 crores)	140
7.	Land Cost (140.42 Ha)	937
	Total	**5,187**

2.27 Project Implementation Schedule

It is aimed at to achieve commissioning of the phase-I port with in a period of 38 months. The project implementation schedule is given in **Table 2-35**.

Table 2-35: Project Implementation Schedule for Phase-I Development

Vizhinjam Port Implementation Schedule	Approx. Duration in Months
EPC Activities & Mobilization	
Start of Construction	
Harbour Construction	**24**
Breakwater Construction	18
Dredging - Approach Channel	21
Dredging - Harbour Basin	11
Reclamation Bund	10
Shore Protection Revetment	6
Reclamation	21
Ground Improvement	4
Container Terminal	**20**
Container Berth	20
Container Yard & Paving	14
Equipment Acquisition	20
Buildings & Other Infrastructure	16
Commissioning	6
Port Craft Berth	6
Coast Guard & Navy Berths	14
Cruise cum Multipurpose Berth	12
Fishery Berths	12
FLC Buildings & Infrastructure	12
Ancillary Infrastructure	**20**
Container Freight Station (CFS)	12
Warehousing/Distribution Center	12
Truck and Rail Terminal	12
Commercial Facilities	12
Residential Facilities	12
Road/Rail Access Within Port	20
Utilities	16



Chapter 3
Analysis of Alternatives

Chapter 3 Analysis of Alternatives

3.1 Analysis of Alternatives for Site Selection

Analysis of alternatives is one of the most important steps that must be followed to enhance the overall 1) positive impacts of the project and 2) minimize the negative impacts of the project. This is particularly true in the case of social impacts. Avoidance of all major impacts along the dropped alternative alignments could be rated as the best impact mitigation achieved by way of avoidance strategy. The Vizhinjam port project is one of the most ever studied port project in the country, especially during the pre-project scenario. Undoubtedly all aspects of this project has been studied in depth, consulted and analyzed before being finalized.

Ever since the proposal for a port in the vicinity of Vizhinjam region, there had been several additions and deletions with regards to the nature of the deepwater port and its proposed capacity and infrastructure requirements. This has resulted in a progressive evolving of the project to the current scope with the latest addition of a defence berth during March 2013; in addition to an already planned coast guard berth. With the current scope, the viability of the project has increased many folds as the defence requirement (including coast guard) at this location cannot be easily quantifiable. This is all about the safety and security of the country with over 1.3 billion people. This is more important as the shallow nature (12.5 m draft) of the Cochin port with very high magnitude of maintenance dredging every year. Therefore Cochin port cannot act for the future swift operational requirements of defence vessels. Especially when considering the latest size and space requirements. *Therefore it can be concluded that* ***Vizhinjam would add to the countries military teeth in the south even as China ramps up presence in neighbouring Sri Lanka and Maldives within an ear shot from Thiruvananthapuram (Business line, April 2, 2013)***. Since the situational requirements of defence are fast changing, this is no way negating the requirements and importance of the Cochin port.

The important additions are the **additional fish landing centre, berth for navy** and **cruise terminals**. While the fish landing centre with doubling of capacity will largely address all parking related issues during monsoon season, the cruise terminal is to include the ever increasing tourism prospects of the region and also to negate any otherwise negative impacts to tourism industry. Based on the latest vision, the project land area requirement (for backup area and all other facilities) also substantially changed/improved due to the pro-people land acquisition policy of GoK. As a whole any complaint or stakeholder concern based "*on the latest requirements* and *old analysis of alternatives*" will be cleared. Here one important point on conclusion is emerging; that is the old analysis of alternatives and site selection of Vizhinjam location is final and complete in all respects with all the old criteria's as mentioned in original siting study. Any attempt to mix the old scenarios and new scenarios will result in incorrect values as the project is evolving with newer possibilities. Almost all concerns received in this direction are of this type.

With all the above major changes representing present condition and the old analysis of alternatives were provided in 0-100 scale, in the remaining part of this chapter.

3.2 Identification of Suitable Alternative Sites

The maximum required draft in the port area is about 17.0 m as per the siting report, 2003 and hence it is clear from **Figure 3-1** that the required draft can be easily accessed in a shorter distance from the

shore as the 20 m contour starts converging towards shore from the south of Kollam (Quilon).

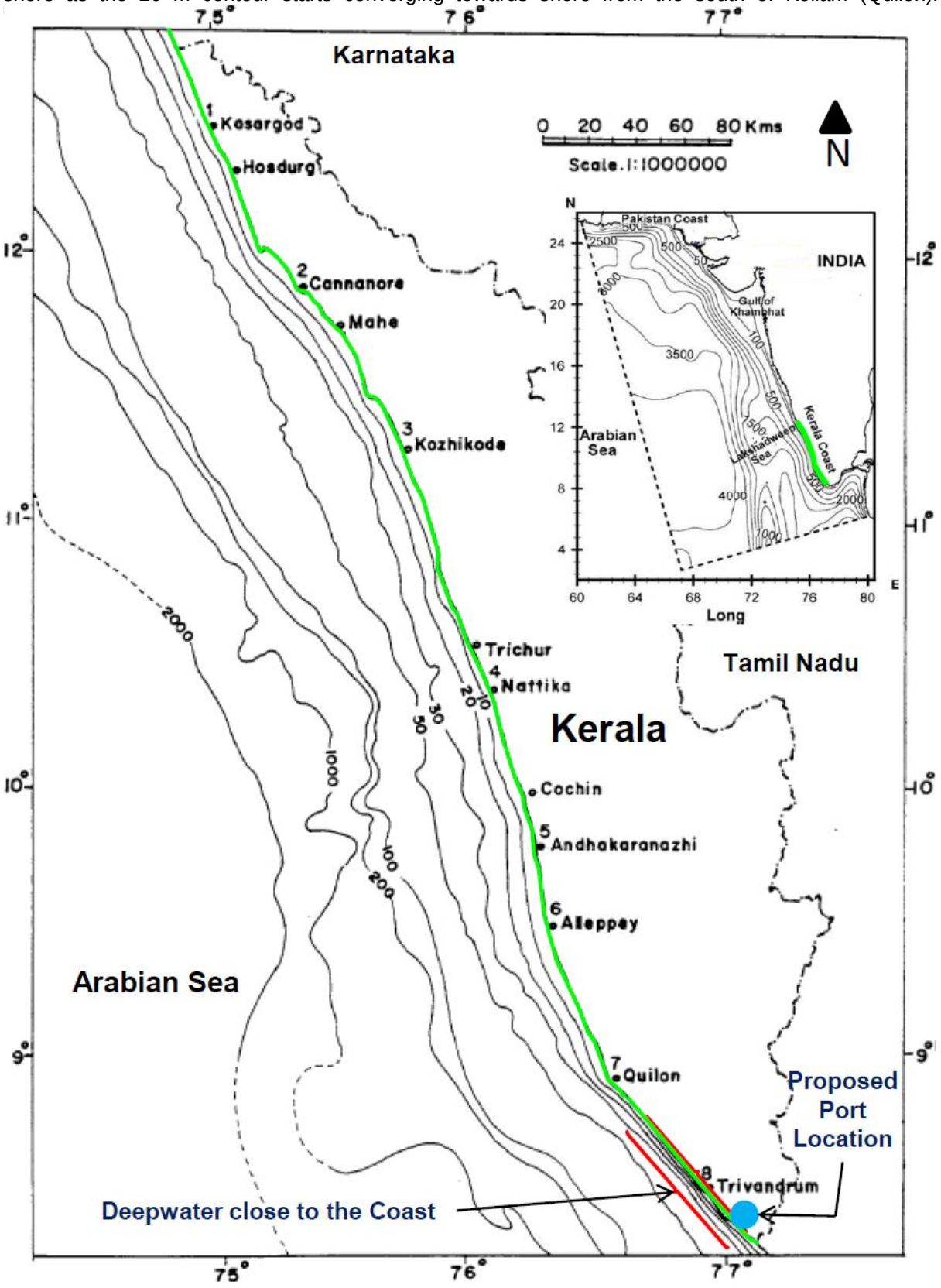


Figure 3-1: Depth Contours showing Location of Proposed Vizhinjam Deepwater Port

The 20m contour reaches a much closer distance near Vizhinjam. This makes the place much suitable for the deepwater port development. The coastal stretch identified at the southern part of Kerala for a

possible development of a transhipment hub is between Vizhinjam fishing harbour and all the way down to the southernmost village in Kerala, Poovar; because the northern side of vizhinjam is eroding and also the coast is more dynamic especially till Kollam (Based on “Status of Shoreline Change sue to Erosion and Accretion”, IOM Anna University Chennai & MoEF). In regards to the identification of possible site for a major port, the following criteria/considerations have led to the selection:

- Port Development
- Operational & Navigational
- Hinterland Connectivity
- Environmental Aspects
- Social Aspects
- Cost

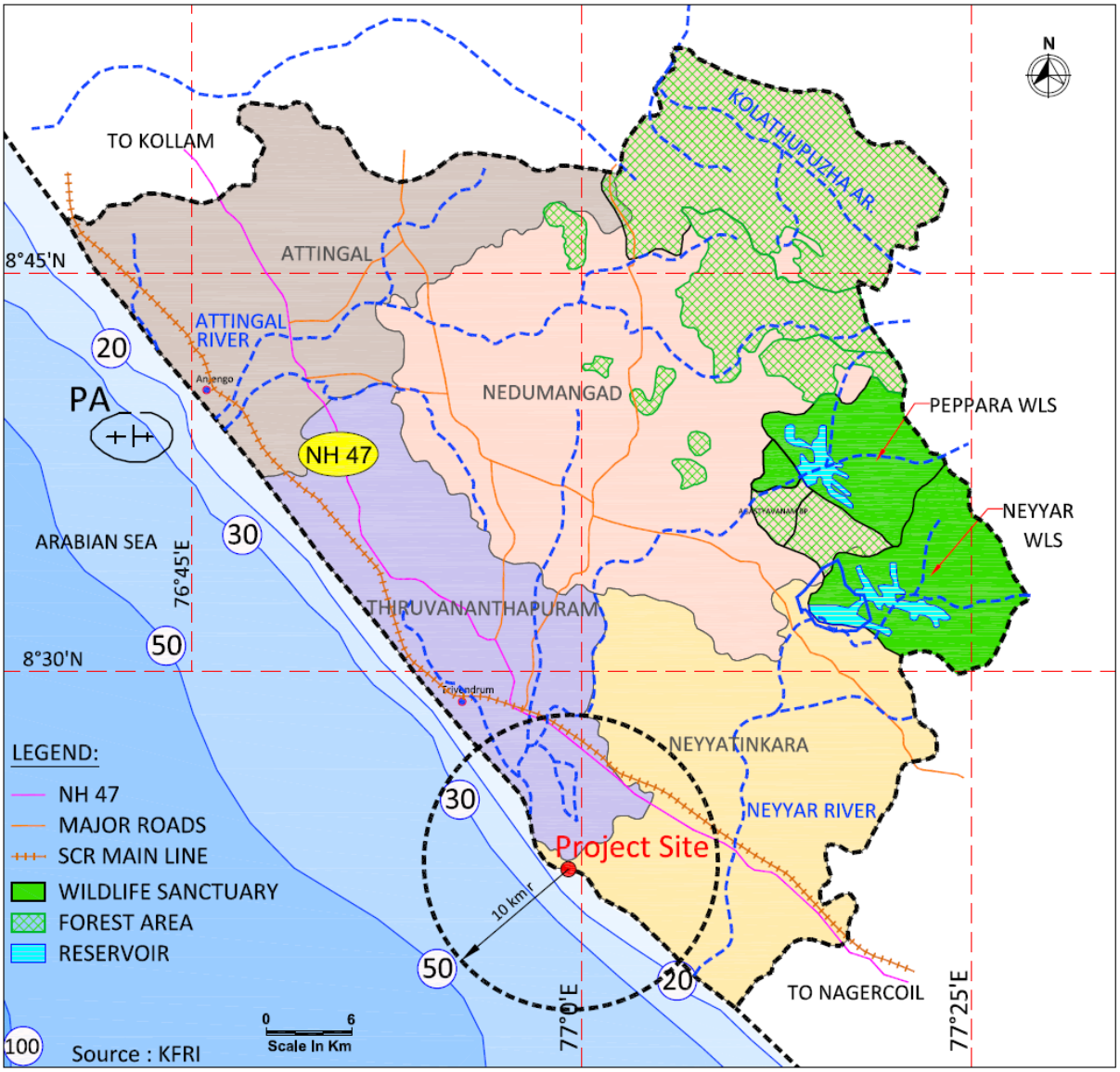


Figure 3-2: 20 m, 30 m, and 50 m Contours along Coast between Kollam (Quilon) - Kanyakumari

Based on the above six major criteria, three potential sites A, B and C as shown in **Figure 3-3** have been investigated for the port development. Along these three sites, the 10 m contour lies between 200 to 1000 m from the coast, the 20 m contour lies between 1300 to 1800 m from coast and the 30 m contour lies between 2500 to 4000 m from the coast. The tendency is that the coast is somewhat steeper at the southern end than at the northern end of Kerala.

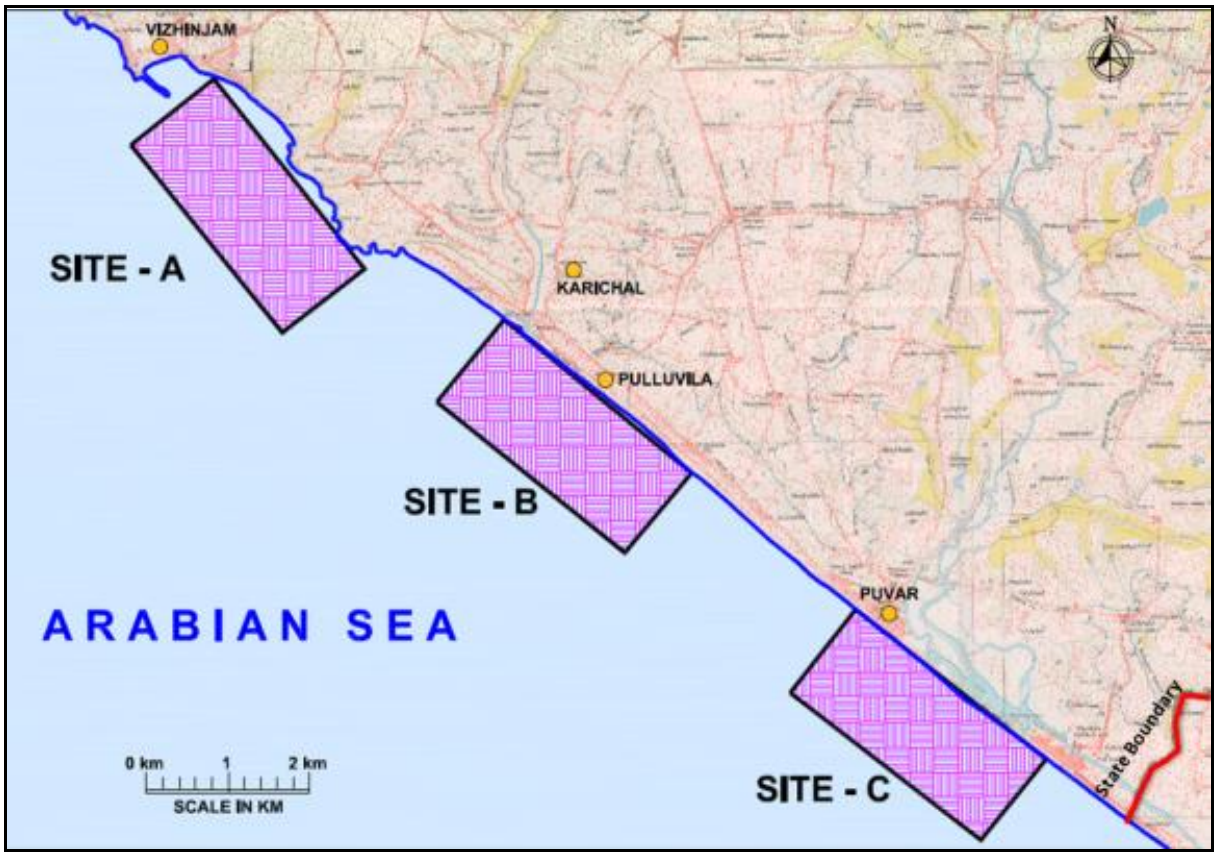


Figure 3-3: Alternative Identified Sites with Poovar (Site C) very close to Tamil Nadu Boundary

Table 3-1: Description of Site and Location

SITES	LOCATION	DESCRIPTION
Site A	Vizhinjam	Location from the southern breakwater of Vizhinjam fishing port to the promontory of the coastal hillocks 2.5 km further south-east.
Site B	Pulluvila	Location from Karichal River and 2.5 km towards Southeast in front of Pullivila
Site C	Poovar	Location in front of the backwaters around the mouth of River Neyyar, from Poovar and 2.5 km towards Southeast.

The site C at Poovar has a major disadvantage as neyyar river backwater is present and also it is very close to the State border with Tamil Nadu as shown in **Figure 3-3**. This will have serious implications for GoK with regards to several administrative issues. The most of them were sought after induced positive economic development will be haphazard and uncontrollable when located in two States with all investments by GoK and the developments shared by two states. Although logically correct, technically this cannot be included in the analysis as both states are equally important with regards to the Union of India. Therefore this attribute is not part of the site selection analysis.

3.2.1 Scenarios

As described in the introduction, the project vision has evolved over a period of time starting from 2003 to 2012 and still continuing to evolve for the better with regards to the study objectives. Therefore to get a complete idea of the site selection analysis, we have considered three scenarios. In this case, the variable is the **Site A** development concept. There are three scenarios considered over a period of time since the inception of the project studies, viz:

S. No.	Scenarios	Reference Year
A.	Project planned during 2003 based on the Original Siting studies	2003
B.	Analysis based on Technical Feasibility Report (Basis of approved ToR)	2011
C.	Analysis based on today's latest project concept till April 2013	Present

3.2.1.1 Attributes

The 21 attributes that are used for the scoring purpose and its specific details about each attribute are explained in the subsequent sections. A list of attributes is given in **Table 3-2**. Each attribute is then divided into one or more parameters that may influence each site for selection.

General Scoring Criteria for Impact rating:	
1	Implies positive or that there is no impact to the site due to a specific parameter
2	If the site is neutral to any change
3	For negative impacts that may happen because of the influence of a specific parameter on the site
0	Not Applicable (NA)

The sum of these values under each attribute is then multiplied with a weightage value designed based on its importance (or relevance) at the location. These scores are considered to be the final score based on which the site is selected. The minimum the score, the maximum will be the suitability of the site for port development. **Assigned Importance Weightage (AIW) values:** Weightage for each attribute is given in the **Table 3-2**. This weightage will be same for all the scenarios and only the rating values will differ between alternative sites and between scenarios.

Table 3-2: Attributes and their Importance Weightages

S. No.	Attribute	AIW Values
Port Development		
1.	Level inland area available	10
2.	Required Water Depths available	10
3.	Required Water area available	1
4.	Harbour protection works required	10
Operational & Navigational		
5.	Safety of navigational approach	1
6.	Ease Maintenance dredging	10
Hinterland Connectivity		
7.	Easiness of Access to Hinterland (terrain)	5
8.	Distance to NH-47	1
9.	Distance to Railway line	1
10.	Access to public supplies(power & water)	5
Environmental Aspects		
11.	Coastal Regulation Zone	10
12.	Impact to Ecologically sensitive areas	10
13.	Impact to Existing river system (diversion)	10
14.	Change in shoreline	10
Social Aspects		
15.	Impacts on Fishing activities	10
16.	Impacts to Tourism Activities	10
17.	Land Acquisition/loss of land	10
18.	Operation impact on livelihood quality	10

S. No.	Attribute	AIW Values
19.	Resettlement and Rehablitation impact	10
Comparative Costing		
20.	Capital and Land Acquisition	1
21.	Operation & Maintenance	1

Attributes having influence on environment, morphology, social aspects are given a higher weightage of 10, the attributes having technical influence are given a value one (1) and if they fall under any partial influence with greater importance over technical part then they are given a value five (5). **Attributes and Parameters:** The following attributes are the main considerations for scoring. Each attribute have their own parameter that relates the attribute and the site to be scored. The parameters are given in this section.

3.2.1.2 Port Development

The **Table 3-3** is the attribute details considered relating to port development considerations.

Table 3-3: The Attributes relating to Port Development

Attribute	Parameter		
Level Inland Area available	Topography	Terrain	Rocky
			Level
			Undulating
			Marshy
		Usage	Cutting
			Filling
	Land Usage	Resorts	Small
			Medium
		Fishermen Dwellings	
		Land	Plain
			Coconut Plantation
	Source of Availability	Ownership	Fully Private
			Partly Private owned/Partly Govt. owned
			Fully Govt. Owned
Required Water Depths available	Depth		15-17 m
			18-20 m
			21-23 m
	Dredging		for 15-17 m depth
			for 18-20 m depth
			for 21-23 m depth
Required Water Area available	Manoeuring		if BW* Parallel to coast/Perpendicular to coast
	Berthing		safe stopping distance
	Flexibility of phase wise construction		if BW Parallel to coast/Perpendicular to coast
Harbour protection works required	Wave Incidence & Tranquility		if BW Parallel to coast
			if BW Perpendicular to the coast
	Shoreline Protection based on Littoral Drift		North of Port
			South of Port
			Both Sides

*where BW is breakwater

3.2.1.3 Operational & Navigational

The **Table 3-4** is the attribute details considered relating to Operational/Navigational considerations.

Table 3-4: Attributes relating to Operational and Navigational

Attribute	Parameter	
Safety of navigational approach	Maneuverability (Wave Hitting the Beam of the Ship)	if BW Parallel to coast
		if BW Perpendicular to the coast
Ease of Maintenance dredging	Maneuverability (Wave assisted entry)	if BW Parallel to coast
		if BW Perpendicular to the coast

3.2.1.4 Hinterland Connectivity

The **Table 3-5** is the attribute details considered relating to Hinterland connectivity considerations.

Table 3-5: Attributes relating to Hinterland Connectivity

Attribute	Parameter	
Easiness of Access to Hinterland	Distance to District Road/SH	within 1 km
		within 2 km
		within 3 km or more
	Built-up areas in access to district roads	Low
		Heavy
Distance to NH-47	Distance to NH47	0-10 km
		10 km and above
	Built-up areas in access to NH47	Low
		Medium
		Heavy
	Distance to NH47 bypass	0-10 km
		10 km and above
	Built-up areas having access to NH47 bypass	Low
		Heavy
Distance to Railway Line	Distance to Railway Line	0-10 km
		10 km and above
	Built-up areas along the access to Railway line	Low
		Heavy
Access to Public Supplies	Water Supply-surface water source	
	Built-up area in Water Supply Route	Low
		Heavy
	Power supply Distance to Substation	0-5 km
		5-10 km
	Need for Upgradation in Substation (110KVor 220KV)	
	Built-up area in Power Supply Route	Low
		Medium
		Heavy

3.2.1.5 Environmental Aspects

The **Table 3-6** is the attribute details considered relating to environmental aspects.

Table 3-6: Attributes relating to Environmental Aspects

Attribute	Parameter
CRZ	Restrictions to Port Development falling between HTL & LTL- CRZ I (B)
	Sensitive ecosystems - corals eligible to be categorised as CRZ I A(b) in seaward side

Attribute	Parameter	
	Areas classified as CRZ I (A) in landward side	
Impact to Ecologically Sensitive Areas	Ecologically sensitive areas as per CRZ falling under estuaries, creeks, rivers, backwaters	
Impact to Existing River System	Flow alteration	
	Alteration of sediment transport	
Change in Shoreline	Shoreline	Bay
		Straight
	Degree of Erosion	Rocky/Stable
		Erosion/Accretion
	Sediment Supply From River	

3.2.1.6 Social Aspects

The **Table 3-7** is the attribute details considered relating to social aspects and considerations.

Table 3-7: Attributes relating to Social Aspects

Attribute	Parameter	
Impact on Fishing	Fishing Villages in Shadow Zone	
	Type of Fishing	Shoreseine
		Mussel
		other
	Difficulty in movement of boats	
	Fishing intensity with respect to use of beach front for Fish landing, boat parking, fish drying, etc.	
	Nearness to existing fishing harbour and improved tranquility, lesser accretion & lesser down time	
Impact to Tourism Activities	Resorts in the backup area	1-5 resorts
		5-10 resorts
		10 resorts and more
	CRZ violation by resorts	
	Use of Beach by Resorts	
	River/Backwater Cruise	
Land Acquisition/Loss of Land	Backup Facility	No Land Required
		0-50 Acres
		50-100 Acres
		100-150 Acres
		150 Acres and more
Operation Impact on Livelihood Quality	Fishermen	
	Resort/Tourism Dependent	
	Other induced Development	
R&R impact	Others/Fishing Family	
	Resorts	

3.2.1.7 Comparative Costing

The **Table 3-8** is the attribute details considered relating to comparative costing considerations.

Table 3-8: Attributes relating to Comparitive Costing

Attribute	Parameter
Capital & Land Acquisition	Capital & Land Acquisition
	Flexibility of phase wise Construction & cost involved
O&M	Dredging
	Phase wise development of Breakwater

Impact Scoring: Final scores are the product of importance Weightage value and impact rating value. Score = (Weightage * Rating), For example: score for the attribute "level inland area available" at **Site A** in Scenario A will be **250** i.e., (10 * 25), Score for **Site B** in scenario A will be **180** i.e., (10 * 18) and Score for **Site C** in **Scenario A** will be **220** i.e., (10 * 22). Final score is calculated as ((Score for Site A)/(total of Site A, B, C))*100 similar for Site B & C. Hence Site A, B and C gets values of 38, 28 & 34 respectively for that particular attribute.

In order to evaluate the conceptual layout plans for the port, the first step is to assess the facility requirements. This report details about the comparative evaluation of the alternate sites and justifications.

3.2.2 Scenario A - Analysis related to Original Siting studies in 2003

This section explains the site selection details based on the project as envisaged originally. This report was prepared based on:

- EIA notification, 1994 (old)
- CRZ notification, 1991 (old)
- United Nations Convention on Law of Seas (1982-2002)

3.2.2.1 Abstract of the Study on Site Alternatives for Vizhinjam Deepwater Port

The details as per the siting study in 2003 are given in subsequent sections.

3.2.2.1.1 Port Development

Comparison between basic needs for the port development such as level inland area available, required water depth available, water area available, and for the harbour protection works helps us to know about the requirement for the initial planning.

Site A	• First stretch from the fishing harbour towards SE of about 3.5 km is a rocky coast with practically no continuous sandy beaches and the ocean waves breaking directly at the steep rocky face. Behind the coast, the steep rocky slopes rise towards a hillock area of 60-70 m height. • Natural depth of 20 - 23 m is available at approximately 2.0 km from the coastline. • Protection is available naturally by the presence of fishing harbour north of the site.
Site B	• Southern promontory to the Karichal River is a stretch of approximately 2.0 km length with 400 to 500 m wide flat foreland in front of a steep rocky face up to a 50-60 m high hillock area. The Sandy beach in front of the village is around 220 m wide at the northern end, reducing to 170 m near Karichal River. Around Karichal River is located a low lying marshy area behind the coast, 500-1000 m wide and stretching around 1.5 km inland from the coastline. The Area is frequently flooded during rains and is not inhabited, but filled with coconut trees, as all other soil areas in the vicinity. Southwards from Karichal River, the sandy coast continues with gently sloping area up from the rear line of the sandy beach. Right from the back of the beach and landwards, the fishing village Pullivila is located.

	• Natural depth of 16 - 20 m is available at approximately 2.0 km from the coastline.
Site C	• Southwards, the sandy coast continues for further 4.5 km, to the bigger village Poovar (in this stretch of 10 km). In between is Karumkulam fishing village, of similar type as the others. South of Poovar, a large low lying area with marshy parts, prone to flooding from the river, backwaters and small hillocks are located around the big Neyyar River. This wetland area stretches along the coast, and due to lack of area behind the coast for fishermen's dwellings. The wetlands seem to have extent of several square kilometres. • Coastal contours are a little less steep here. Natural depth of 20 m is available only at 2 - 3 km from the coastline. • Sandy foreshore is only approximately 50 m, and a rubble mound seawall protecting Pozhiyoor village.

3.2.2.1.2 Operational & Navigational

Operational arrangements and navigational aids for the big regular port area can be laid out in an optimal way as required by the operators.

Site A	• Full port area of 200 Ha will be established as quay apron area by reclamation. • Approximately 2.0 km from the coastline having a natural depth of 20-23 m is an easy and safe approach. • Outer breakwater will be located at water depths of around 18 to 23 m • Breakwater is planned parallel to the coast based on the studies and it was found to be efficient.
Site B	• It is located from the mouth of River Karichal and 2.5 km southwards in front of Pullivila village. • It is assumed that backup area of 50 Ha can be established in the marshy area along Karichal River. This means that the quay apron area will be 150 Ha in the full development by reclamation. • Approximately 2.0 km from the coastline a natural depth of 16-20 m makes an easy and safe approach. The outer breakwater will be located at around 20 m water depth. • Since no study has been conducted relating layout plans, Based on the sediment transport and littoral drift, wave direction the breakwater layout is considered to be perpendicular to the coast to reduce siltation along the approach channel.
Site C	• It is located in front of the Neyyar River backwaters, between Poovar and Pozhiyoor. • It is assumed that backup area of 50 Ha can be established in the wetland area along Neyyar River. This means that the quay apron area will be 150 Ha in the full development by reclamation. • Approximately 2 - 3 km from the coastline is having a natural depth of around 20 m. And the outer breakwater will be located at 20 m water depth. • Breakwater layout is considered to be perpendicular to the coast based on similar reasons as at Site B.

3.2.2.1.3 Hinterland Connectivity

The coastal road (District Road) is running all the way just behind the fishing villages, providing easy access from coastal areas to this local connection road, except for the northern part where the coastal road is behind/on top of the hillock, providing more difficult access to the coastline.

National Highway and Railway Line: Following parallel to the coast around 8.0 km inland. Terrain conditions will permit access from any point of the coast, but with different, somewhat winding routes.

However it was observed during the site visit that people in villages along the shoreline get their drinking water supplies by the panchayat. The villages also have a good network of power supplies although it is learnt that there is an overall shortage of power in the State.

Site A	Presence of cliff behind the coastline poses difficulty for surface linkage access to the site. One alternative could be to use the existing village road connecting the District Road and fishing harbour. However this connecting road is already congested with heavy traffic to/fro fishing harbour and encroachments on the either side of the road. Another alternative could be to make an access from around the base of rocky promontory to Adimulathurai village and from there to District road.
Site B	Village road connecting the District Road at Adimulathurai can access the proposed site. Widening of this road may be needed to cater to road traffic. Other surface linkage connection could be to construct a road/rail corridor along the Karichal River from the proposed port site to the main transport links - NH-47 and railway line at Balaramapuram. Feasibility of such a corridor remains to be checked. The surface linkage passes through heavily built-up area.
Site C	Village road connecting the District Road at Poovar can access the proposed site. Widening of this road may be needed to cater to the anticipated road traffic. Feasibility of construction of railway line from main railway line to the proposed port remains to be checked. The road passes through heavily built-up area. Currently the access to the project is from the Poovar village through a single lane road. This site is connected to NH 47 through a two-lane road till Neyyatinkara village.

3.2.2.1.4 Environmental Aspects

While Site A compares better than Site C, it is apprehended that due to its closeness to neighbouring State; Tamil Nadu, construction of breakwaters at Site C may affect in undesirable changes in the shoreline of Tamil Nadu. Although engineering solutions can be found to minimise the shoreline changes, on this account, Site C is more disadvantageous compared to Site A where such problems can be avoided at Site A.

- Coastal area covering the three Sites A, B & C fall under the Poozhiyur – Pulinkudi and Vizhinjam – Beemapalli stretches in state CRZ map. Site A partially falls under the Vizhinjam – Beemapalli stretch & Pulinkudi – Poozhiyur stretch whereas Site B and Site C fall under Pulinkudi – Poozhiyur stretch as per state CRZ map.
- Entire stretch between Poozhiyur – Pulinkudi, in which Site A (partially), Site B and Site C fall, is classified as CRZ III except for a small area adjoining the laterite cliff zone (0.063 sq. km) which is classified as CRZ I **(CRZ notification, 1991)** considering its susceptibility to slumping and its outstanding natural beauty.
- Stretch between Vizhinjam – Beemapalli, in which Site A partially falls, is a complex coast comprising of rocky areas, laterite cliffs, pocket beaches and barrier beaches. The rocky areas are observed in Mulloor, south of Vizhinjam and the laterite cliffs are observed between Mulloor and Vizhinjam. The entire stretch between Mulloor and Pachalloor is classified as CRZ III except for laterite cliff area between Mulloor and Vizhinjam, in which Site A falls, which is classified as area of outstanding beauty and hence, a 50 m zone was demarcated as CRZ I.
- Perusal of the area under CRZ tabulated by CESS for the above stretches showed that the 50 m zone is 0.0580 km^2. in Poozhiyur – Pulinkudi stretch and 0.1120 km^2 in Vizhinjam – Beemapalli stretch.

Site A	Shoreline in this stretch is rocky characterised with thick laterite capping with exposures of gneissic rocks at the foothills. The beachfront in this stretch is nonexistent or very narrow at few locations. Environmentally sensitive coastal vegetation like mangroves is not observed

	along this stretch.
Site B	Coastal vegetation like mangroves is not observed in this stretch.
Site C	Backup area (swampy area) earmarked for the port is devoid of mangroves. The vegetation observed in the site is mostly represented by local floral varieties i.e. coconut trees.

3.2.2.1.5 Social Aspects

Further there will be an impact on the tourism potential due to decrease in the tourists as the construction and operation of the port could result in loss of beachfront, sea visibility, silt deposition along the shoreline, contamination of beach waters due to ship discharges, harbour wastes etc. and increase in air and noise pollution. This is common to site A and C since tourism resorts were observed at the site.

Site A	• No fishermen dwelling (no coastal backup area available) and no coastal fishing or boat landing (no sandy beach). The fishermen communities are using the beachfront occasionally between Mulloor and Vizhinjam for fishing activity by shoresien method. Development of port in this stretch will affect the livelihood of this community. The coastal stretch at this site shadow zone does not come under active fishing. Fishing activity in this area is confined to deep seas. In addition to the deep-sea fishing, shoresien fishing (also known as long lining fishing) is occasionally reported in this stretch between Mulloor and Vizhinjam. • First stretch from the fishing harbour towards SE of about 3.5 km is a rocky coast with practically no sandy beaches and the ocean waves breaking directly at the steep rocky face. Behind the coast, the steep rocky slopes rise towards a hillock area of 60-70 m height. On the hill slopes overlooking the sea, several tourist resorts are located. Few prominent ones are Coral Beach Resort, Coconut Bay Resort, Soomatheram Resorts and Travencore Estates. • There may be an impact on the tourism potential, especially during the construction period. On the contrary, once the project is completed the deep water port would most likely attract a considerable number of cruise ships per year bringing thousands of tourists to the area, as it is now the case of the ports of Colombo, Seychelles, Maldives etc.
Site B	• This stretch is a plain stretch with a good beachfront and exhibits intensive fishing activity by shoresien method. The beachfront in the area is used for parking the fishing crafts and also used for drying the fish. Compared to the Site A, fishing activity (shoresien) is highly intensive in this stretch. • Site involves land acquisition covering the marshy land along the Karichal River for creating the necessary backup area for the port. Further it also involves land acquisition for providing road / rail links to the port. The villages close to the beachfront viz. Adimulathurai; Pulivilla, Puthiyathura and Karumkulam are basically fishing villages.
Site C	• No fishermen dwelling behind the coastal area. The important aspect in this site is that there is no fishing activity in this beachfront. Further there is no fishing activity observed in the Neyyar River. • Site is located south of Poovar village and extends up to Pozhiyoor village bordering Tamil Nadu. Like Site A, this site also has tourism potential due to the scenic backwater of the Neyyar River. Three resorts are observed on the southern banks of the Neyyar River, which are meant for the tourism promotion in the area. Boating in the Neyyar River is one of the important activities of these resorts. As stated, this site also has some tourist potential due to the presence of the resorts along the Neyyar banks. There could be impact on the tourism front due to the development and operation of the port at this

	site. The landscape in the site is very good with the backwater channels comprising of coconut groves giving a good visual treat to the visitors. Decline in the tourist trips could affect the revenue of the resorts, which will be one of the issues of concern in this site.

3.2.2.1.6 Comparative Costing

The comparison of site costing is done based on the following assumptions:

- Outer breakwater will be located at an average depth of Site A: 22 m, B: 20 m, C: 20 m. As the design significant wave height will not be exceeding 10 m, this difference in water depth in front of the breakwater will not have major influence on the structure of the breakwater from e.g. -17 m upwards. Therefore, the structure above level -17 m is assumed to be equal for the three sites, so the variation in quantities will be additional core fill and cover layer at the lower part of the breakwater (A: 5.0 m extra height, B and C: 3.0 m extra height). Site A has the advantage of using cutting material along the land side for filling. Also the breakwaters planned at Site A is flexible for phase wise construction but, at other two sites the final phase layout should be constructed initially itself.
- Quay wall structure is assumed equal for the three sites, as all will be a wall with draft at harbour basin of 16.0 m, and reaching 4.0 m above datum at the top, total 20-m height. Therefore, the variations in quay aprons cost will be the difference in width of the area: Site A: 800 m, B: 600 m, C: 600 m; as well as in the water depth of the area to be reclaimed. In addition to the above mentioned reclamation, Site B & C have reclamation of wetlands of 50 Ha each, which are assumed to be of 4.0 m height.
- Where the natural seabed in the harbour basin and approach channel is situated above -16 m, dredging down to the mentioned levels are calculated as differential cost (Site A: nil; B and C around half of the basin).
- Diversion of river may be taking place at Site B and Site C. Estimation of costs is based on the following assumptions:
    - Site B – Bottom at – 2.0 m, width 50 m, length 10.8 km
    - Site C - Bottom at – 3.0 m, width 75 m, length 1.4 km
- Maintenance dredging for Site A very minimal compared to Site B & C.
- All other facilities and infrastructure elements needed such as pavements, buildings, utilities and installations, etc. are assumed to be equal for the three sites. The same goes for the access road/railway to national grids, which are assumed to be of about the same magnitude for the three sites. With respect to operational costs these are assumed as equal for the three sites, so the difference in O&M costs is mainly in the maintenance of infrastructure elements. Unit prices for calculating the differential prices are taken at average international price level as on study.

3.2.2.2 Scenario A Results

The results of the analysis are provided in **Table 3-9**. According to this analysis Site A Vizhinjam scored minimum and hence selected for development.

Table 3-9: Multi-criteria Matrix for Scenario for Sites A, B and C

Attributes	Impact Rating for Site			Weigtage	Impact Score for Site		
	A	B	C		A	B	C
Level inland area available	25	20	22	10	37	30	33
Required Water Depths available	6	12	13	10	19	39	42
Required Water area available	3	7	7	1	18	41	41
Harbour protection works required	1	6	9	10	6	38	56

Attributes	Impact Rating for Site			Weigtage	Impact Score for Site		
	A	B	C		A	B	C
Safety of navigational approach	13	10	12	1	37	29	34
Ease Maintenance dredging	1	5	6	10	8	42	50
Easiness of Access to Hinterland (terrain)	4	9	9	5	18	41	41
Distance to NH-47	6	6	6	1	33	33	33
Distance to Railway line	3	7	7	1	18	41	41
Access to public supplies(power & water)	6	16	12	5	18	47	35
Coastal Regulation Zone	4	6	6	10	25	38	38
Impact to Ecologically sensitive areas	2	3	3	10	25	38	38
Impact to Existing river system (diversion)	2	6	6	10	14	43	43
Change in shoreline	4	8	8	10	20	40	40
Impacts on Fishing activities	14	12	11	10	38	32	30
Impacts to Tourism Activities	8	0	10	10	44	0	56
Land Acquisition/loss of land	1	6	6	10	8	46	46
Operation impact on livelihood quality	6	6	7	10	32	32	37
R&R	0	3	0	10	0	100	0
Capital & Land Acquisition	3	6	5	1	21	43	36
O&M	3	6	6	1	20	40	40
Total	**115**	**160**	**171**	**-**	**460**	**831**	**809**

3.2.3 Scenario B - Analysis based on the Technical Feasibility Report, 2011

This section explains the site selection details based on the project as envisaged after 2004. The report is prepared based on regulations as on 2011.

Scenario A - Older Regulations	Scenario B- New Regulations
EIA Notification, 1994	EIA Notification, 2006
CRZ Notification, 1991	CRZ Notification, 2011
Envisaged mode of development for Vizhinjam port was by Public Private Partnership (PPP)	Envisaged mode of development for Vizhinjam port was by Landlord Model
Environmental clearance with the Concessioner	EC is with the Government

3.2.3.1 Abstract of the Study on Vizhinjam Port

In order to evaluate the conceptual layout plans for the port based on **Form-1** and **ToR** for the project in 2011, the assessment of facility requirements are based on the site selected in Siting Report 2003. This report details about the project location. Since the study was carried out for Site A the major changes compared with Scenario A is discussed. Still in Scenario B, the important points to be mentioned about all the three sites that are highlighted as included in techno feasibility report.

3.2.3.1.1 Port Development

Out of the three sites only variable is Site A and site B and site C conditions remain same.

Site A	• General topography of the site shows exposed rock along the coast except at a few locations where beaches are present. • Site at Vizhinjam enjoys a natural water depth of around 24 m within a 1.85 km from the coast. With several rock protrusions and associated pocket beaches around, additional

	advantages include minimal littoral transport along this coast, thus, practically relieving the port from maintenance dredging, unlike most port locations.

3.2.3.1.2 Operational & Navigational

With regards to this parameter, all aspects of site B and C remain same.

Site A	Near-shore wave simulations (model studies) showed that the near-shore waters off Vizhinjam are exposed to waves from the west during the SW monsoon and SSW and S during the NE monsoon. About five months of the year waves are from the W and NW direction and the other seven months predominant waves are from S. It can therefore be concluded that the harbour design with the two breakwaters on the west and south side effectively reduce wave action inside the port, both under extreme conditions and during normal overall sea state. The port configuration with the SW Channel alignment with straight channel starts at -20.4 m contour extending up to the turning circle almost parallel to the shoreline for a length of about 4.0 km. was finally chosen as the preferred layout, because of its minimal impact on the existing fishery port, its good protection against waves, and most economic. This alignment is giving a stopping distance of more than 2,000 m, which is adequate for safe manoeuvring.

3.2.3.1.3 Hinterland Connectivity

With regards to this parameter all aspects of site B and C remain same.

Site A	• Improvement of the current road from the junction with the NH 47 by-pass to project site. This improvement will be done by GoK and is planned for completion in January 2012. • Extension of the NH 47 Bypass. This extension is undertaken by NHAI. • Road connection from project site to the NH 47 bypass will be undertaken by the GoK. (**Figure 2-6**) Through KSTP a wing of Kerala State PWD. • Rail connection from existing Southern Railway Main Line (**Figure 2-6**) to the port site will be undertaken by the RVNL through a connectivity scheme under last mile connectivity scheme.

3.2.3.1.4 Environmental Aspects

With regards to environmental parameters:

- No ecologically sensitive areas reported along this stretch
- Minimal impact on shore line and rivers
- No mangroves or other coastal ecosystems

3.2.3.1.5 Social Aspects

- No fishing village in the shadow zone but fishing harbour and village located adjacent
- Limited fishing activity in the beach area
- Main advantage of this alternative is that the movement of the fishing boats to Vizhinjam Fishery Harbour will not be a hindrance to the movement of vessels to the proposed commercial port. Any further expansion of the port can be towards south only
- Site B has strong disadvantages due to negative impact on local residents and fishing activities. Site A and C have similar advantages and disadvantages; however site A scores better when comparing relocation and rehabilitation requirements and impact on the shoreline and rivers. Site C however scores better with regards to development costs Site A has ultimately been selected for the port development
- High tourism activity is noticed at Site A.

Comments:

1. These beaches are functioning like private beaches
2. Unlike Kovalam, the number of visitors here is a fraction of the total tourists (domestic & foreign)
3. Only three resorts are to be acquired in backup area 1 & 2
4. About 8 other resorts between the backup are seem to function in violation of the CRZ regulations.

3.2.3.1.6 Comparative Costing

Layout selected has the flexibility for the future expansion and so a huge investment is not required for initial progress. All other important details about the cost involved are discussed in the previous scenario itself.

3.2.3.2 Scenario B Results

The results of the analysis are provided in **Table 3-10**. As per this analysis also, Site A - Vizhinjam scored minimum and hence recommended for port development.

Table 3-10: Multi Criteria Matrix for Scenario B

Attributes	Impact Rating for Site			Weigtage	Impact Score for Site		
	A	B	C		A	B	C
Level inland area available	20	23	27	10	29	33	39
Required Water Depths available	6	13	13	10	19	41	41
Required Water area available	3	7	7	1	18	41	41
Harbour protection	1	6	9	10	6	38	56
Safety of navigational approach	14	10	13	1	38	27	35
Ease Maintenance	3	6	6	10	20	40	40
Easiness of Access to Hinterland	4	9	9	5	18	41	41
Access to National Highway	8	11	11	1	27	37	37
Access to Railway	4	10	10	1	17	42	42
Access to public supplies	6	13	11	5	20	43	37
CRZ	3	6	6	10	20	40	40
Ecologically sensitive areas	1	3	3	10	14	43	43
Existing river system	2	6	6	10	14	43	43
Change in shoreline	4	9	9	10	18	41	41
Impacts on Fishing activities	14	14	15	10	33	33	35
Impacts to Tourism Activities	12	0	10	10	55	0	45
Land Acquisition/loss of land	4	6	6	10	25	38	38
Operation impact on livelihood quality	7	6	9	10	32	27	41
R&R	0	3	3	10	0	50	50
Capital & Land Acqusition	5	6	5	1	31	38	31
O&M	3	6	6	1	20	40	40
Total	**124**	**173**	**194**	**-**	**472**	**773**	**854**

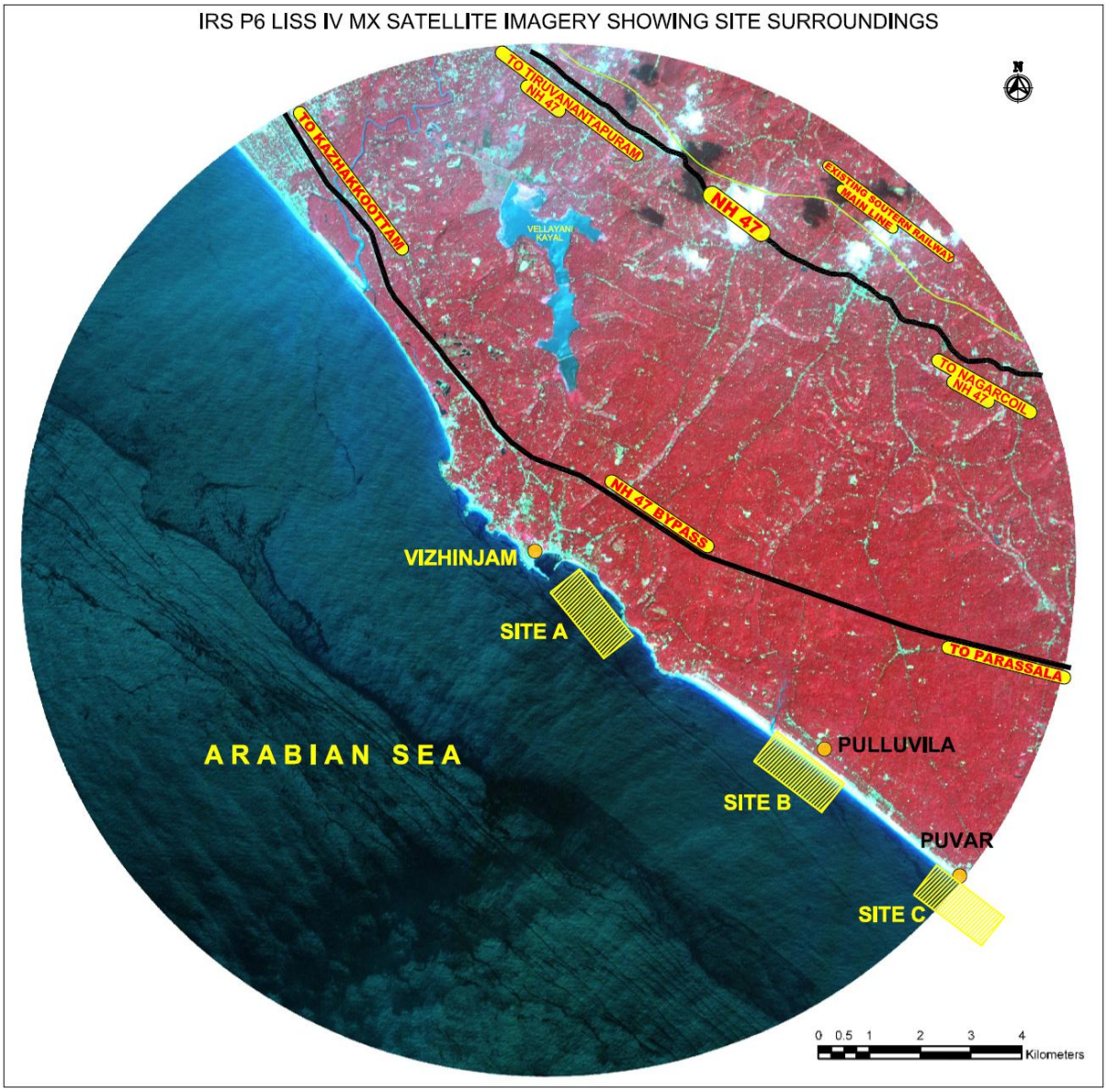


Figure 3-4: Satellite Imagery showing location of Alternative Sites

3.2.4 Scenario C - Analysis based on Today's Project Concept, 2013

This section explains the site selection details based on the project as envisaged after 2004. The report is prepared based on the EIA notification, 2006 (as amended) and CRZ notification, 2011.

Scenario A	Scenario B	Scenario C
EIA notification, 1994	EIA notification 2006	EIA notification, 2006 (as amended)
CRZ notification, 1991	CRZ notification 2011	CRZ notification, 2011
Envisaged mode of development for Vizhinjam port was by Public Private Partnership (PPP)	Envisaged mode of development for Vizhinjam port was by Landlord Model	Envisaged mode of development for Vizhinjam port is by Landlord Model

Over a period of time project vision has changed for the better. Today the project vision has several additional components which includes **cruise terminal**, **truck parking area**, **warehousing area**,

Seafood Park, defence berth, **Coast guard berth** and **fish landing** are planned. Many studies were conducted after 2011 and analysis of alternatives for:

- Road rail connectivity
- Backup areas
- Layout of the port

Almost all the studies including EIA and EMP relating to the above are discussed and explained in detail under this analysis and also in **Chapter 5**, **Chapter 7** and **Chapter 10**.

3.3 Analysis of Alternatives for Road and Rail Connectivity

In addition to the basic engineering aspects the environmental sustainability, social acceptability, and the economic viability of the project were the major criteria in identification and selection of the finally accepted and most suitable alignment. As mentioned in **Chapter 2**, there were several studies carried out to assess the existing condition of the proposed take-off point (start chainage) and alignment of the railway connectivity and the feasibility of the transit yard and railway terminal (end chainage) at Vizhinjam.

The reason for alternatives came up because of many social, environmental, engineering and economic barriers that came into the picture after a series of discussions with the stakeholders and PAP's for educating them regarding the project and also to get their consent for the land acquisition. Accordingly various possible options have been considered which enabled to short list the most promising route.

Unlike other chapters for the two modes of connectivity (road/rail), analysis of alternatives is to be considered separately.

3.3.1 Road Alignment

In the case of alternatives for road, there were only two options based on technical viability.

3.3.1.1 Alternative 1

To take the road along the stream/nalla near the fishing harbour and connect it to the NH 47 bypass which is under construction. Basically this is the current finally opted proposed railway (not road) alignment.

3.3.1.2 Alternative 2

To take the alignment almost 0.5 km south of the fishing harbour adjacent to the northern side of the coastal temple along Mullur and connect to the NH 47 bypass.

3.3.1.3 Comparison of the Alternatives

Compared to the overall size and investment of Vizhinjam port infrastructure and its investment, the analysis of alternatives options available for the road alignment was not many for a length of less than 2.0 km.

Alternate - 1 was ruled out as soon as the finalization of railway alignment issue cropped up and RITES had finally chosen this alignment for the route of railway line to Balaramapuram (BAM) railway station.

Alternate - 2 was shorter and viable considering all technical aspects of the alignment. Furthermore, the cruise terminal of the port had been finally identified along the northern side of the port and this alternative gives an easy access to the road for commuters and tourists without them actually entering into the overall complexity of the port infrastructure. This is possible through a newly planned road parallel to the shoreline along the back up area. The planned 2.0 km long road connectivity alignment mostly passes through valley area and has minimum resettlement and rehabilitation related impacts and issues.

The drawbacks of both these alternatives are same. The connection to the unfinished (incomplete) section of NH 47 bypass towards south is no way going to help the project in the immediate future. This is mainly because this is the most important and number one priority part of all components of the port.

3.3.2 Rail Alignment

The railway alignment had two issues which needed consideration for alternatives. They are:

1. Take-off point for the railway connectivity to Vizhinjam port
2. End point alignment for the terminal into Vizhinjam port and site for the transit yard

These alternatives for the two issues mentioned above are given in **Figure 3-5**.

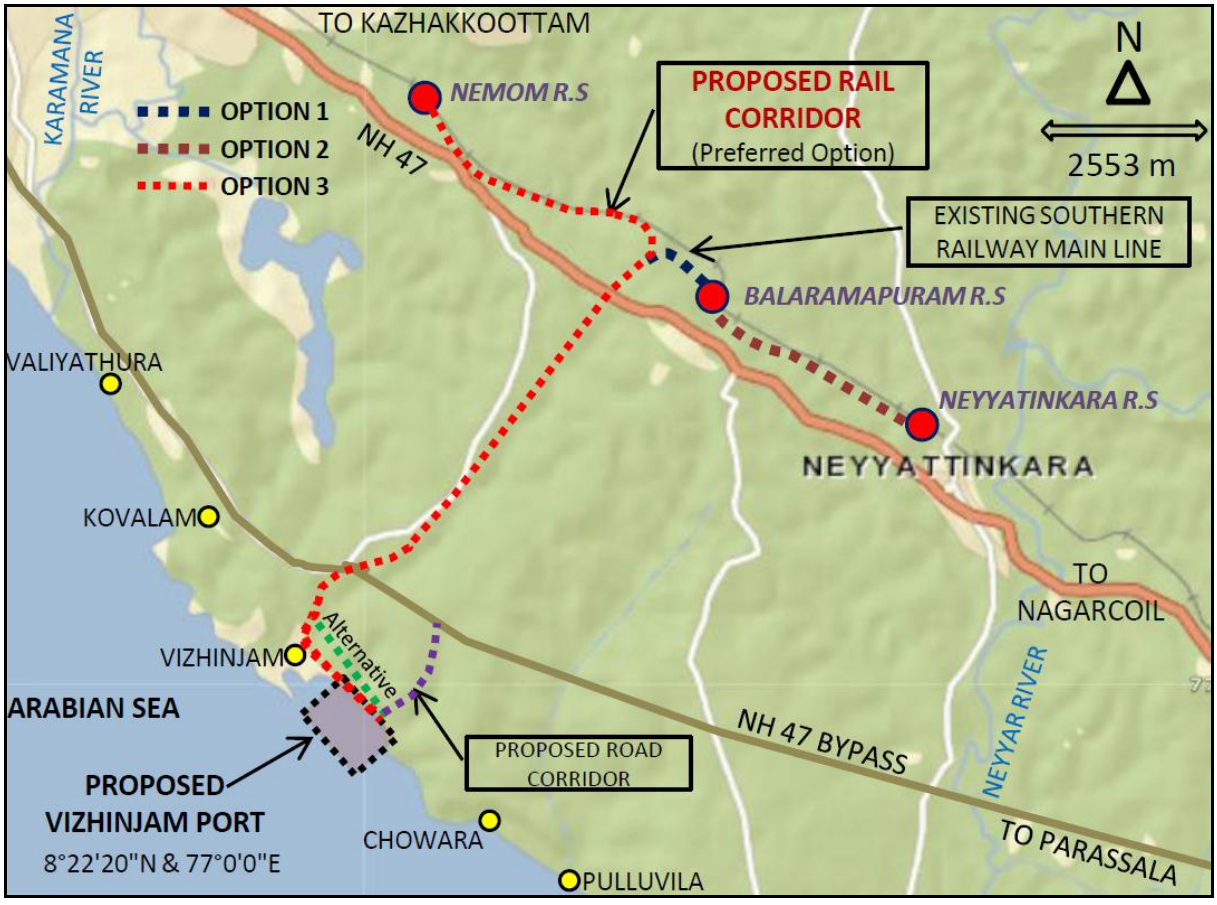


Figure 3-5: Engineering Alternatives for the Proposed Railway Alignment

3.3.2.1 Take-off Point for the Railway Connectivity to Vizhinjam Port

There were three major options (**Figure 3-6**) for selection of the take-off point and starting chainage for the railway alignment to Vizhinjam port. All of their advantages and disadvantages are provided.

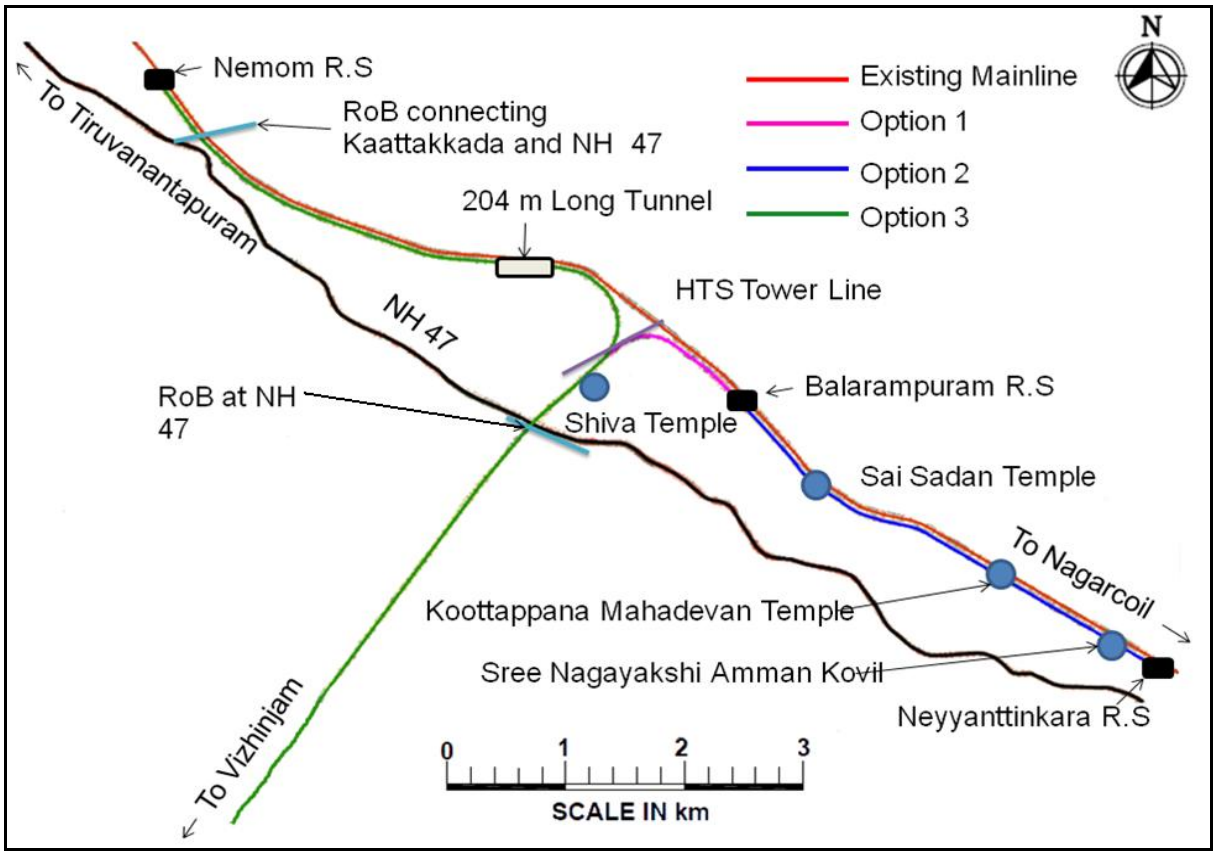


Figure 3-6: Options for Railway Alignment to Vizhinjam Port

3.3.2.2 Option 1: Taking off from Balaramapuram (BAM) Railway Station

The rail alignment to Vizhinjam in the feasibility report prepared by RITES was proposed to be taken off from BAM situated at km 233.21 between Thiruvananthapuram Central – Nagercovil Junction (TVC – NCJ). It is a halt station having only a small booking office for sale of tickets. This station lies in the block section between Nemom (NEM) station on the north and Neyyatinkara (NYY) in the south. It was proposed to make BAM a crossing station for handling the anticipated traffic for Vizhinjam port. It was also suggested to set up a transit terminal between BAM station and Vizhinjam.

Advantages: This was the most obvious option as it has the least distance from Vizhinjam port and is the closest railway station. Since the track length will be short, the cost of this alignment will also be considerably less than the other options. Therefore prima fascia, it appears that this is the most cost effective and technically best option.

Disadvantages: There was not enough land at the BAM station to develop a new yard to the extent required to handle the projected container traffic at Vizhinjam port. This would have burdened the project in terms of land acquisition and land development and hence the costs would have also increased for the project with this option. Provision of 8^{o} curve is invariable for the proposed take-off at TVC end, taking into consideration of technical unsuitability and railway land/private land availability between the existing tunnel and proposed take-off. Provision of a tunnel for a length of around 0.350

km is imperative in view of terrain nature of land requiring deep cutting of 22 to 28 m. Originally a Road over Bridge (RoB) was required to be provided where the proposed alignment crosses NH-47.

3.3.2.3 Option 2: Taking off from NYY Railway Station

As per the detailed project Report (DPR) carried out by Rail Vikas Nigam Limited (RVNL), they had originally proposed the rail alignment to take off from the existing NYY station situated at km 237.21 run a 14.72 km route between TVC – NCJ line to Vizhinjam touching BAM station in between. The existing yard facilities at NYY and NEM stations were to be augmented to take care of the additional traffic generated by the proposed port.

Advantages: There was enough vacant land belonging to the railways which could be made use of for a new yard and additional space for parking trucks and vehicles outside the railway station and further land acquisition thus can be minimized. This location has all elements that could enable Indian Railways (IR) to beautifully develop a station and for meeting all the requirement of the Vizhinjam port.



Exhibit 3-1: Age old Koottappana Mahadevan Temple near Neyyattinkara

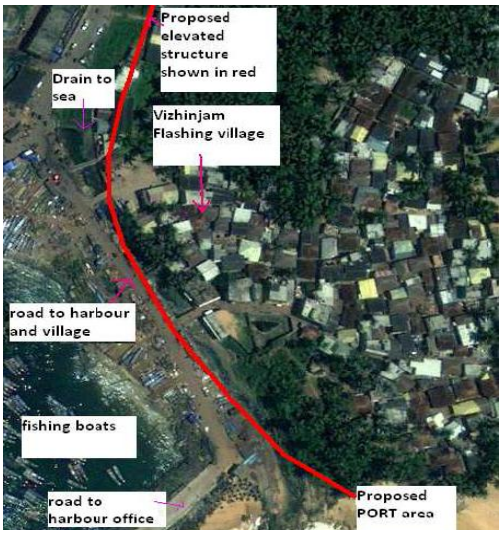


Exhibit 3-2: Rail Alignment near Fishing Harbour and Vizhinjam Fishing Village

Disadvantages: There is an additional distance of 5.0 km to NYY station from BAM station. The alignment passes through three temples including one age old Koottappana Mahadevan temple (**Exhibit 3-1**) near Neyyattinkara which will add to many social issues in relation to relocating the temples and land acquisition. The proposed alignment crosses many feeder roads and village roads and also Neyyattinkara main canal. There are three level crossings (LCs) in the line towards NYY station; (two manned LCs and one unmanned) and 19 minor bridges.

3.3.2.4 Option 3: Taking off from NEM Railway Station

This alignment deviates to NEM Station from the original DPR alignment so taking it backwards from BAM towards NEM. NEM Station is situated at km 227.70 between the TVC – NCJ line. The proposed track runs parallel to the existing track and then deviates to the Vizhinjam side.

Advantages: The length of the alignment to NEM station is shorter by 0.925 km compared to the distance to NYY station. It follows that the land acquisition also will get reduced by about 2.30 Hectares (5.70 Acres). However the number of Project Affected Houses (PAHs) to be acquired will be almost the same (Approximately 66 PAHs). There is only a small temple (private kaavu or sacred

groove) in the alignment towards NEM. In addition, there is less number of bridges (11 minor bridges) than in the route from Vizhinjam to NYY station. There is only one Unmanned LC (No. 5) towards NEM station. However, two RoBs are to be rebuilt for both the alignments and hence no savings on that account. And also, the alignment to NEM station would cost less by INR 27.3 Million (₹ 2.73 Crores) and the general topographical profile of the area are easier for construction activity and hence better rates may be got while awarding the contracts.

Most important is that, this alignment will avoid the Koottappana Mahadevan temple near Neyyattinkara. Due to the importance of the temple there were serious objections to this impact. This was the most important impediment for considering Option 2.

Disadvantages: The greatest weakness of the alignment towards NEM station is the existing 0.204 km long tunnel at Chainage km 5.050 i.e. between km 231.900 to 232.400. This has a permanent speed restriction and is considered weak. Hence a box culvert has to be constructed (with lead and trail cutting to this box) 30 m away from the existing weak tunnel. Taking the alignment farther away from the tunnel will involve acquisition of lot of built up area and may not be viable.

At Chainage km 5.375 i.e. at the existing km 232.600, a 66 KV electric line (HTS) wire is crossing the track. Since the proposed alignment is in a higher elevation than the existing track, this HTS wire has to be lifted. The RoB Bridge No. 36 at km 228.500 is a busy one connecting Kaattakkada and NH (at NEM). Reconstruction of this RoB thus will involve land acquisition for approaches to divert the traffic during construction. There is an aqueduct at chainage km 1.580 i.e. km 228.400-228.500 and the Vertical Clearance (VC) is only 4.89 m. Since it is gravity flow and since this is near the NEM yard, the VC may have to be kept the same resulting in condonation requirement. At NEM station, availability of Railway lands is comparatively less than in NYY premises. So any more addition other than the two additional loop lines now proposed will involve major land acquisition.

3.3.2.5 Comparison of the Options

A comparison of the available options using a Multi Criteria Matrix is given in the **Table** 3-12 below which helps identify the overall preferred option for selection of the take-off (start) point for the railway connectivity to Vizhinjam port.

Table 3-11: Multi Criteria Matrix for Rail Connectivity

Parameter	Option 1	Option 2	Option 3
Length (km)	11.270	15.650	14.725
Topography of Terrain	Relatively plane	Partly hilly	Hilly
Major Bridges	None	None	3
Minor Bridges	Least	19	11
RoBs	None	2	2
Level Crossings	None	3	1
Aquaduct	None	None	One at Chainage km 1.500
Land Acquisition for Station Yard	Major land acquisition at BAL	No major land acquisition at NYY	Major land acquisition at NEM
Electric Power Lines	None	None	HTS
Total No. of Structures	NA	66	66
Religious Structures	None	Kottapana temple Mahadeva temple Small temple	Sacred grove (Kavu)
Archaeological/	None	1	None

Parameter	Option 1	Option 2	Option 3
Historical Sites			
Water Bodies	-	-	12
Number of PAPs	<66	66	66
Cost Difference	Least Cost	2.73 Crores	<2.73 Crores (compared to option 2)

(Source: RVNL, 2012 & RITES, 2010)

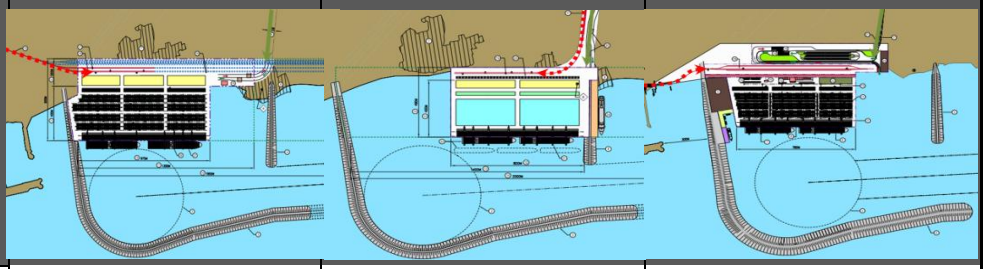
3.3.2.6 Overall Preferred Option

Taking into consideration all the aspects of the railway connectivity in regards to the existing baseline environmental conditions, the social issues and other technical barriers; NEM station (Option 3) is found to be superior because of the less social and environmental impacts, cost, and finally length (by almost one km). The alignment to NEM station was found to be the overall preferred option and hence will be the final selection of the take-off point for the dedicated railway connectivity to Vizhinjam port.

3.3.2.7 End-point for Terminal at Vizhinjam

3.3.2.7.1 Master Plan alternatives

Table 3-12: Master Plan alternatives for End-point Terminal at Vizhinjam

Parameters	Option 1	Option 2	Option 3
			
Planning Flexibility	**Moderate:** Flexibility in rail yard planning	**High:** highest level of flexibility in planning as the proposed road & rail connectivity would be expandable with port	**Low:** layout offers the lowest flexibility in planning due to the rail yard entry constraints because of "S" curve of the rail line
Social Impact	**High:** Social cost would be high due to the displacement, R&R of local community	**Medium:** Social cost would be overcoming the resistance of the local community due to the rail corridor physically dividing the land adjacent to the rail.	**Low:** Social cost would be minimal as the proposed rail corridor will be through the existing drainage so displacement of local community would be minimal
Technical Feasibility	**Difficult:** due to the unfavorable topography	**Very Difficult:** rail connectivity will need tunneling & land cut to overcome steep grading and highly unfavorable topography	**Moderate:** Technical difficulty to be overcome for the last mile connectivity (sharp "S" curve) which will be an elevated structure & yard entry has to be through the northern breakwater
Impact on Port Costing	**High** economic cost involved in Land Acquisition, R&R for the rail corridor	**High** economic cost involved due to the tunneling requirement for rail corridor	**Moderate** economic cost involved in providing an elevated structure for the last mile rail connectivity

Due to the limited options available for the rail and road access to the proposed port and significant cost involved in land acquisition, R&R, and technical issues for Option 1 and Option 2 which are already discussed in **Chapter 2** based on the study conducted by RITES, 2010 and RVNL, 2012 and hence Option 3 was considered and taken forward for the final master plan.

This consideration looks into the alignment at the end chainage at Vizhinjam port for a railway terminal based on the selected Option 3 following alternatives were analysed.

3.3.2.7.2 Alternate – 1: Entry into Port Adjacent to the Fishing Harbour

This option was to have the ending chainage for the railway connectivity to run along the fishing harbour and stop at the Vizhinjam port terminal location at chainage km 15.500. At the Vizhinjam end is medium built up area consisting of harbour offices, Kerala State Road Transport Corporation (KSRTC) depot, and other government and private buildings.

Advantages: The displacement of people is a minimum with this alignment (**Exhibit 3-2**). The social issues involved with land acquisition and relocation will be less as the alignment will run into land reclaimed from the sea.

Disadvantages: This alignment would have to pass through a heavily built up area. This was originally paddy cultivation in low lying land and remains as wet during the monsoon season. The alignment has low lying land, dry land and some government land near Vizhinjam. A good portion of the alignment goes through banana and tapioca plantation.

3.3.2.7.3 Alternate – 2: Entry into Port through the Fisherman's Village

This entry into the port through the fishing village at Vizhinjam changes from Chainage km 13.400 of the alignment in Alternate – 1. It diverts towards the fishing village, along the coastline and the port terminal end of this proposal is at chainage km 15.758.

Advantages: The five additional lines proposed at NYY station based on old market study report by LTR and that could be reduced to the minimum based on the latest AECOM market study report that is required from operational point of view. The entry to the yard through a tunnel can avoid the entry to the yard circumventing the fisherman's village as envisaged in the preferred option.

Disadvantages: In the alternate - 1, the port terminal end was at chainage km 15.650. This means that there is an increase of 0.108 km in track length for this alignment. As the approaches to the yard at the end of the alignment is at 25 to 30 m from the proposed yard level, the entry to the yard may have to be through a tunnel of approximately 0.214 km long, from chainage km 13.800 to km 14.014. This alignment is near the Kottappuram Church a famous church in Vizhinjam and spreads over the predominantly Christian fishing village in its vicinity. There are approximately 434 closely packed houses (see **Exhibit 3-2**), mainly small RCC buildings in this entire area and they will have to be relocated. Though the church does not come under the land to be acquired, the road leading to it and the surrounding villages have to be acquired. It may not be possible to do the above at the prevailing social set up. There is also a small Muslim Durgah at Karumpalli, which need to be relocated if this alignment is finalized. There are few of beach resorts mainly Coconut Bay resort, Tapovan resort and small restaurants which align the beach. The alignment will come close to the way of the beach which will possibly alter their business model.

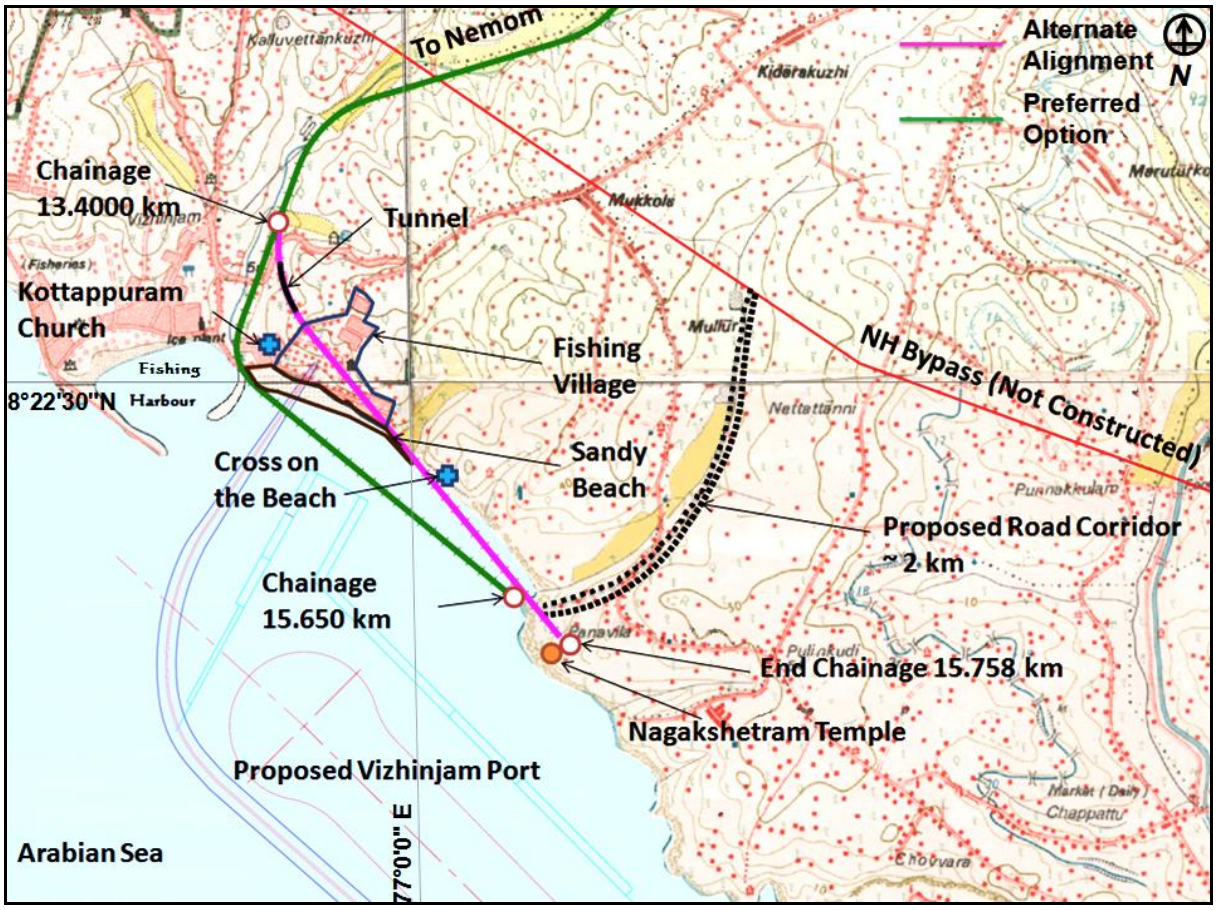


Figure 3-7: Alternatives for Terminal Alignment at Vizhinjam

3.3.2.7.4 Selection of Preferred Option

Finally after taking into consideration all the advantages and disadvantages of the above given alternatives, Alternate - 1 was found to be the most suitable option.

After finalizing the master plan alternative, several iterations were done to optimize & refine the layout as per the VISL requirements. The major modifications carried out to the master plan considering railway alternative is,

- In order to gain more length for the proposed rail sidings without impacting the existing temple site and to maintain the degree of curvature for the rail entry (from North), the terminal layout was rotated in anti-clockwise direction in 1° increments up to 6°, in order to test the impact of each degree of rotation.
- After comparing the pros and cons of each degree rotation layout, a two degree rotation of the layout was freezed which gave the minimum shifting of the breakwater in deeper water while providing for the sufficient clearance for the rail line from the temple site at an agreeable S-degree curve.

3.3.2.8 Transit Yard Alternative

Once the Vizhinjam port is in full swing of operations, the container traffic being handled by trains will increase and the new railway alignment will be used to move the goods to the hinterland. It is estimated that around three trains per day would be calling into the port for the forecasted hinterland traffic for Phase-1 development. But as they run into the existing mainline, there has to be some

facilities to handle the additional traffic emerging from the port operations. For this, a transit yard for the freight trains to halt, load/unload and maneuver is required. This part looks into the options considered for such a transit yard.

3.3.2.8.1 Option – 1: Transit Yard in between BAM Station and Vizhinjam Port Terminal

In the original Feasibility study proposal of RITES, they had recommended a transit yard in between BAM station and Vizhinjam for the emerging traffic from Vizhinjam port. The idea was to then have three lines connecting the existing railway network by making two tunnels, side by side, at different gradients and directions so that it can be connected to the existing track in the form of a "Y".

Advantages: The major advantage to this plan is the fact that there will be no need to expand any of the existing railway stations. A fully fledged dedicated transit yard would exist for the purpose of the port container movement. This location would be closer to the port compared to using any of the existing BAM, NYY or NEM stations as a transit yard.

Disadvantages: The exact location was not chosen and either way for the railways to construct a transit yard anywhere between BAM station and Vizhinjam, there would be land acquisition required for the full land to be acquired at a heavy price which would add to the cost of the project. It was not elaborated as to how the arrangement at this location will join the existing network. Even if the transit yard was to be made, it would have been technically not advisable to connect the lines from it to the existing railway network at BAM station. It is now found that this proposal is not technically feasible because of the difference in levels between Balaramapuram and Madavurpaara. Inevitably the track has to be taken either to NYY or NEM station to ease the gradient.

3.3.2.8.2 Option – 2: Transit Yard at the Existing NYY Station

In this option considered in the DPR, no intermediate stations are proposed between NYY station and Vizhinjam, only a terminal station at Vizhinjam is proposed. There will be yards at NYY, NEM and Vizhinjam, thus eliminating the RITES proposal of transit terminal in between Vizhinjam and BAM. At Vizhinjam, it is proposed to construct a yard, with two loop lines and loading and unloading lines as required by the port. At NYY station, five more extra loops are proposed with 715 m. At NEM station, two more extra loops are planned. At Vizhinjam, it is proposed to construct a yard, with two loop lines and loading and unloading lines as required by the port apart from the mainline to facilitate the engine reversal and unloading of containers.

Advantages: NYY station has large amounts of available space within the railway boundary. If it were to be expanded there would not be much land acquisition required. Shunting can be done at NYY yard and by making additional loop lines at the next block station NEM; the movement of trains towards TVC can be made easy. The augmented yard at NYY station, reduced the rail yard facilities to be provided at the Vizhinjam port terminal area. Consequently, the tunnels proposed for the transit yard in between Vizhinjam and BAM station are done away with so as to reduce any additional costs.

Disadvantages: The most prominent disadvantage and the reason this option was written off was because of the social issues along the railway alignment to NYY station; specifically because of centuries old Koottappana Mahadevan temple near Neyyattinkara falling in the line of the alignment.

3.3.2.8.3 Option – 3: Fully Fledged Transit Yard at Vizhinjam Terminal

The third option envisages a major yard at the port area itself with 13 railway lines considering the traffic that will be generated at the port. This implies that the five additional lines proposed in the DPR

at NYY station could be reduced to the minimum that is required from operational point of view. This also gives scope for taking the line to NEM station since the major yard at NYY station may not be required if this proposal at the Vizhinjam port premises itself can be accommodated.

Advantages: The five additional lines proposed at NYY station and the additional lines at NEM station could be reduced to the minimum that is required from operational point of view. The yard would be close to the shoreline, which would make handling of cargo easier as the port is right next to it.

Disadvantages: At the point where the entry into the proposed yard begins, the ground level (GL) is at 38.47 above mean sea level (MSL) and since the highest point in the proposed yard is at 4.30 above MSL; to form the yard, earth will have to be cut for about 34.16 m. This is not feasible and if this alternative has to be taken for cutting, the whole area in and around will have to be acquired. Maintaining such a yard will be a huge task as well. The southern corner of the yard is located in front of the Nagashetram temple. Since the proposed yard is at 4.302 above MSL, to form the yard, earth will have to be cut for about 15.94 m. This is difficult and the whole area in and around will also have to be acquired to get the slope required to keep the cutting. Further, the Nagashetram temple may get affected which could result in social concerns. Besides the temple, there is a Christian cross kept predominantly on the beach and this comes within the proposed yard area. The yard boundary is approximately 72 m to the land side from this spot. Here the GL is 9.967 m above MSL and since the yard is at chainage 4.302 above MSL, cutting depth will be 5.66 m. This option can be very expensive for VISL apart from the social problems it could create. The report on the alternate alignment proposal for Vizhinjam rail connectivity by RVNL concludes that this location is not feasible and recommends VISL to suggest an alternate site in tune with the port requirements.

3.3.2.8.4 Option – 4: Transit Yard at the Existing NEM Station & at Vizhinjam Port Terminal

As none of the above options were possible, the only option left is to use the existing NEM station as a transit yard. The NEM and NYY railway stations would be augmented with extra loop lines to accommodate the increase in freight trains carrying containers from the proposed Vizhinjam port, but the NEM station will be the site for the major transit yard. Also, the terminal at Vizhinjam would act as a transit yard having three lines for transshipment purposes which will be on reclaimed land.

Advantages: The major advantage will be that the alignment will not go towards Neyyattinkara and hence the social issues of relocating people and the three temples would be avoided.

Disadvantages: The NEM station will have to be developed as a major yard and this will require additional land acquisition at Nemom.

3.3.2.9 Finally Selected Option

Nemom option (Option – 4) with additional land acquisition is the finally selected option and transit yard at Vizhinjam as per the Port master plan finalized during November 2012.

3.4 Analysis of Alternatives for Ancillary Sites

3.4.1 Backup Areas

There were little options in the coastal area for port related land acquisition. Avoidance of social impacts was the main criteria used for selection of two set of alternatives. The chosen alternative locations are one with least impacts to people and properties. Vizhinjam fishing village is close to

backup area. The Naga temple at Mullur beach is adjacent to backup area towards south need access road through the middle of the backup area. This will have to be retained. Although not proposed as on today, the consultants visualise two engineering alternatives. These are described in section 3.4.1.1 & 3.4.1.2. These two sections describe the environmental and social aspects of the two engineering alternatives.

3.4.1.1 Alternative-1: Development and Construction of Building with Total Excavation of Material

At 10 m contour the entire earth material available can be excavated for development of various port facilities. This is not environmental friendly and tourism friendly (Ref: Cruise terminal). The wharf and the rail terminal could be at 5.0 m above mean sea level. The backup areas can be developed at 10 m contour this enabling 4.62 MCM of borrow material available reclamation on the beach side. In this case almost all trees, primarily coconut trees, in the area will be removed. The contour map of the terrain is provided in the **Figure 3-8** for the backup areas.

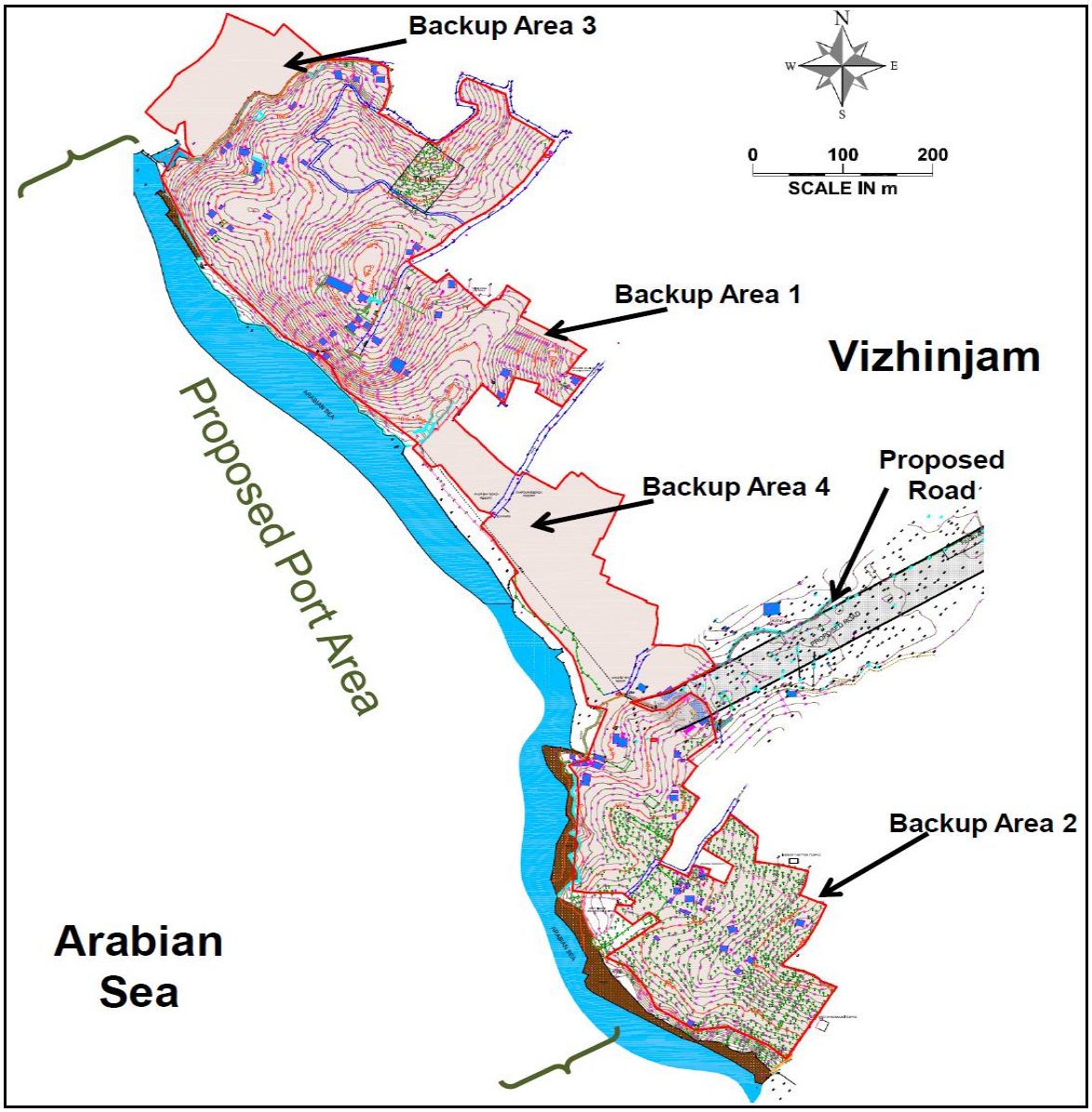


Figure 3-8: Contour Map of Backup Areas

Existing buildings (three tourist resorts in backup area 1 & 2) in the backup area will also have to be demolished and this will be a loss and 8 resorts lies between the backup areas 1 & 2. The details about the resorts are provided in the Social Impact Assessment (SIA).

Advantages: Total construction material that can be excavated from the backup area would be of the order of 23.36 Ha X 20 m (Average excavation of borrow materials is 4.62 MCM). For all port related operations this will be an added advantage.

Disadvantage: This is not tourism friendly or environmental friendly as it cuts all trees located in the area. With the removal of all coconut trees, the area could lose its natural beauty. Soil erosion would be very high due to excavation. Fertile top soil will be lost if not stored and reused properly. Being close to Kovalam tourist area, this can never be an option for this kind of project.

3.4.1.2 Alternative-2: Development as per the Landscape Architecture

Because of the proximity to a major tourism area and also because of the tourism terminal area, this alternative is highly recommended. The various buildings and facilities can be developed beautifully according to the landscape with most of coconut trees retained without cutting of trees and also retaining all buildings that usable by aesthetic land treatments/improvements. In this case some tourist facilities also can be developed. Lot of planning required with the help of an expert landscape consultant. The rainwater harvesting can be useful to supply/use downstream by gravitational force.

A 2.0 km long link road to connect all port side facilities and land side facilities is required for this planning. This can be developed at the bottom level to separate the port facilities and land ward side facilities at 5.0 m port side facility level. The road connectivity will be a parallel road along the side of all backup areas. This will be the only linking road for all port side facilities and land ward side facilities to be developed as a part of the Vizhinjam port infrastructure. This will require a 15.0 m wide corridor accommodating a two lane road with covered drain and a median. The covered drainage will also facilitate as the foot path. As an added advantage, the drains (left and right side drains) will be connected by Cross Drainage (CD) structures to improve the efficiency and capacity of the lateral or longitudinal drainage. This will be designed to take all four natural drainage or streams entering the coast from the backup areas up stream.

Advantages: The development will support the green port concept of the project. Most of trees will be retained. Development will be aesthetically beautiful accommodating all latest concepts about development. This will be more useful for rainwater harvesting and solar power harnessing due to the larger level difference. During construction phase, noise and air quality impacts will be minimum as the development will be focussed and limited at places.

This is the most tourism friendly development as far as the coastal area is concerned. All the buildings such as resorts in the acquired area can be profitably used for some port or cruise terminal related tourism activities. Only few resort buildings are good buildings that can be retained after scrutiny of a team of engineers/planners.

Port master plan has been prepared with detailed study on layout as mentioned in **Chapter 2** with port operator facilities for phase-I, phase-II, phase-III development, power supply, rainwater harvesting, cruise service facility, access road to cruise facility, navy & coast guard facility which is isolated from container traffic within proposed port area, other office buildings, security services.

Disadvantages: In normal case the area is actually meant for port development. Because of the landscape architecture and planning this will not allow effective use of the space for port related core activities. Because of this kind of development movement of vehicles such as containers need to be much more constrained towards the coast; if not developed/excavated close to the coastal area. Integration with the lower port infrastructure like rail terminal and container movements will not be energy friendly. For example vehicles will have to climb upwards, perhaps several times per vehicle/day. So, alternative-2 was considered based on the above reasons.

3.4.2 Port Annex Facility (PAF) Zone

The criteria kept in mind while selection of the site for the truck terminal was the closeness and accessibility to the major roads in the area, namely; the proposed road connectivity from Vizhinjam port, the proposed NH 47 bypass and the existing Vizhinjam - Poovar road. The PAF zone falls very close to all the three above mentioned roads; in addition there are other inner roads as well.

3.4.2.1 Option-1 with Two NH Underpasses

The analysis of alternatives also includes the route and pathway for trucks to enter into and exit the truck terminal and other vehicles going to the port operator's colony. As the truck terminal is located adjacent to the existing Mukkola - Balarampuram road and next to the upcoming NH 47 bypass, there will have to be a set course for vehicles coming from the proposed road for Vizhinjam port and entering into the truck terminal without hindering or obstructing the path of vehicles on either the Mukkola - Balarampuram road or the proposed NH 47 bypass. The **Figure 3-9** gives the path to be taken by the trucks with all entry and exit points of the truck terminals.

This alternative suggests two underpasses. After leaving the road alignment, the vehicles going to the truck terminal can use one underpass and enter. Vehicles going to the port operator's colony will exit the road alignment by taking a left turn, use the service roads and take a right turn using another underpass to get onto the Mukkola - Balarampuram road. This option is more complicated and will take a lot of considerations in regards to design of the NH 47 bypass and underpasses to get the right setup for vehicle movements.

3.4.2.2 Option-2 with One NH Underpass

In this option only one underpass is considered to enter both the truck terminals. Vehicles will exit the proposed Vizhinjam port road alignment and use and underpass to enter the truck terminal. With the help of inner roads and truck pathways, the trucks can travel through the truck terminal and crossover/go through the Mukkola - Balarampuram road and enter the port operator's colony. This option is more convenient and will avoid a lot of confusion for other traffic along the NH 47 bypass, but it will mean vehicles not related to the truck terminal will also have to cross through the truck terminal to enter the port operator's colony which would not be the best option for people who might not consider the experience a good one.

3.4.2.3 Option-3 with One NH Flyover

This Vizhinjam port project being a major development and all port infrastructures ideally need to work as a single unit; the GoK shall advise NHAI to construct a flyover in the region for free movement of both port vehicles including trucks and local vehicles.

This not only integrates the port infrastructure as a single unit but also improves the safety and security of the area in terms of road safety (pre-accident care like provision of all signage), accidents (post-accident care) and traffic management (current safety care - traffic policing) in addition to a reduction of crime rate. This being at an elevated area a tourist tower can be added here with pedestrian facility to view the entire Kovalam and port area. This can be positioned in the middle of the flyover.



Figure 3-9: Entry and Exit points for the PAF Zone, Two Lane Service Road for NH and the Proposed under Passes

This flyover option is good because of the huge embankment to be created with a maximum height of some 6-8 m in the middle of the valley area. This option will allow both truck movements and other vehicles to easily manoeuvre through the Mukkola - Balarampuram road and the proposed road corridor for Vizhinjam port without affecting the movement of vehicles on the NH 47 bypass.

3.5 Analysis of Alternatives for Vizhinjam Deepwater Port Development

3.5.1 Analysis of Alternatives

Exploring alternatives is really a part of building mitigation into concepts. The range of alternatives extends to:

- The MoEF approved this process and final location (F. No. 11-122/2011-IA III dated 1st July 2011). Therefore, this ESIA study is site specific (Royal Haskoning, 2013) and builds on the formally taken decisions by the authorities.

- Alternative designs for port development (i.e. alternative breakwater designs, quay wall designs, etc.); the required amount of quarry material for the breakwater is a clear issue to be subject for the analysis of alternatives.
- Alternative methods for constructing the port (i.e. alternative piling techniques, alternative dredging plant, etc); which will be suggested to taken care by the port operator for analysing and implementing various construction methods.

3.5.2 Proposed Alternatives

3.5.2.1 Port Layout Plan Alternatives

Following the alternative site discussion by Siting Report, 2003, the layout plan alternatives are analysed for the selected site A. The design considerations are key issues affecting the development of the alternative concept layouts for the new port at Vizhinjam. For the complete analysis, reference is of Royal Haskoning report Initial Concept Plan (2010). The overview of alternative concept layouts for Vizhinjam port is given in **Figure 3-10**.

The following design considerations are discussed below:

- Environmental & social design considerations
- Other operational design considerations

Environmental & social design considerations

Project Site Boundaries

Figure 3-11 shows the boundaries of the project site:

- NW boundary is 300 m south of fishing harbour
- NE boundary is formed by the existing coastline. Not all land on top of the rocks is available for Port development, part of it is owned by VISL.
- SE boundary is set at the east-side of the rocky outcrop near the Azhimala temple.
- The Port development will be carried out into the sea perpendicular to the coast in SW direction.

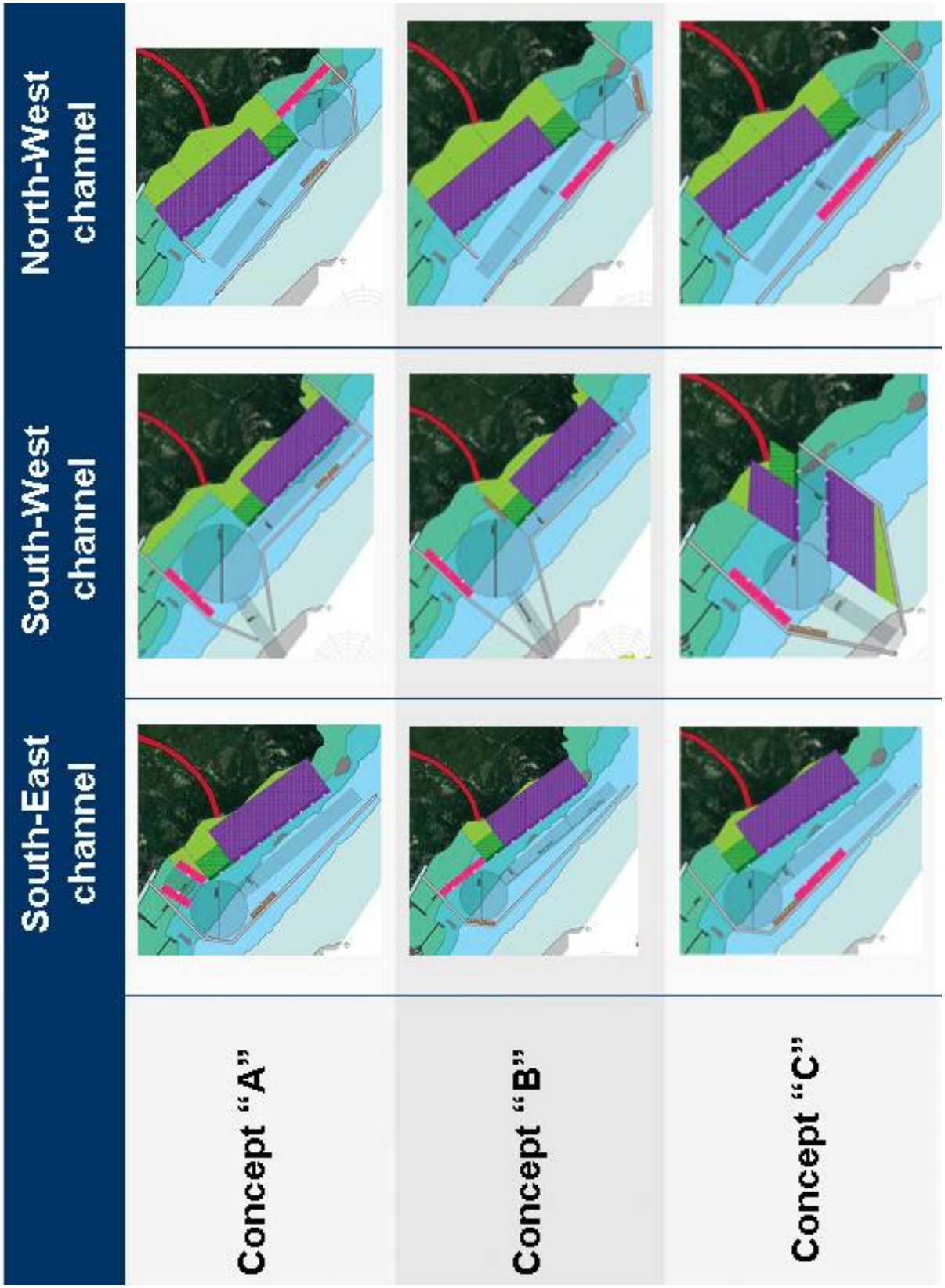
Dredge and fill considerations: In the alternative concept layouts the volumes of the dredging and filling should be kept minimal in order to minimise the CAPEX and the associated environmental impacts. Further, the volumes of material dredged and filled should preferably be in balance. In order to get the cut & fill balanced as much as possible the location of the port terminals and marine infrastructure can be varied as follows.

- All the port terminals have to be reclaimed from the sea and to minimise the fill volumes the terminals should be constructed in shallow water. Impacts due to dredging on surrounding environment are discussed in **Chapter 5**.
- Approach channel, turning circle and port basins should be sufficiently deep and when this marine infrastructure is constructed in deeper water the required volume of material to be dredged is reduced.

    - **Hinterland access:** Terminals should be well connected with the final hinterland destinations in order to achieve the required high service level. In the developed alternative concept layouts the hinterland access points are taken as indicated by VISL. The alignments of the VISL proposed road and rail connections are indicated in the alternative concept layouts.

    - **"Green and Clean" port area:** It is envisaged to develop the new port at Vizhinjam as a "**green and clean**" port as this will enhance profiling the port better into the Kerala context. In

the alternative concept plans some "***green and clean areas***" have been added such as the area behind the terminals.



(Source: Initial Concept Plan; Royal Haskoning 2010)

Figure 3-10: Overview of Alternative Concept Layouts for Vizhinjam Port

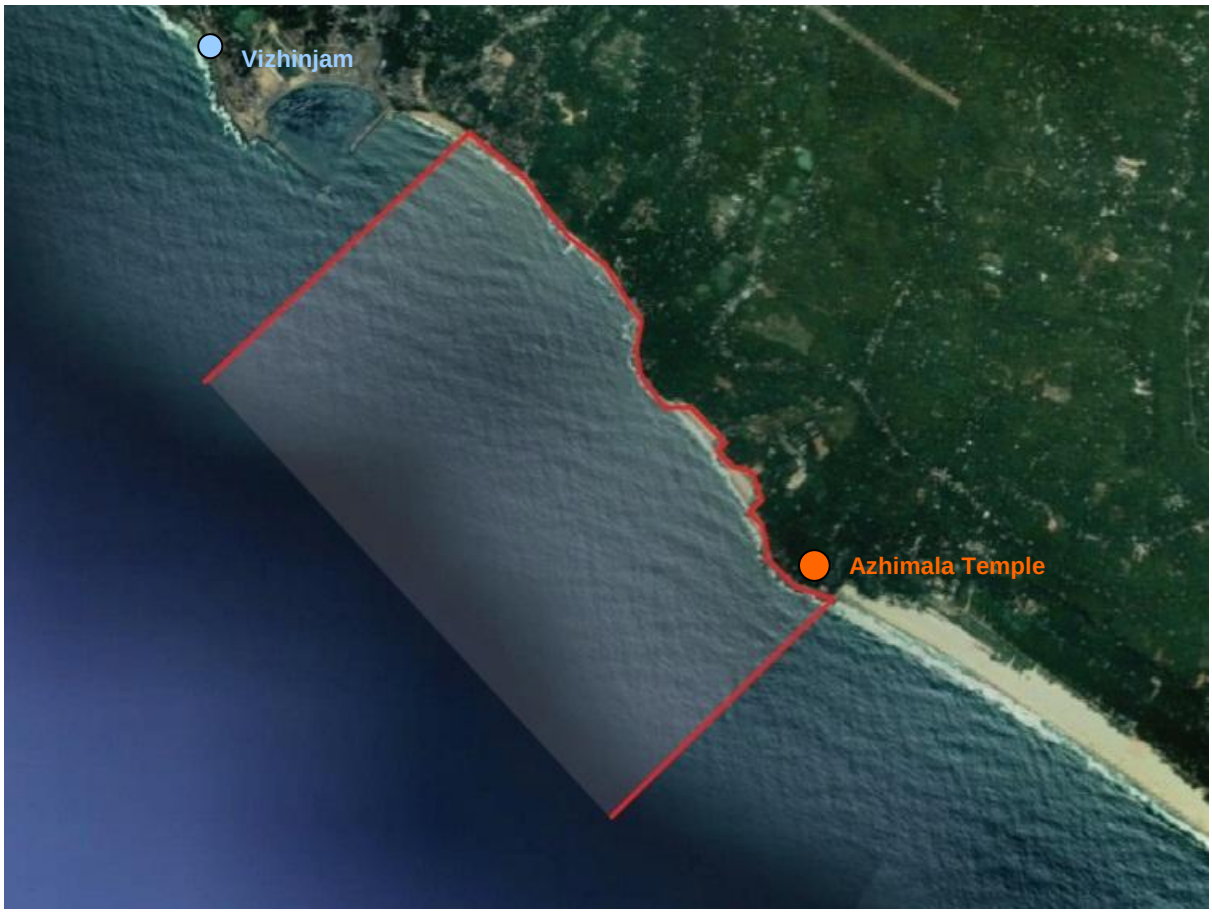


Figure 3-11: Project Boundaries of the Vizhinjam Port PPP Project Site

Social issues: In the development of the alternative concept layouts the extent to which the Port layout affects the local population has been taken into account. Social design considerations which are included in the layout development are:

- Port terminals are constructed at least 300 m away from the breakwaters of the existing fishing harbour located to the NW. This ensures a limited impact of the port operations on the fishing harbour. In addition, it ensures to leave the beach next to the fishing harbour intact.
- Preferably the container terminal and general cargo operations are located as far away as possible from the settlements and resorts.
- Impact of the port layout on churches, temples and other currently existing cultural structures should be minimised.

Description of alternative concept layouts: In this section the three most promising concept layouts are described in more detail. For each alternative the initially selected layout is presented, together with an overview of the phased development. The layout pictures are accompanied by a short description of the key issues of layout focussing on the approach channel direction, breakwater alignment and port terminal location. Also the variations in layouts presented in **Concept "B"** and **Concept "C"** are discussed.

South-East direction of the approach channel & marine infrastructure: Final approach of the incoming vessels is more or less parallel to the coastline, which is somewhat more risky.

- Incoming vessels approach the channel with waves beam-on. This is somewhat less favourable for entering the port basin. In addition strong winds may push/drift the vessel towards the coast. Ship manoeuvrability study has been carried out under Ship Simulation Study

- In the basin in front of the container terminal a hard rock area is located which needs to be removed in phase I
- Traffic flows to/from the fishing harbour and the new port are separated. Impacts on surrounding environment including fishing harbour are discussed in **Chapter 5**.

Breakwater alignment: Breakwater needs to shelter the final section of the approach channel with a length of one nautical mile (1,850 m) to allow safe tug fastening and efficient tug assistance behind the breakwater

- Breakwater shelters the quays in each phase of port development
- Breakwater is aligned around the turning circle and constructed in as shallow water as possible to reduce the initial CAPEX and raw material use

Port terminals: The port terminals are located such that the volume of fill material is limited.

- Quays of the general cargo berths and the container terminal berth are planned in one line next to each other in order to increase flexibility in the use of the berths. In case a berth would be free, a vessel at an adjacent berth may partially overlap with the empty quay
- Cruise berths are placed near Vizhinjam village in view of the following:
  - Cruise vessels require limited water depth in comparison to the other incoming vessels. Therefore, the cruise berths are placed in the shallower area of Vizhinjam port site
  - Impact on the village is reduced since the industrial activities are moved away as far as possible from the village
  - Cruise berths are placed upwind of the industrial activities to minimise noise and odour hindrance for the passengers

Variations in concepts: In concept “B”, assessed in the Initial Concept Plan Study, the cruise berths are placed in line with the general cargo and container quays. In this case the quays of the cruise terminal, general cargo terminal and container terminal are all linear which increases the flexibility of the berth use. The cruise vessels however will be berthed adjacent to the turning circle which may cause some, yet still acceptable, hindrance. In addition, the cruise berths are now placed in deeper water which will increase the volume to be filled.

In concept “C” the cruise berths are located adjacent to the approach channel. The additional space adjacent to the multipurpose terminal can be used for expansion, if required, due to changing market demands. On the other hand, placing the cruise berths in deepwater will increase the required fill volume.

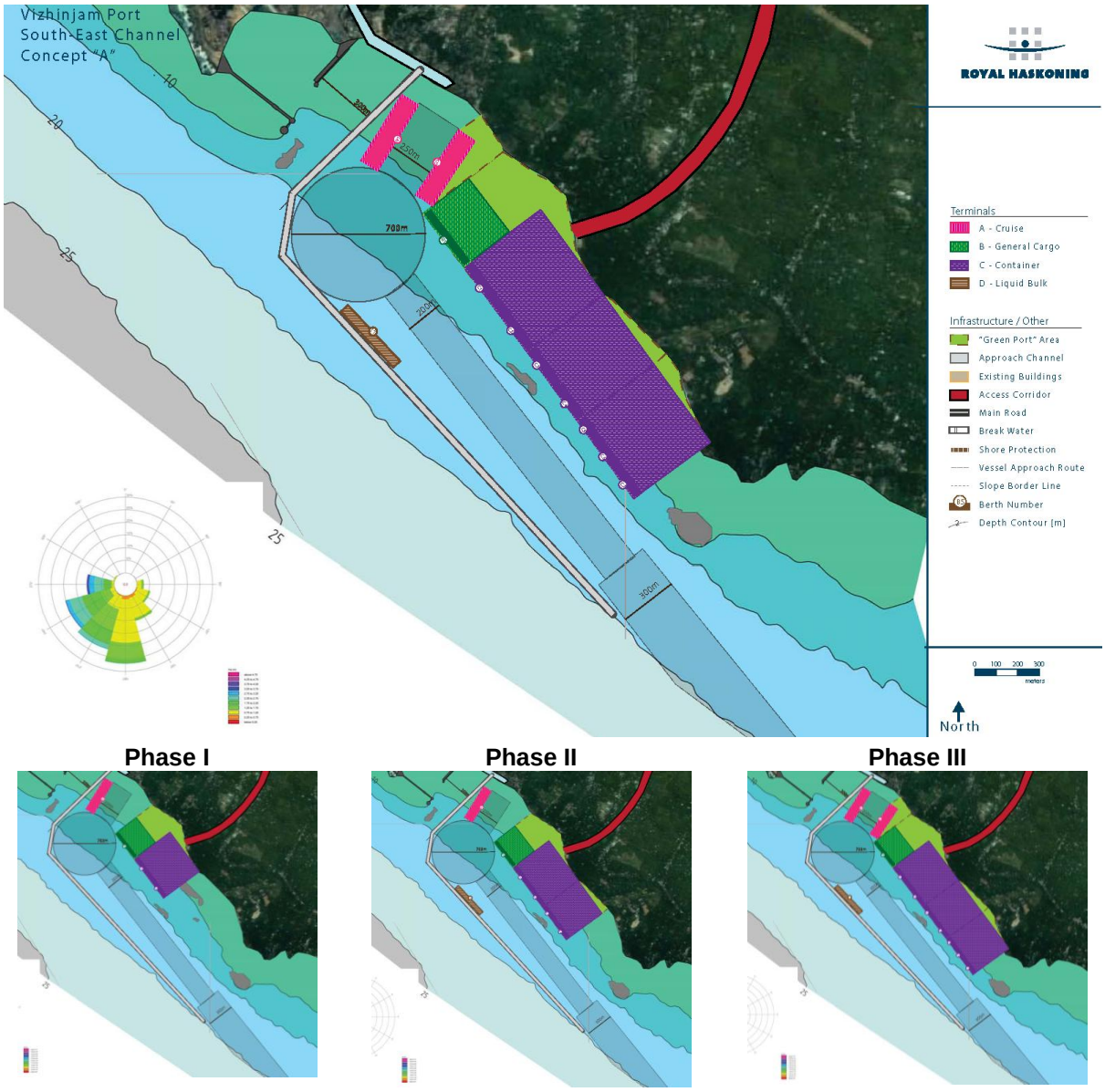
After finalizing the master plan alternative, several iterations were done to optimize & refine the layout as per the VISL requirements. The modifications carried out to the master plan are as listed below:

- Shifting the terminal layout towards Sea by 90 m
- Terminal layout rotated by 2° (anticlockwise)
- Shifting back the port layout by 40 m towards landside
- Shifting the layout to south along the Coast
- Shifting container berth to south by 100 m

SW direction of approach channel & marine infrastructure

- Incoming vessels approach the port more or less perpendicular to the coastline, which is less risky compared to a parallel approach.
- Incoming vessels approach the port with waves and winds coming in on their sterns which may affect the steering of the arriving vessels.

- In this layout a different towing procedure will be required. Tugs can only attach to the incoming vessel in the sheltered water inside the two breakwaters. Vessels will therefore arrive into the Port at their own power. For this layout a larger turning circle of 1,000 m is required for safe stopping and manoeuvring.
- Potential problems with crossing fishing traffic flows are limited.



- ***(Source: Initial Concept Plan; Royal Haskoning 2010)***

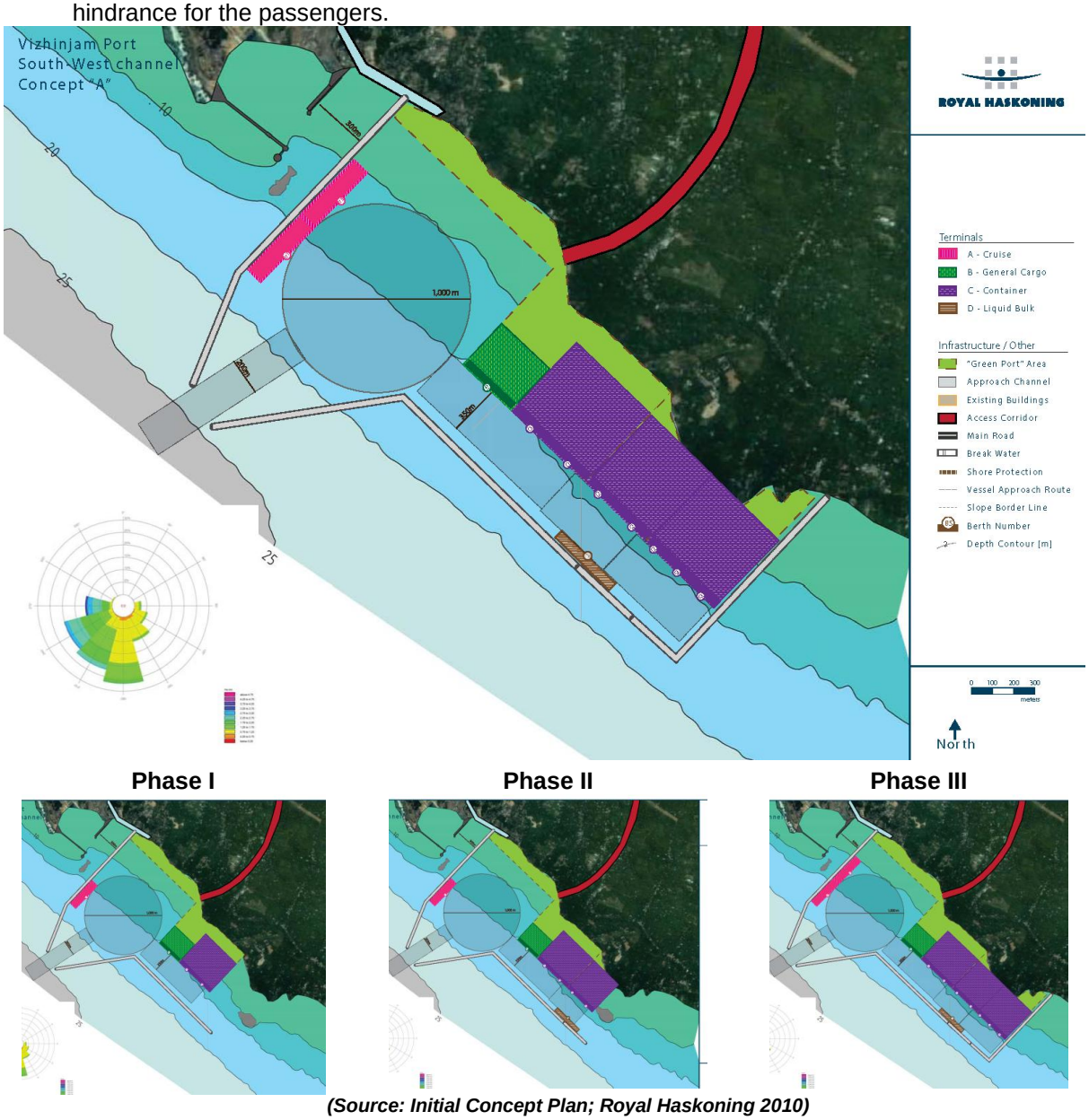
Figure 3-12: South-East Channel – Concept "A"

Breakwater alignment: Towing procedure described above requires a sheltered approach channel with a minimum length of 0.5 nautical miles (925 m) up to the turning circle.

- Breakwaters shelter the quays in each development phase.
- Breakwater is aligned around the turning circle and constructed in as shallow water as possible to reduce the initial CAPEX and raw material use.

Port terminals: Port terminals are placed such as to reduce the volume of filling material needed for the construction of the terminals.

- Quays of the general cargo berths and the container terminal berth are linear in order to increase flexibility in the use of the berths. In the case a berth would be unoccupied; a vessel berthed at a berth adjacent can partially overlap with the empty quay.
- Cruise berths are placed near Vizhinjam village in view of the following:
  - Choice of location of the cruise berth can be used to optimise the cut & fill balance.
  - Impact on the village is reduced since the industrial activities are moved away as far as possible from the village.
  - Cruise berths are placed upwind of the industrial activities to minimise noise and odour hindrance for the passengers.

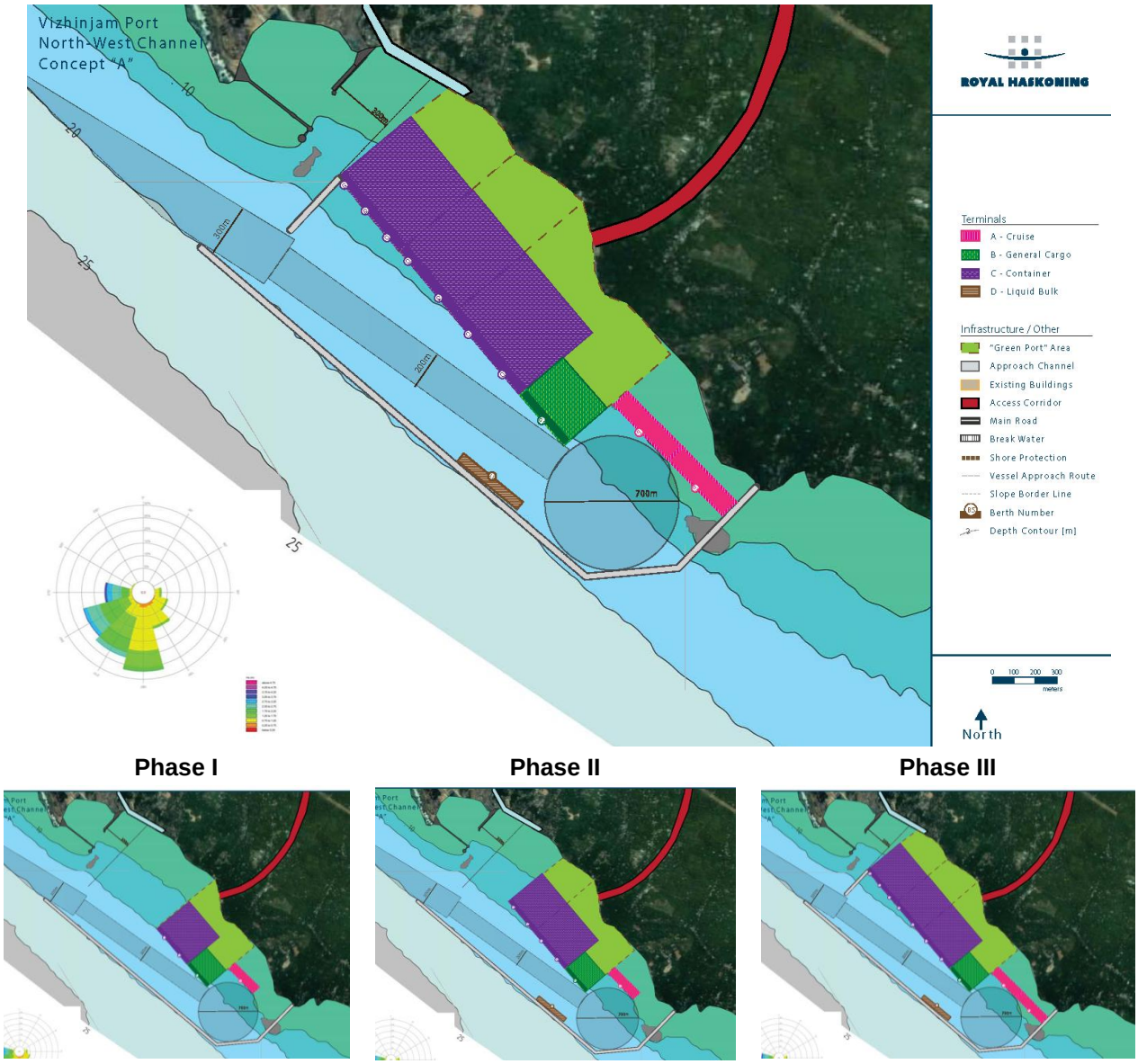


(Source: Initial Concept Plan; Royal Haskoning 2010)

Figure 3-13: South-West Channel – Concept "A"

Variations in concepts: In concept "B" the liquid bulk terminal is placed adjacent to the turning circle. In this layout the breakwater facing the berths of the container terminal can be constructed in shallower water. In concept "C" a basin is constructed with the container terminals on each side. The breakwater for the final phase needs to be constructed in the first phase. In addition, the breakwater is located in deep water. Both issues will increase the initial CAPEX and use of rock. Also the

construction of the container terminal needs large volumes of fill material, since these terminals are now planned in deeper water.



(Source: Initial Concept Plan; Royal Haskoning 2010)

Figure 3-14: North-West Channel – Concept "A"

<u>North-West direction of approach channel & marine infrastructure:</u> The final approach of the incoming vessels is more or less parallel to the coastline, which is somewhat more risky.

- Incoming vessels approach the channel with waves coming in their beam, which is somewhat less favourable for entering the Port basin. In addition strong wind may push the vessel towards the coast.
- Marine infrastructure is placed in such a way to avoid hard rock areas and to reduce the volumes of dredging.
- Potential problems due to crossing fishery traffic flows are larger.

<u>Breakwater alignment:</u> Breakwater needs to shelter the final section of the approach channel over a length of one nautical mile (1.850 km) to allow tug fastening and efficient tug assistance

- Breakwater shelters the quays in each development phase.

- Breakwater is aligned around the turning circle and constructed in as shallow water as possible to reduce the initial CAPEX and raw material use.

Port terminals: Terminals are placed alongside the approach channel. By aligning the quay with the coastline, the filling for the terminals can be reduced.

- Container terminal and general cargo terminal are placed as far away as possible from Vizhinjam.
- Quays of the general cargo berths and the container terminal berth are linear in order to increase flexibility in the use of the berths. In the case a berth would be unoccupied; a vessel berthed at a berth adjacent can partially overlap with the empty quay.
- Cruise berths are placed near the turning circle on the east side of the port for the following reasons:
  - Cruise vessels require limited water depth in comparison to the other vessels. Therefore, the cruise berths are placed in the shallower area in the South-East corner.
  - Cruise berths are placed downwind of the industrial activities which may increase noise and odour hindrance for the passengers.

Variations in concepts: Both concept "B" and "C" are variations to concept "A". In Concept "B" and "C" the cruise berths and liquid bulk berth are located at the leeside of the breakwater. This way more flexibility in the layout is included for potential expansion at the east side of the Port. In addition, the cruise berths are not placed downwind of the industrial activities. Further, the liquid bulk berth is placed downwind of the cruise terminal. Concept "B" and "C" differ in the separation of the cruise berths and the liquid bulk terminal as shown.

3.5.2.2 Quarry Location Alternatives

A detailed study has been carried out with respect to the selection of a suitable quarry location for the proposed port project by the Department of Mining and Geology in the year 2007-2008 (Study on Availability of Granite (Building Stone) for the Construction of the Vizhinjam port and related infrastructure. Out of nine quarry locations present in Kerala and Tamil Nadu, four locations are shortlisted for the quarry investigation by Royal Haskoning (Preliminary Project Plan (Royal Haskoning 2010), they are: Karavaram (Kerala), Kadavila (Kerala), Malayam (Kerala), and Thakala (Tamil Nadu).

Table 3-13 provides an overview of the characteristics of the four selected quarry sites. From the table, it is evident that the Karavaram quarry site has insufficient quarry capacity. The Kadavilais quarry is owned by the GoK and has the highest (together with Karavaram) pricing but it has the option of barge transporting which could be beneficial.

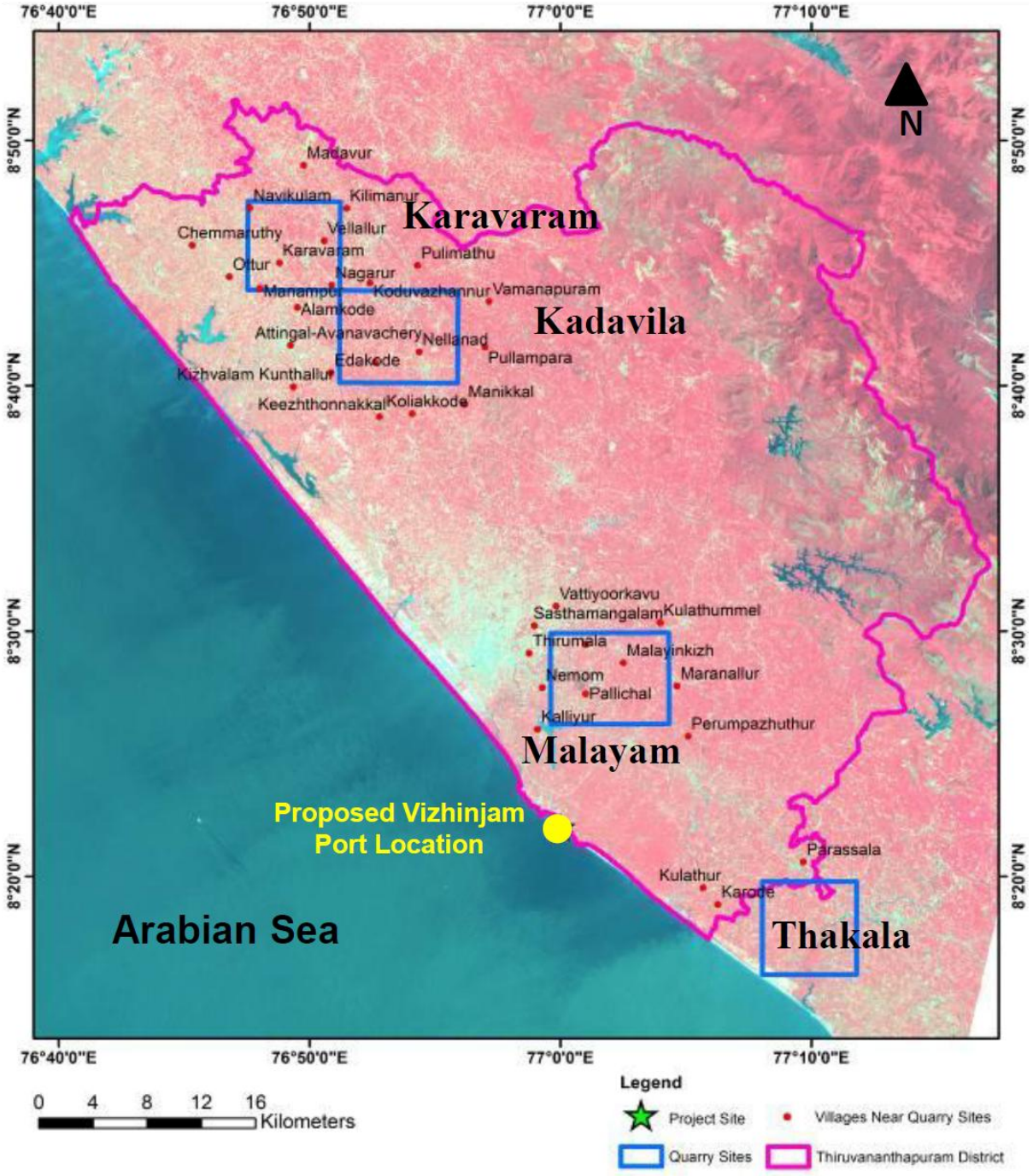
Table 3-13: Comparison of Shortlisted Quarry Locations

S. No.	Name of the Quarry Site	Location	Distance from Project Site (km)	Distance from Shore	Ownership	Total Capacity (MCM)	Cost (₹/MT)
1.	Karavaram	Kerala	65	17 km	Private	0.5	2000
2.	Kadavilla		70	20 km	Government	5.0	2000
3.	Malayan		25	25 km	Private and Government	Sufficient	330
4.	Thakala	Tamil Nadu	70	25 km	Private	Sufficient	1500

(Source: Preliminary Project Plan (Royal Haskoning 2010))

The location map of the shortlisted quarry sites are given in **Figure 3-15**. An impression of the Karavaram, Kadavila and Thakala quarry sites are presented in **Exhibit 3-5** to **Exhibit 3-3**.

In Aug 2012, VISL informed RH/ACE that the Kadavila quarry and/or another brown field quarry (Theviyodu) located nearer to Thakala, could be considered as source of the quarry materials. The final quarry location will be chosen by the contractor depending upon the ease of transportation such as the barging possibilities at muthalapozhi/colachel and cost effectiveness.



(Source: Preliminary Project Plan (Royal Haskoning 2010))

Figure 3-15: Location Map of Shortlisted Quarry Locations on Satellite Imagery (March 2011)

Yet, it is clear that the distance from the quarry to the port is crucial for the potential impacts related to atmospheric emissions (combustion gasses and dust) and community health and safety (heavy traffic). It has been discussed with VISL that road transport (during construction around 700 trucks a day in total) is not acceptable in the densely populated area close to the coast. Therefore, it is suggested to make barging of the quarry material to the site compulsory for the contractor.

The contractor for the civil works will have the following responsibilities regarding the quarry location:

- Selection of preferred quarry or quarries for the Project (as per the requirements indicated in the tender documents e.g. development of an EMP including specific management plans if applicable)
- Finalising of contract with the quarry owners
- Implementation and monitoring of the environmental and social, as well as community health and safety mitigation measures proposed in the quarry permit and additional in the EMP

Aspects from the quarries which should be considered in the selection and later in the EMP are:

- Physical environment: impacts on soils and geology, water resources, air quality, noise, resource use and waste;
- Biological environment: impacts on biodiversity including habitats, fauna and flora; and
- Social–economic environment: impacts on people and communities including the economy, development and livelihoods, cultural heritage, community health, safety and security, occupation health and safety, labour and working conditions, human rights, gender and youth, and ecosystem services.

The need for additional site-specific E&S and OHS will be mitigated and associated plans will be reviewed by VISL during the development of the selected quarry which will be executed by the EPC contractor. For instance, emergency plans should be prepared for the construction period for Project vehicles, taking into account potential impacts on local communities and measures needed to ensure the safety and security of individuals in this regard. Local authorities and affected communities will be provided with appropriate information communicating the nature and extent of any potential incidents that could arise and procedures to be followed in the case of an unplanned accident or emergency.



Exhibit 3-3: Karavaram Quarry Site



Exhibit 3-4: Thakala Quarry Site



Exhibit 3-5: Kadavilla Quarry Site

Exhibit 3-5 put on view of a photographer taking photos of the quarry site at kadavilla.

3.5.3 Scenario C Results

The results of the analysis are provided in **Table 3-14**. As per this analysis also Site A - Vizhinjam scored minimum and hence recommended for port development.

Table 3-14: Multi Criteria Matrix for Scenario C

Attributes	Impact Rating for Site			Weigtage	Impact Score for Site		
	A	B	C		A	B	C
Level inland area available	21	24	26	10	30	34	37
Required Water Depths available	6	14	14	10	18	41	41
Required Water area available	3	7	7	1	18	41	41
Harbour protection works required	3	6	9	10	17	33	50
Safety of navigational approach	14	10	13	1	38	27	35
Ease Maintenance dredging	4	6	6	10	25	38	38
Easiness of Access to Hinterland (terrain)	5	9	9	5	22	39	39
Distance to NH-47	11	14	14	1	28	36	36
Distance to Railway line	4	10	10	1	17	42	42
Access to public supplies(power & water)	6	13	11	5	20	43	37
Coastal Regulation Zone	3	7	7	10	18	41	41
Impact to Ecologically sensitive areas	1	3	3	10	14	43	43
Impact to Existing river system (diversion)	2	6	6	10	14	43	43
Change in shoreline	4	9	9	10	18	41	41
Impacts on Fishing activities	14	15	16	10	31	33	36
Impacts to Tourism Activities	12	0	8	10	60	0	40
Land Acquisition/loss of land	7	6	6	10	37	32	32
Operation impact on livelihood quality	7	6	9	10	32	27	41
R&R	3	3	3	10	33	33	33
Capital & Land Acquisition	5	6	5	1	31	38	31
O&M	3	6	6	1	20	40	40
Total	**138**	**180**	**197**	**-**	**540**	**745**	**815**

3.6 Score Comparison

Based on the analysis of three scenarios, the scores were given for the three scenarios separately and also a comparison of the three scenarios is presented which help us to conclude the analysis of site selection and alternatives.

The **Table 3-15** provides the criteria and ratings used for the multi criteria analysis. The general scoring criteria for the impact rating is given as:

1 Implies positive or that there is no impact to the site due to a specific parameter
2 If the site is neutral to any change
3 For negative impacts that may happen because of the influence of a specific parameter on the site
0 Not Applicable (NA)



Figure 3-16: Google Earth Imagery of Alternative Sites

Table 3-15: Parameter and Rating used for Multi Criteria Analysis

Parameters			Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
			A	B	C	A	B	C	A	B	C			
Level inland Area Available														
Topography	Terrain	Rocky	1	0	0	1	0	0	1	0	0	Undulating, rocky, cutting, Fishermen dwellings -north back up; Resorts - small / medium sizes on the middle & southern side; plain land with coconut plantations, full private ownership	Level, river mouth/marshy, filling, Fishermen dwellings, Plain land with coconut plantations, Part private ownership/ part Government ownership	Level, river mouth/marshy, filling, Fishermen dwellings, Resorts, Plain land with coconut plantations, Part private ownership/ part Government ownership
		Level	0	2	2	0	3	3	0	3	3			
		Undulating	3	2	0	3	0	0	3	0	0			
		Marshy	0	3	3	0	3	3	0	3	3			
	Usage	Cutting	2	0	0	1	0	0	1	0	0			
		Filling	2	3	3	1	3	3	1	3	3			
Land Usage	Resorts	Small	3	0	2	3	0	2	3	0	2			
		Medium	3	0	2	3	0	2	3	0	0			
	Fishermen Dwellings		0	3	2	0	3	3	0	3	3			
	Land	Plain	3	2	2	2	2	2	2	3	3			
		Coconut Plantation	3	3	2	2	2	2	2	2	2			
Source of Availability	Ownership	Fully Private	0	0	0	2	2	2	2	2	2			
		Partly Private owned/Partly Govt. owned	3	0	2	1	2	2	1	3	3			
		Fully Govt. Owned	2	2	2	1	3	3	2	2	2			
Sub-Total			**25**	**20**	**22**	**20**	**23**	**27**	**21**	**24**	**26**			
Required Water Depth Available														
Depth	15-17 m		1	1	1	1	1	1	1	1	1	Natural depth 20-	Natural depth 16-	Natural depth 16-

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
	18-20 m	1	1	2	1	2	2	1	3	3	24 m	20 m	20 m
	21-23 m	1	3	3	1	3	3	1	3	3			
Dredging	for 15-17 m depth	1	1	1	1	1	1	1	1	1			
	for 18-20 n depth	1	3	3	1	3	3	1	3	3			
	for 21-23 m depth	1	3	3	1	3	3	1	3	3			
Sub-Total		**6**	**12**	**13**	**6**	**13**	**13**	**6**	**14**	**14**			
Required Water Area Available													
Manoeuvring	if BW Parallel to coast/ Perpendicular to coast	1	3	3	1	3	3	1	3	3	Entry parallel to coast due to minimal littoral drift, 2 Km ship channel & 730 M turning circle	Port entry perpendicular to coast due to littoral drift, 2 Km ship channel & 730 M turning circle	Port entry perpendicular to coast due to littoral drift, 2 Km ship channel & 730 M turning circle
Berthing	safe stopping distance	1	1	1	1	1	1	1	1	1			
Flexibility of phase wise construction	if BW Parallel to coast/ Perpendicular to coast	1	3	3	1	3	3	1	3	3			
Sub-Total		**3**	**7**	**7**	**3**	**7**	**7**	**3**	**7**	**7**			
Harbour protection works required													
Wave Incidence & Tranquillity	if BW Parallel to coast	1	0	0	1	0	0	1	0	0	Full protection to waves from south-south west due to south entry to port, Port location in area of minimal littoral drift movement having rocky beaches and	Partial protection to waves due to west entry to port, Port location in area where littoral movement & sedimentation from river exists, requiring shoreline	Partial protection to waves due to west entry to port, Port location in area where littoral movement & sedimentation from river exists, requiring shoreline
	if BW Perpendicular to the coast	0	3	3	0	3	3	1	3	3			
Shoreline Protection based on Littoral Drift	North of Port	0	3	3	0	3	3	0	3	3			
	South of Port	0	0	3	0	0	3	0	0	3			
	Both Sides	0			0	0	0	1	0	0			

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
Sub-Total		**1**	**6**	**9**	**1**	**6**	**9**	**3**	**6**	**9**	hence no additional shore protection measures	protection measures and difficulties arise due to those measures	protection measures and difficulties arise due to those measures
Safety of navigational approach													
Manoeuvrability (Wave Hitting the Beam of the Ship)	if BW Parallel to coast	3	0	0	3	0	0	3	0	0	Entry parallel to coast, maximum 3 ships per day from more than 400 ships sailing through the route, aids are proposed	Port entry perpendicular to coast, maximum 3 ships per day from more than 400 ships sailing through the route, aids are proposed	Port entry perpendicular to coast, maximum 3 ships per day from more than 400 ships sailing through the route, aids are proposed
	if BW Perpendicular to the coast	0	1	1	0	1	1	0	1	1			
Manoeuvrability (Wave assisted entry)	if BW Parallel to coast	2	0	0	3	0	0	3	0	0			
	if BW Perpendicular to the coast	0	1	1	0	1	1	0	1	1			
Difficulty connecting with international shipping route-Angular connectivity		3	3	3	3	3	3	3	3	3			
Interference with fishing Vessel		3	3	2	3	3	3	3	3	3			
Navigational Aids		1	1	1	1	1	1	1	1	1			
Communication Arrangements		1	1	1	1	1	1	1	1	1			
Interference with tourism Cruise		0	0	3	0	0	3	0	0	3			
Sub-Total		**13**	**10**	**12**	**14**	**10**	**13**	**14**	**10**	**13**			
Ease of Maintenance Dredging													
Littoral Drift		1	3	3	1	3	3	1	3	3	Only minimal/nil	Moderate level of	Moderate level of

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
Sediment from River Mouth		0	2	3	2	3	3	3	3	3	litoral drift envisaged due to the rocky promontory at the site and hence minimum maintenanace dredging, No river mouth	litoral drift envisaged due to alterartion of the straight line beach having seasonal accretion & erosion and hence need for maintenance dredging, river mouth is present	litoral drift envisaged due to alterartion of the straight line beach having seasonal accretion & erosion and hence need for maintenance dredging, river mouth is present
Sub-Total		**1**	**5**	**6**	**3**	**6**	**6**	**4**	**6**	**6**			
Easiness of access to hinterland (terrain)													
Distance to District Road/SH	within 1 km	1	3	3	1	3	3	1	3	3	District road (near 600M), low built up area along road line	District Road (1-2 Km), heavy built up area along road line	District Road (1-2 Km), heavy built up area along road line
	within 2 km	1	1	1	1	1	1	1	1	1			
	within 3 km or more	0	0	0	0	0	0	0	0	0			
Built-up areas in access to district roads	Low	2	2	2	2	2	2	3	2	2			
	Heavy	0	3	3	0	3	3	0	3	3			
Sub-Total		**4**	**9**	**9**	**4**	**9**	**9**	**5**	**9**	**9**			
Distance to NH-47													
Distance to NH47	0-10 km	2	2	2	2	2	2	2	2	2	NH is within 10 Km, medium built up area along road line, NH byepass line is within 2 Km,	NH is within 10 Km, medium built up area along road line, NH byepass line is within 4 Km,	NH is within 10 Km, medium built up area along road line, NH byepass line is
	10 km and above	0	0	0	0	0	0	0	0	0			
Built-up areas in access to NH47	Low	2	2	2	2	2	2	2	2	2			
	Medium	2	2	2	2	2	2	2	2	2			

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
	Heavy	0	0	0	0	0	0	3	2	2	low built up area along NH byepass line	medium built up area along NH byepass line	within 4 Km, medium built up area alongNH byepass line
Distance to NH47 bypass	0-10 km	0	0	0	1	2	2	1	3	3			
	10 km and above	0	0	0	0	0	0	0	0	0			
Built-up areas having access to NH47 bypass	Low	0	0	0	1	3	3	1	3	3			
	Heavy	0	0	0	0	0	0	0	0	0			
Sub-Total		**6**	**6**	**6**	**8**	**11**	**11**	**11**	**14**	**14**			
Distance to Railway line													
Distance to Railway Line	0-10 km	1	0	0	1	3	3	1	3	3	Railway within 10 Km (to balaramapuram), low built up area along Railway line	Railway within 10 Km-15 km (to Neyyattinkara), heavy built up area along Railway line	Railway within 10-15 km (to Neyyattinkara), heavy built up area along Railway line
	10 km and above	0	2	2	0	2	2	0	2	2			
Built-up areas along the access to Railway line	Low	2	2	2	2	2	2	2	2	2			
	Heavy	0	3	3	1	3	3	1	3	3			
Sub-Total		**3**	**7**	**7**	**4**	**10**	**10**	**4**	**10**	**10**			
Access to public supplies (power & water)													
Water Supply-surface water source		1	1	1	1	1	1	1	1	1	Vellayani lake, since other surface water sources are not potable and ground water sources are not reliable, water supply Via-Kdarakkuzhy-	Neyyar river, since water from Karichal river is already being utilised, water supply Via-Kdarakkuzhy-Mulloor-Karichal, Vizhinajm sub	Very close to Neyyar river, water supply through medium populated areas, Poovar Substation
Built-up area in Water Supply Route	Low	1	1	1	1	1	1	1	1	1			
	Heavy	0	3	3	0	2	2	0	2	2			
Power supply Distance to Substation	0-5 km	1	3	1	1	3	1	1	3	1			
	5-10 km	0	2	0	0	0	0	0	0	0			
Need for Upgradation in Substation (110KVor 220KV)		2	2	2	2	2	2	2	2	2			
Built-up area in Power	Low	1	1	1	1	1	1	1	1	1			

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
Supply Route	Medium	0	3	3	0	3	3	0	3	3	Mulloor, Vizhinajm sub station	station	
	Heavy	0	0	0	0	0	0	0	0	0			
Sub-Total		**6**	**16**	**12**	**6**	**13**	**11**	**6**	**13**	**11**			
Coastal Regulation Zone													
Restrictions to Port Development Vs CRZ-I falling between HTL &LTL- CRZ I (ii)		1	1	1	1	1	1	1	1	1	Port development is a permissible activity in CRZ-I	Port development is a permissible activity in CRZ-I, wetlands	Port development is a permissible activity in CRZ-I, wetlands with estuarine plants
Sensitive ecosystems such as corals eligible to be categorised as CRZ I(i) in sea side		1	3	3	1	3	3	1	3	3			
Areas classified as CRZ I(i) in land ward side like lateritic cliffs and adjacent 50M land ward, mangrove families, filtration ponds		2	2	2	1	2	2	1	3	3			
Sub-Total		**4**	**6**	**6**	**3**	**6**	**6**	**3**	**7**	**7**			
Impact to Ecologically sensitive areas													
Ecologically sensitive areas as per CRZ falling under estuaries, creeks, rivers, backwaters		**2**	**3**	**3**	**1**	**3**	**3**	**1**	**3**	**3**	No estuaries, creeks,rivers, backwaters-only small drains	Estuaries, Rivers & Backwaters	CRZ V(2011)-Areas requiring special consideration in CRZ to be protected
Impact to Existing river system (diversion)													
Flow alteration		0	3	3	2	3	3	2	3	3	No river outlet,	River outlet diversion/permane	River outlet diversion/obstructi
Alteration of sediment transport		2	3	3	0	3	3	0	3	3			

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
Sub-Total		**2**	**6**	**6**	**2**	**6**	**6**	**2**	**6**	**6**	only small drains	nt opening must be constructed to sea, salt water intrusion	on/permanent opening to sea, salt water intrusion
Change in shoreline													
shoreline	Bay	1	0	0	1	0	0	1	0	0	pocket beaches in the shadow of rock protrusions, No sediment supply from rivers- only small streams	Straight beaches exposed to waves, sediment supply from Karichal river	Straight beaches exposed to waves, sediment supply from Neyyar river
	Straight	0	2	2	0	3	3	0	3	3			
Degree of Erosion	Rocky/Stable	1	0	0	1	0	0	1	0	0			
	Erosion/Accretion	0	3	3	0	3	3	0	3	3			
Sediment Supply From River		2	3	3	2	3	3	2	3	3			
Sub-Total		**4**	**8**	**8**	**4**	**9**	**9**	**4**	**9**	**9**			
Impact on Fishing activity													
Fishing Villages in Shadow Zone		1	3	3	0	3	3	0	3	3	No designated fishing villages, mussel fishing at Mulloor & shoreseine at Valiakadappuram, Increased tranquility, lesser accresion & lesser downtime at Vizhinjam fishing harbour	Entire coast is fishing village, shoreseine & other type of fishing along entire project stretch, not advantageous to Vizhinjam fishing harbour	No designated fishing villages, shoreseine & other type of fishing along entire project stretch, not advantageous to Vizhinjam fishing harbour
Type of Fishing	Shoreseine	3	0	0	3	3	3	3	3	3			
	Mussel	3	0	0	3	0	0	3	0	0			
	other	0	3	3	0	2	2	0	3	3			
Difficulty in movement of boats		3	2	2	3	2	3	3	2	3			
Fishing intensity with respect to use of beach front Fish landing, boat parking, fish drying etc		1	3	2	2	3	3	2	3	3			
Nearness to existing fishing harbour and improved tranquillity, lesser accretion & lesser down time		3	1	1	3	1	1	3	1	1			
Sub-Total		**14**	**12**	**11**	**14**	**14**	**15**	**14**	**15**	**16**			

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
Impact ot Tourism activities													
Resorts in the backup area	1-5 resorts	3	0	3	3	0	3	3	0	3	3 resorts (2 in back up south, 1 in back up north), 8 in between these backup, seems to be violating of CRZ and hence it is necessary to highlight this parameter but still it is not given a negative value	No resorts are present	No detailed analysis is conducted on the violation issues at this site
	5-10 resorts	2	0	1	3	0	2	3	0	2			
	10 resorts and more	0	0	0	3	0	0	3	0	0			
CRZ violation by resorts		0	0	0	0	0	0	0	0	0			
Use of Beach by Resorts		3	0	3	3	0	2	3	0	0			
River/Backwater Cruise		0	0	3	0	0	3	0	0	3			
Sub-Total		**8**	**0**	**10**	**12**	**0**	**10**	**12**	**0**	**8**			
Land Acquisition/loss of land													
Backup Facility	No Land Required	1	3	3	1	3	3	1	3	3	No government land available due to lesser width of beaches	More beach area (govt land) available	More beach area (govt land) available
	0-50 Acres	0	3	3	3	3	3	3	3	3			
	50-100 Acres	0	0	0	0	0	0	3	0	0			
	100-150 Acres	0	0	0	0	0	0	0	0	0			
	150 Acres and more	0	0	0	0	0	0	0	0	0			
Sub-Total		**1**	**6**	**6**	**4**	**6**	**6**	**7**	**6**	**6**			
Operation impact on livelihood quality													

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
Livelihood	Fishermen	2	3	2	3	3	3	3	3	3	Livelihood for already existing will be increased by development of fishing harbour and infrastructure	If the port is constructed in this site it is not sure that a fishing harbour will be developed and hence increasing the livelihood of the surrounding area. Also newer development may increase the conflict in and around	If the port is constructed in this site it is not sure that a fishing harbour will be developed and hence increasing the livelihood of the surrounding area. Also newer development may increase the conflict in and around
	Resort/Tourism Dependent	3	0	2	3	0	3	3	0	3			
	Other induced Development	1	3	3	1	3	3	1	3	3			
Sub-Total		**6**	**6**	**7**	**7**	**6**	**9**	**7**	**6**	**9**			
Resettlement & Rehabilitation impact													
R&R	Others/Fishing Family	0	3	0	0	3	3	0	3	3	R&R is very minimum if families and 3 resorts	fishing families should have been resettled	it includes fishing families and some resorts
	Resorts	0	0	0	0	0	0	3	0	0			
Sub-Total		**0**	**3**	**0**	**0**	**3**	**3**	**3**	**3**	**3**			
Capital & Land Acquisition													
Capital & Land Acquisition		2	3	2	3	3	2	3	3	2			
Flexibility of phase wise Construction & cost involved		1	3	3	2	3	3	2	3	3			
Sub-Total		**3**	**6**	**5**	**5**	**6**	**5**	**5**	**6**	**5**			
O&M													

Parameters		Scenario A for sites			Scenario B for sites			Scenario C for sites			Remarks for Site A	Remarks for Site B	Remarks for Site C
		A	B	C	A	B	C	A	B	C			
Operation & maintenance	Dredging	1	3	3	1	3	3	1	3	3			
	phase wise Development of breakwater	2	3	3	2	3	3	2	3	3			
Sub-Total		**3**	**6**	**6**	**3**	**6**	**6**	**3**	**6**	**6**			

Final scores for selection of Vizhinjam port (Site A) is given in **Table 3-16**.

Table 3-16: Summary of Multi Criteria Analysis for all Scenarios

Attributes	Impact Score								
	Site A	Site A	Site A	Site B	Site B	Site B	Site C	Site C	Site C
	Sce.A	Sce.B	Sce.C	Sce.A	Sce.B	Sce.C	Sce.A	Sce.B	Sce.C
Level inland area available	37	29	30	30	33	34	33	39	37
Required Water Depths available	19	19	18	39	41	41	42	41	41
Required Water area available	18	18	18	41	41	41	41	41	41
Harbour protection works required	6	6	17	38	38	33	56	56	50
Safety of navigational approach	37	38	38	29	27	27	34	35	35
Ease Maintenance dredging	8	20	25	42	40	38	50	40	38
Easiness of Access to Hinterland (terrain)	18	18	22	41	41	39	41	41	39
Distance to NH-47	33	27	28	33	37	36	33	37	36
Distance to Railway line	18	17	17	41	42	42	41	42	42
Access to public supplies(power & water)	18	20	20	47	43	43	35	37	37
Coastal Regulation Zone	25	20	18	38	40	41	38	40	41
Impact to Ecologically sensitive areas	25	14	14	38	43	43	38	43	43
Impact to Existing river system (diversion)	14	14	14	43	43	43	43	43	43
Change in shoreline	20	18	18	40	41	41	40	41	41

Attributes	Impact Score								
	Site A	Site A	Site A	Site B	Site B	Site B	Site C	Site C	Site C
	Sce.A	Sce.B	Sce.C	Sce.A	Sce.B	Sce.C	Sce.A	Sce.B	Sce.C
Impacts on Fishing activities	38	33	31	32	33	33	30	35	36
Impacts to Tourism Activities	44	55	60	0	0	0	56	45	40
Land Acquisition/loss of land	8	25	37	46	38	32	46	38	32
Operation impact on livelihood quality	32	32	32	32	27	27	37	41	41
R&R	0	0	33	100	50	33	0	50	33
Capital & Land Acquisition	21	31	31	43	38	38	36	31	31
O&M	20	20	20	40	40	40	40	40	40
Total	**460**	**472**	**540**	**831**	**773**	**745**	**809**	**854**	**815**

Sce.A-Scenario A, Sce.B – Scenario B, Sce.C – Scenario C

Chapter 4
Description of Environment

Chapter 4 Description of Environment

4.0 General

This chapter presents the existing baseline environmental conditions of the Project Influenced Area (PIA) to evaluate the potential impacts of the proposed port development. A study area with a 10 km radius from the project site and a 15 km stretch along the shoreline for social surveys is taken into account for the EIA. The study area map on Google inverted image is given as **Figure 4-1**.



Figure 4-1: Study Area of 10 km radius (Inverted Colours)

The various components of the environment, such as ambient air quality, ambient noise, inland water quality (surface and groundwater), soil conditions, marine environment (covering both water and sediment) and ecological conditions of the study area is presented. The baseline condition has been presented as primary information (2011-2012) and secondary information (1964-2012).

Monitoring was performed between January 2011 and May 2012 during four seasons for various terrestrial environmental parameters.

Winter 2011 : January to February 2011[6]
Post-monsoon 2011 : November to December 2011
Winter 2012 : January to February 2012
Summer 2012 : April to May 2012

The monitoring of the marine environment was carried out for three seasons, one time sampling during each of the three seasons.

- Post-monsoon : October 2011 to January 2012
- Pre-monsoon : February to May 2012
- Monsoon : June to September 2012

The field monitoring and analysis of terrestrial parameters with respect to ambient air, noise, water (groundwater and surface water) and soil was carried out by Eko Pro Engineers Pvt. Ltd. (Eko Pro), Ghaziabad and the marine monitoring (water, sediment, plankton, benthos and chlorophyll) was undertaken by the regional research office in Vizhinjam of the Central Marine Fisheries Research Institute (CMFRI), Indian Council of Agricultural Research, Kochi, Kerala.

4.1 Land Environment

4.1.1 Topography and Regional Setting

About 54% of the study area consists of marine water body including the sea. Approximately 34% of the total area is land covered by coconut, mango, plantain and others like rubber plantations.

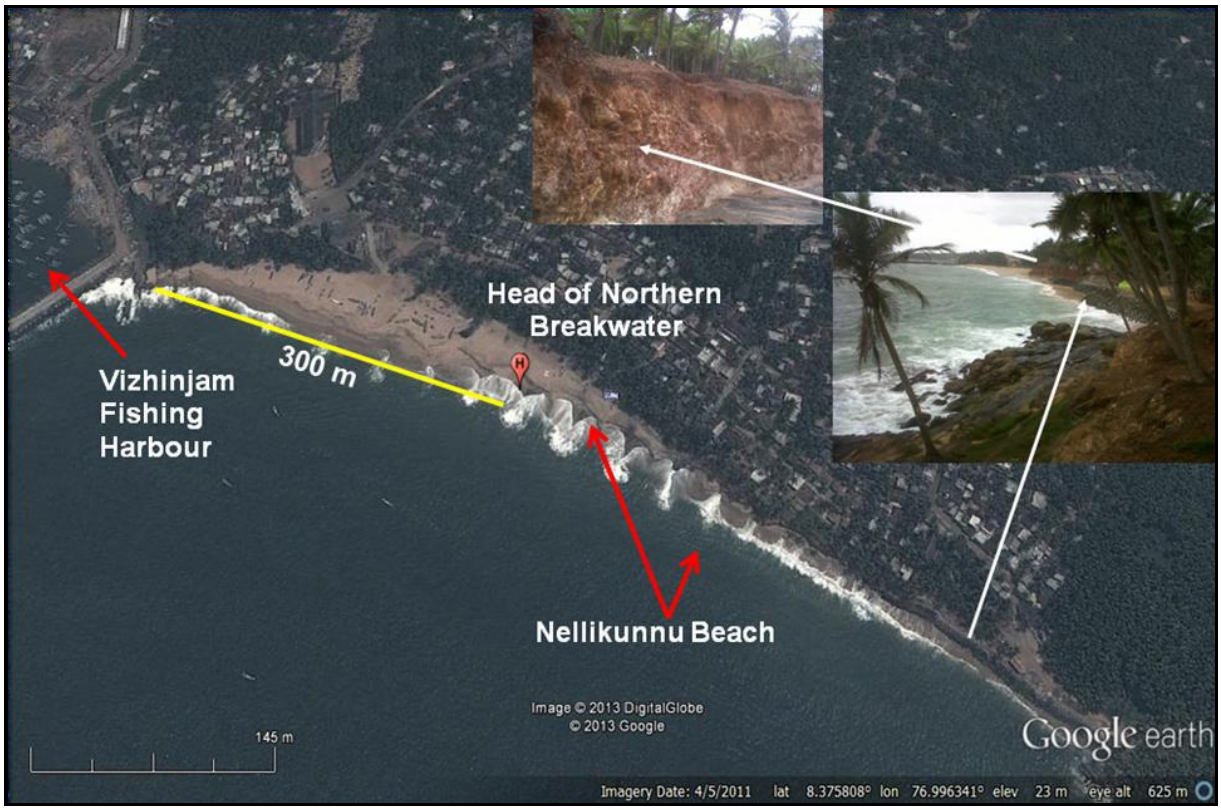
The coastal stretch of the study area (15 km North and South) extends from Poonthura in the North to Poovar in the South. The beaches in the study area are plain and are devoid of sand dunes. The shadow areas of the pocket beaches are intermingled with coconut trees and buildings. At about 500 m inward from the shoreline, agricultural land and coconut plantations are present in between human settlements with a semi urbanised or rural set up. Vizhinjam fishing harbour, which is a natural harbour with manmade infrastructures, is located at the northern side of the project site (at a distance of approximately 300 m).

The region is densely populated predominantly by fishermen communities. Kovalam beach, which is one of the world renowned tourist destinations in Kerala, is located at a distance of about 2.0 km north to the project site (nearest distance). The National Highway (NH) No.47 is approximately 7.0 km from the project site towards North East. A Broad Gauge (BG) railway line of Southern Railway is the nearest railway line to which the site will be connected to Thiruvananthapuram towards north and Nagercoil, and Tamil Nadu in the South. The beach areas in the project stretch are given as **Figure 4-2** and small pockets of beaches and rocky outcrops in the coastal stretch of project site are given as **Figure 4-3**.

[6] VISL has taken an official decision to take three season data after ToR approval when by the time one season data was already generated



Figure 4-2: Beach Areas in the Project Stretch




Mulloor Beach
Approach Road to Project Site from Vizhinjam – Poovar Road
147 m
Image © 2013 DigitalGlobe
© 2013 Google
Mulloor Beach
Google earth


Mulloor Beach
Pulinkudi Beach
146 m
Image © 2013 DigitalGlobe
© 2013 Google
Google earth





Figure 4-3: Small Pockets of Beaches and Rocky Outcrops in the Coastal Stretch of Project Site

4.1.2 Geology and Geomorphology

The coastal geomorphology of the project stretch is described under the Marine Environment (Section 4.3). The data pertaining to geology and geomorphology of the PIA district in general and Vizhinjam in specific has been assimilated by reviewing published literature and documents, especially from the Publication of Geological Survey of India (GSI), 2004.

The PIA District is underlined with Kerala Khondalite Belt (KKB), which consists mainly of garnet – sillimanite graphite gneiss along with garnet-cordierite gneisses, garnet-biotite gneisses and garnet bearing quartz feldspathic gneiss inter-layered with Gharnockites. The geology of this district is shown in **Figure 4-4** and it comprises of the following rocks/sediments:

Precambrian Crystalline: Precambrian crystalline rocks, which consist of khondalites, gneisses and incipient charnockites, have significant composition in this region.

Basic Intrusives: Basic intrusives like gabbro and dolerite are present in the Precambrian crystalline rocks.

Neogene Sedimentary Rocks: Neogene sedimentary rocks are present in the coastal region of Varkala and Chowara. It comprises of carbonaceous clays with lignified tissues/coal seams, china clay and friable sandstone.

Laterites: Laterites are of the recently formed litho units, which are formed above the Precambrian crystallines and Tertiary sedimentaries. They constitute up to 60% of the surface area of the district.

Quaternary Sediments: Quaternary sediments like sand bars, sandy hats, alluvial sands and lacustrine deposits are found in the Poonathura and Poovar regions within the study area. These sediments are found in patches and are separated by laterites.

The elevation map of the project area is given in **Figure 4-5**. Based on the elevation map of the project area, the study area can be classified into four groups:

1. Water body (0 - 10 m): 58% of the total study area consists of marine water body
2. Low Land (10 – 20 m): Area near the inland water comprises of 18% of the total area
3. Mid Land (20 - 40 m): 12% of the study area is between 20 and 40 above sea level
4. High Land (40 – 80 m): 12% of the study area consists of high lands

The geomorphological map of the project area is given in **Figure 4-6**. From this map, it can be inferred that the coastal region consists of:

- A natural levee (flood plain area)
- Rocky coast (rock outcrops)
- Young coastal plain (sandy beach)
- Old Coastal Plains

The majority of the project area (land region) consists of a lower laterite plateau.

4.1.3 Quarry Site

Quarry material is manly required for the construction of breakwater. Material is also required for most of the civil structures including buildings. Based on the quality, for construction of break water Kadavila quarry and/or another brown field (licenced) quarry (Theviyodu) located nearer to the Thakala, will be considered to be used as source of the quarry materials. The former quarry site is located towards NW

direction from the project site, whereas the latter is located at Theviyodu, Tamil Nadu towards a South East direction from the project site.

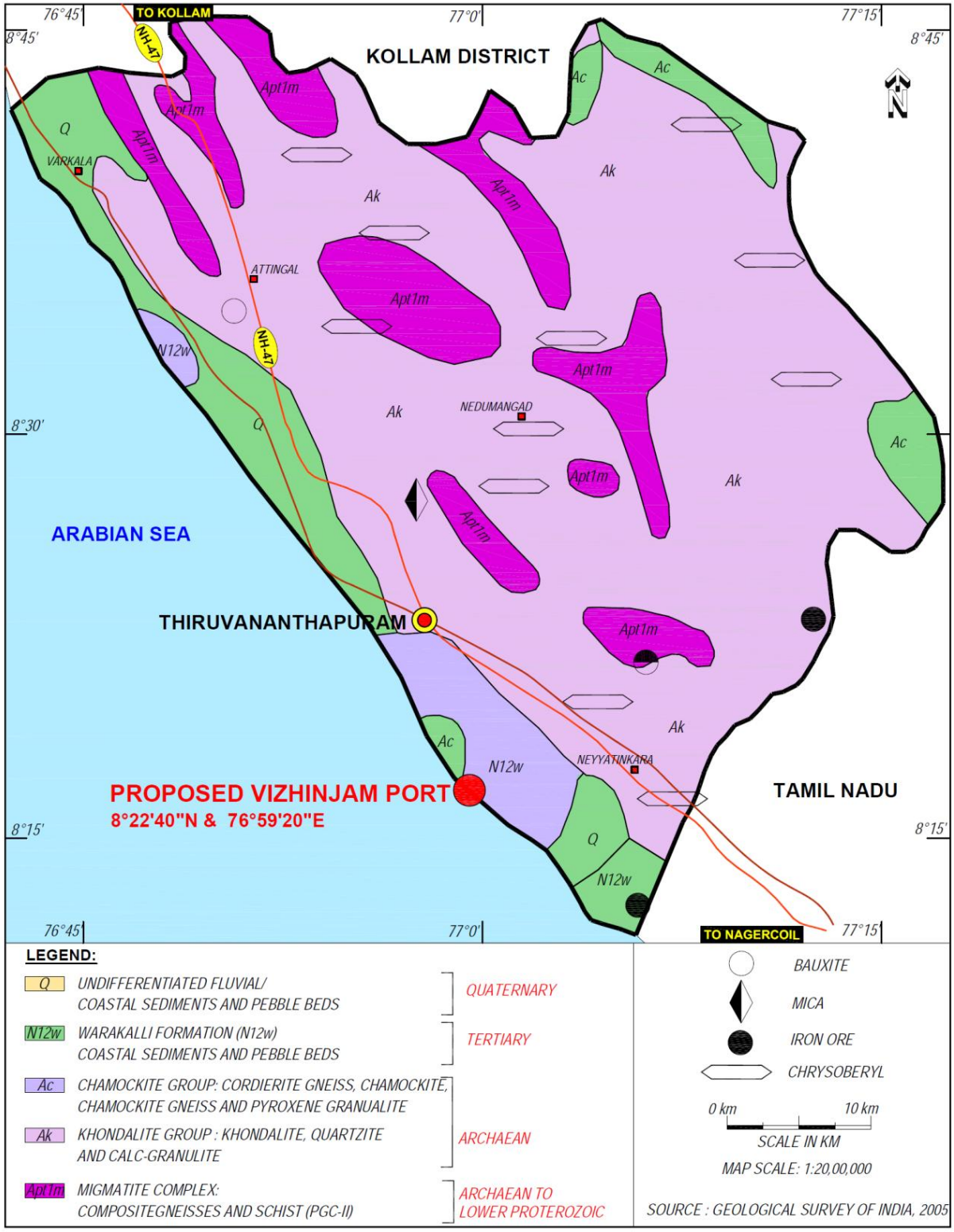
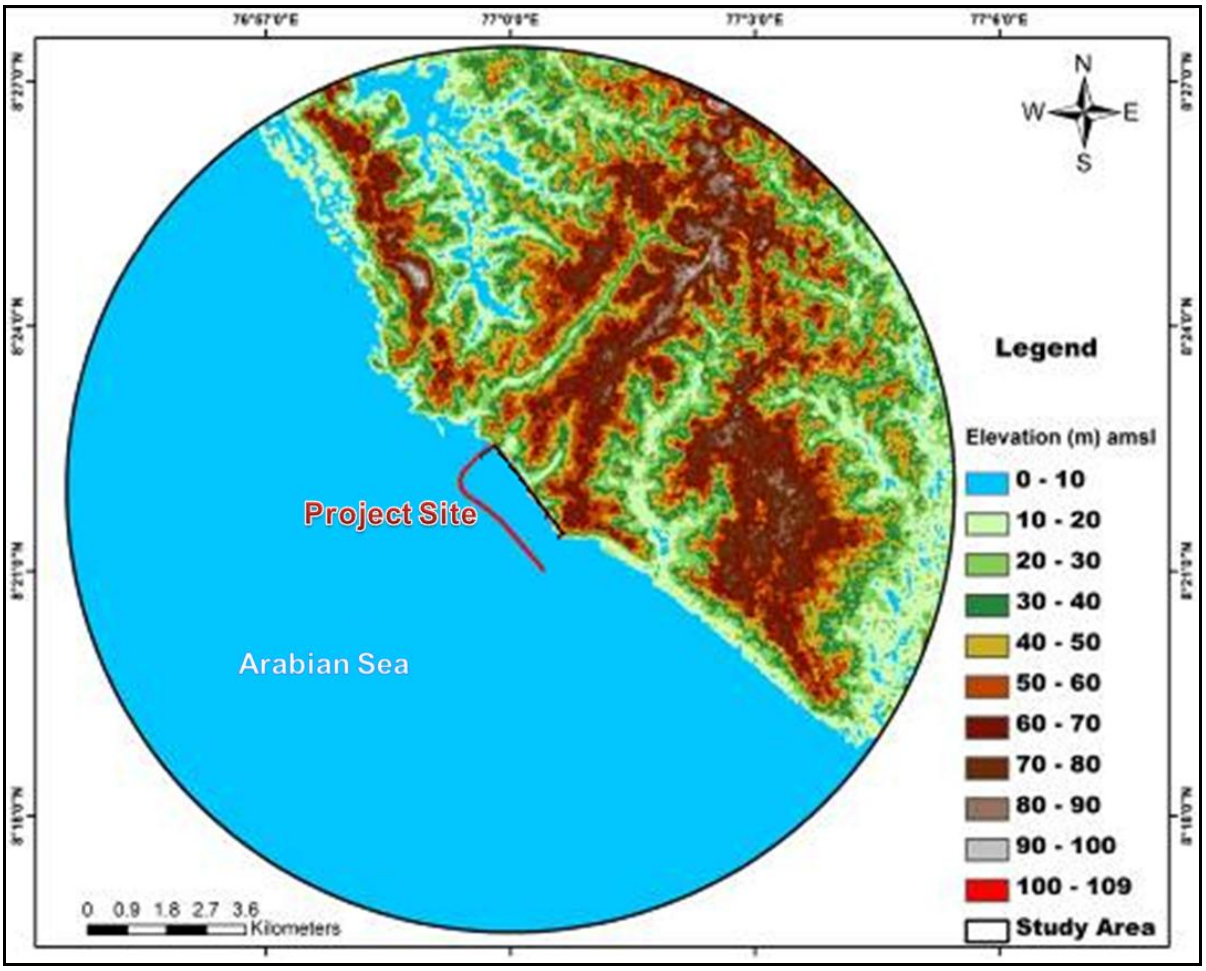


Figure 4-4: Geology Map of PIA District

4.1.3.1 Land Use Pattern at the Shortlisted Quarry Sites

Kadavila: Kadavila quarry site is located in the PIA district, Kerala. This quarry site is owned by the government and is in operation. This quarry is in the NW direction and about 65 km from the proposed project site. The quarry capacity is approximately 5.0 MCM. This quarry site is surrounded by human settlement within a 500 m distance (**Figure 4-7**). The quarry site is surrounded by thick vegetation comprising both of natural tree cover as well as rubber/coconut plantation. The equipment at this quarry includes hydraulic drilling units, tractors and smaller equipment. Quarries are reported to be operational during daytime only. The quarry material from Kadavila will be transported to Muthalapozhy harbour through Kallambalam and Kadakavur Junction. From Muthalapozhy harbour, the quarry material will be transported on barges to the Project site. The total length covered during transportation will be approximately 65 km which is inclusive of roadway transportation (23 km) and transportation through sea (42.km).

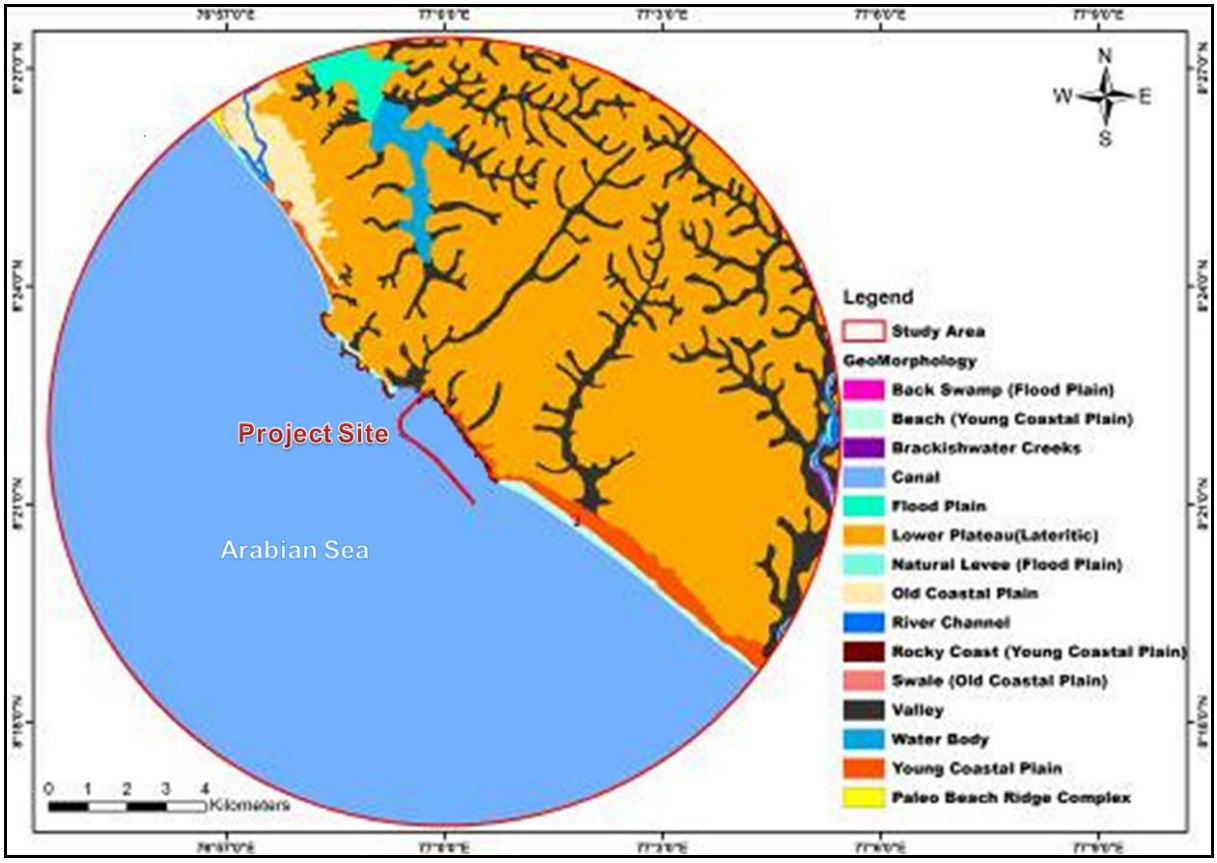


(Source: IRS P6 LISS III satellite Imagery, March 2011 by RH/ACE)

Figure 4-5: Digital Elevation Map of the Study Area

Theviyodu: Theviyodu Quarry is in Tamil Nadu State located in the Kanyakumari district (**Figure 4-8**) nearer (2.8 km) to Nagarcoil Thiruvananthapuram highway (NH 47) and Thottiyoodu junction (3.0 km). The total area of the quarry site is about 161.88 Ha (400 acres). The surrounding area around the quarry site is sparsely vegetated with Coconut, Amla, Neem etc. trees. There is no well-established residential area in the immediate vicinity of the quarry site, only a few mud houses of workers/ labours working in the quarry. An unpaved/dirt road connects the quarry area with NH 47. This quarry is privately owned. Currently dynamite is used to blast the rock and hydraulic units are used to break

large rocks into smaller pieces. Backhoe cranes are used to load small or medium sized trucks for onward transport. Further bulldozers and tractors are used for handling rock. Similar to the Kadavila quarry site, the quarry material will be transported through roadway and sea. The quarry material will be brought from the Theviyodu to Colachel port, via Thottiyoodu and Monday market junction, from where it will be shipped in barges to the project site. The total distance of transportation is approximately 55 km (roadway 17 km and in sea 38 km).



(Source: VISL, May 2012)

Figure 4-6: Geomorphological Map of the Study Area

4.1.4 Transportation from the Proposed Quarry Site to Project Site

The transportation route of the two quarry locations are shown in the following figures. **Figure 4-10** and **Figure 4-11** for the Kadavila quarry site and **Figure 4-12** and **Figure 4-13** for the Theviyodu quarry site.

4.1.4.1 Traffic Survey near Quarry Sites

A traffic survey was conducted at major junctions near the quarry sites Kadavila and Theviyodu. Kallambalam and Kadakkavur are the major junctions near the Kavaila quarry site. In case of Theviyodu, Thottiyoodu junction and Monday market are the major junctions. This survey was conducted for 24 hours in all four junctions. The results are depicted in **Figure 4-9**. It is clear that the traffic flow was highest in Thottiyoodu junction (Theviyodu quarry site), which was mainly constituted by Two wheelers, Four wheelers and Heavy Motor Vehicles (HMV). Attingal junction and Monday market had a higher traffic flow followed by the Thottiyoodu junction. The lowest traffic flow was at Kadakkavur junction (Kadavila quarry site).

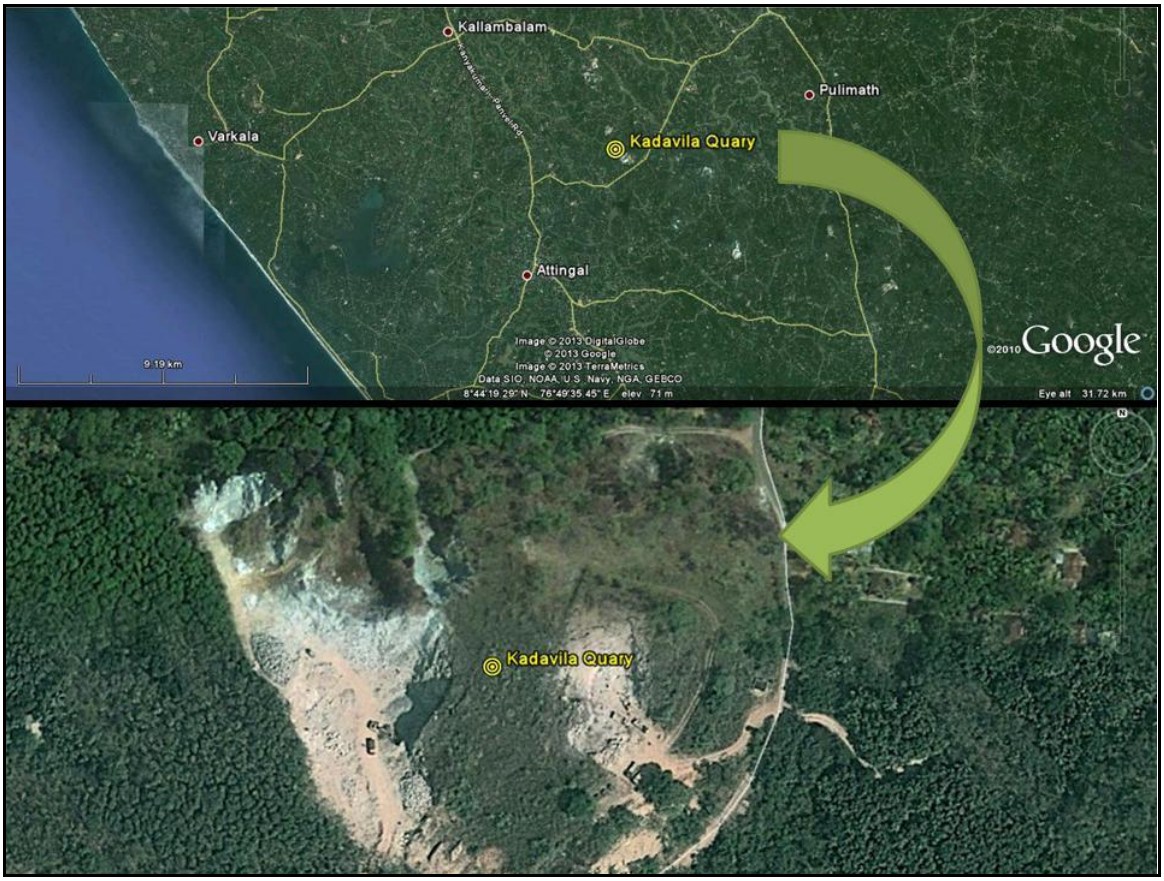


Figure 4-7: Kadavila Quarry Site



Figure 4-8: Theviyodu Quarry Site

From the traffic survey, it can be concluded that the quarry transportation route of Kadavila quarry site is less congested than the Theviyodu quarry site. Also, it was found that the total traffic flow is almost 80 to 90% lesser during night time in almost all the surveyed locations.

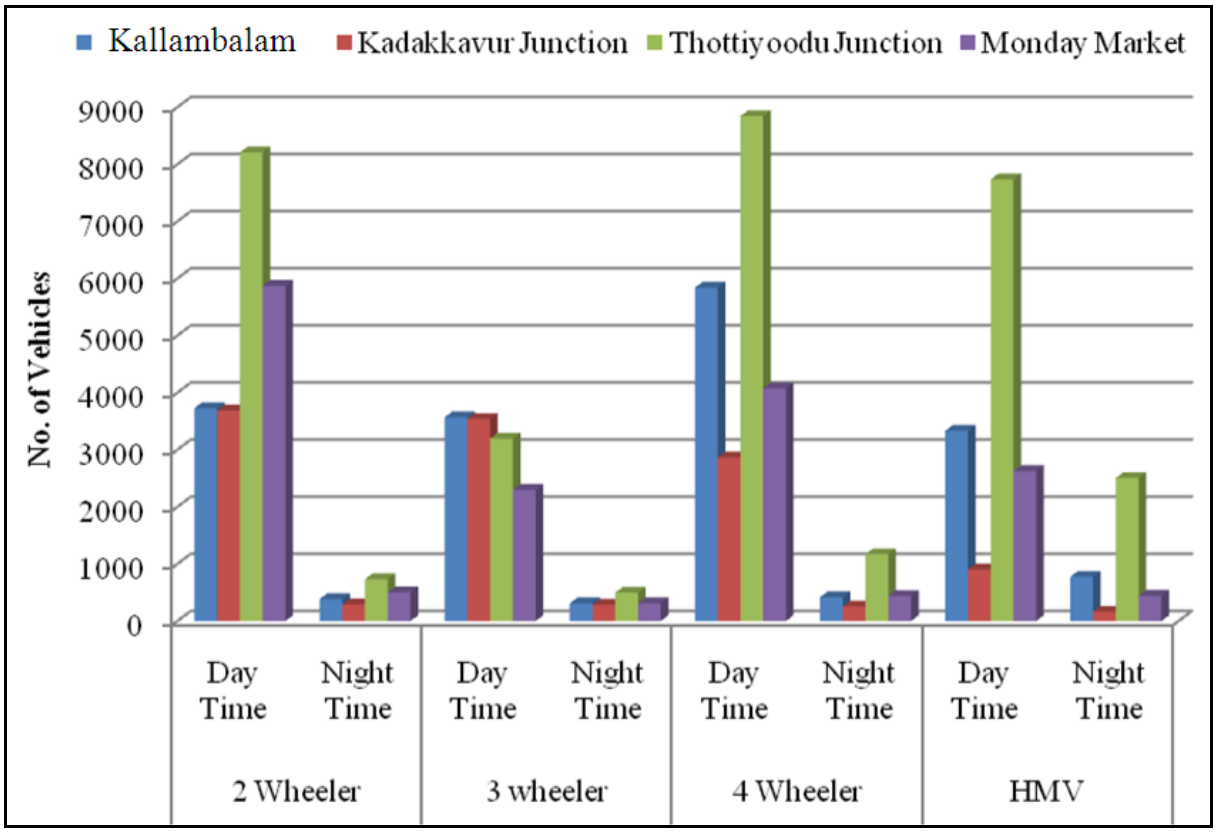


Figure 4-9: Traffic Survey at Major Junctions near the Quarry Sites

4.1.5 Land Use/Land Cover

4.1.5.1 Land Availability

All the port facilities are proposed to be developed entirely on reclaimed land whereas all the infrastructure facilities like back up areas, warehouse, truck terminal areas, administrative buildings, etc. are planned to be developed on the landward side in area of 140.42 Ha, part of which i.e. around 48.2 Ha is owned by VISL. The port facilities which are planned to develop on reclaimed land comprises an area of approximately 66 Ha. The total area required for development of port and associated facilities will be 206.42 Ha (Including the water area inside the port).

4.1.5.2 Land Use Pattern in Study Area

A land use land cover map for the project area is presented in **Figure 4-14**. The classification of the area within 10 km distance from the project site is given in **Table 4-1**. It can be deduced from the table that almost 54.81% of the study area is covered by water (mainly Sea). The "**Built up Area**" and "**Coastal Sand**" (beach area) respectively constitute about 10.87% and 0.74% of the total area. The remaining area of 33.58% is covered by vegetation.



Figure 4-10: Quarry Material Transportation Route - Kadavila Quarry to the Project site

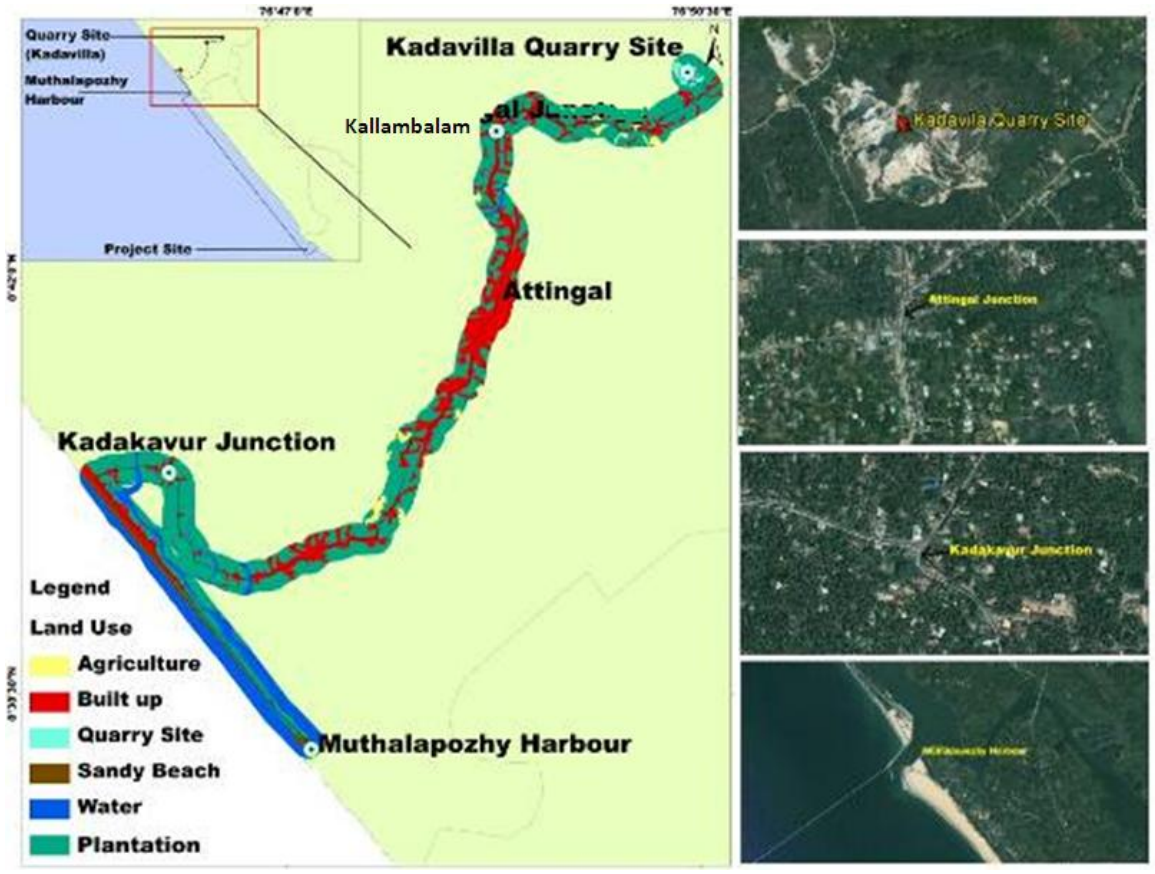


Figure 4-11: LU/LC Map of the Transport Route - Kadavila Quarry to Muthalapozhy Harbour



Figure 4-12: Quarry Material Transport Route - Theviyodu Quarry to the Project Site

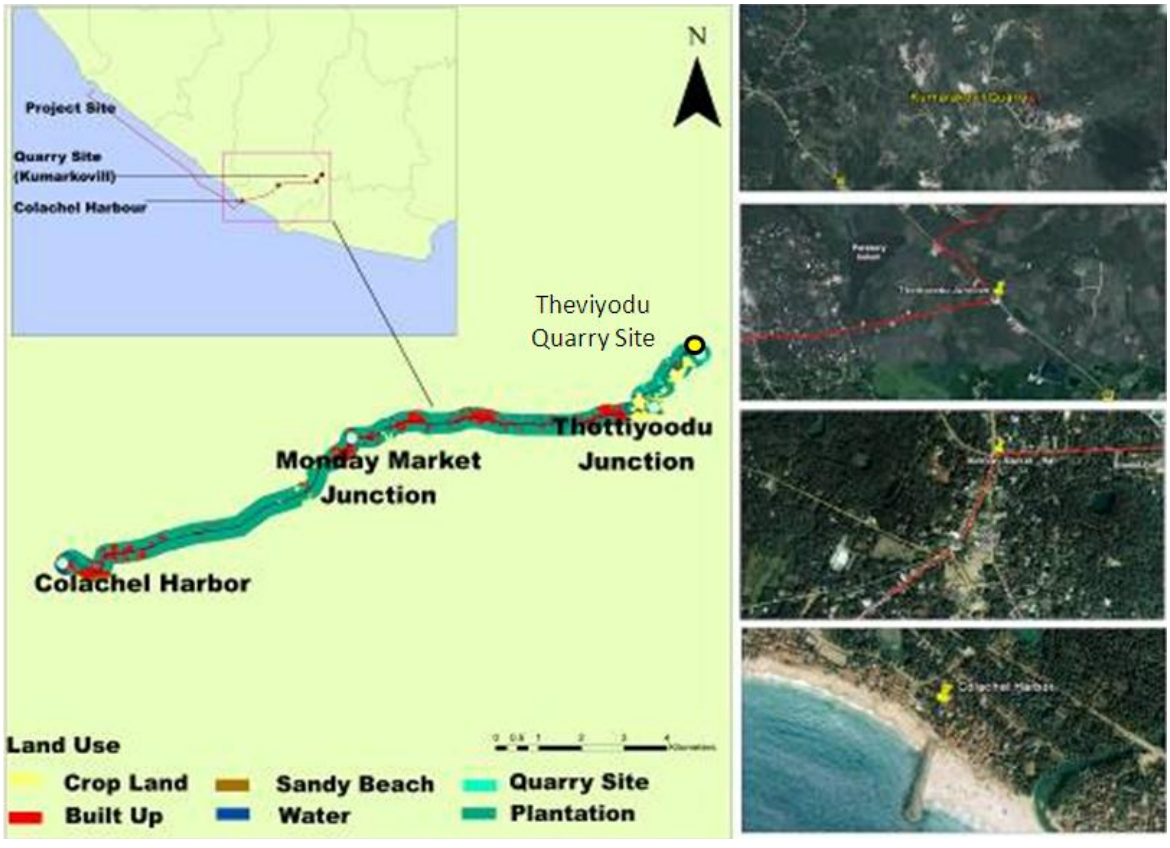
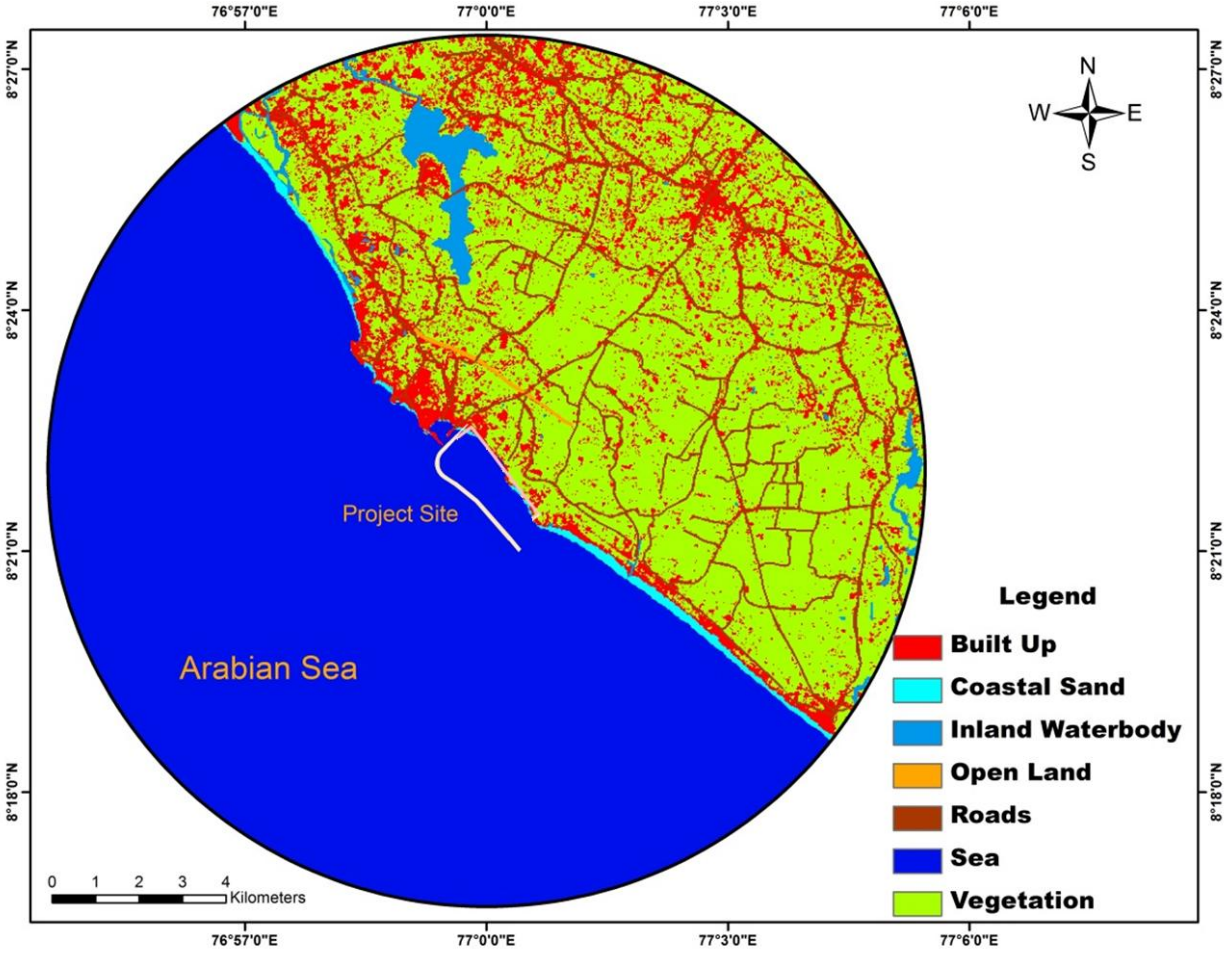


Figure 4-13: LU/LC Map of the Transport Route -Theviyodu Quarry to Colachel Harbour

Table 4-1: Area Distribution of the Study Area

S. No.	Class	Area (km^2)	Area (%)
1.	Built Up Area (Including roads)	34.05	10.87
2.	Vegetation (including open land)	105.20	33.58
3.	Coastal Sand	2.32	0.74
4.	Water Body (including sea area)	171.67	54.81
	Total	**313.24**	**100**



(Source: IRS P6 LISS III satellite Imagery, March 2011 by RH/ACE)

Figure 4-14: Land Use Land Cover Map of the Study Area

4.1.5.3 Environmentally/Ecologically Sensitive Areas

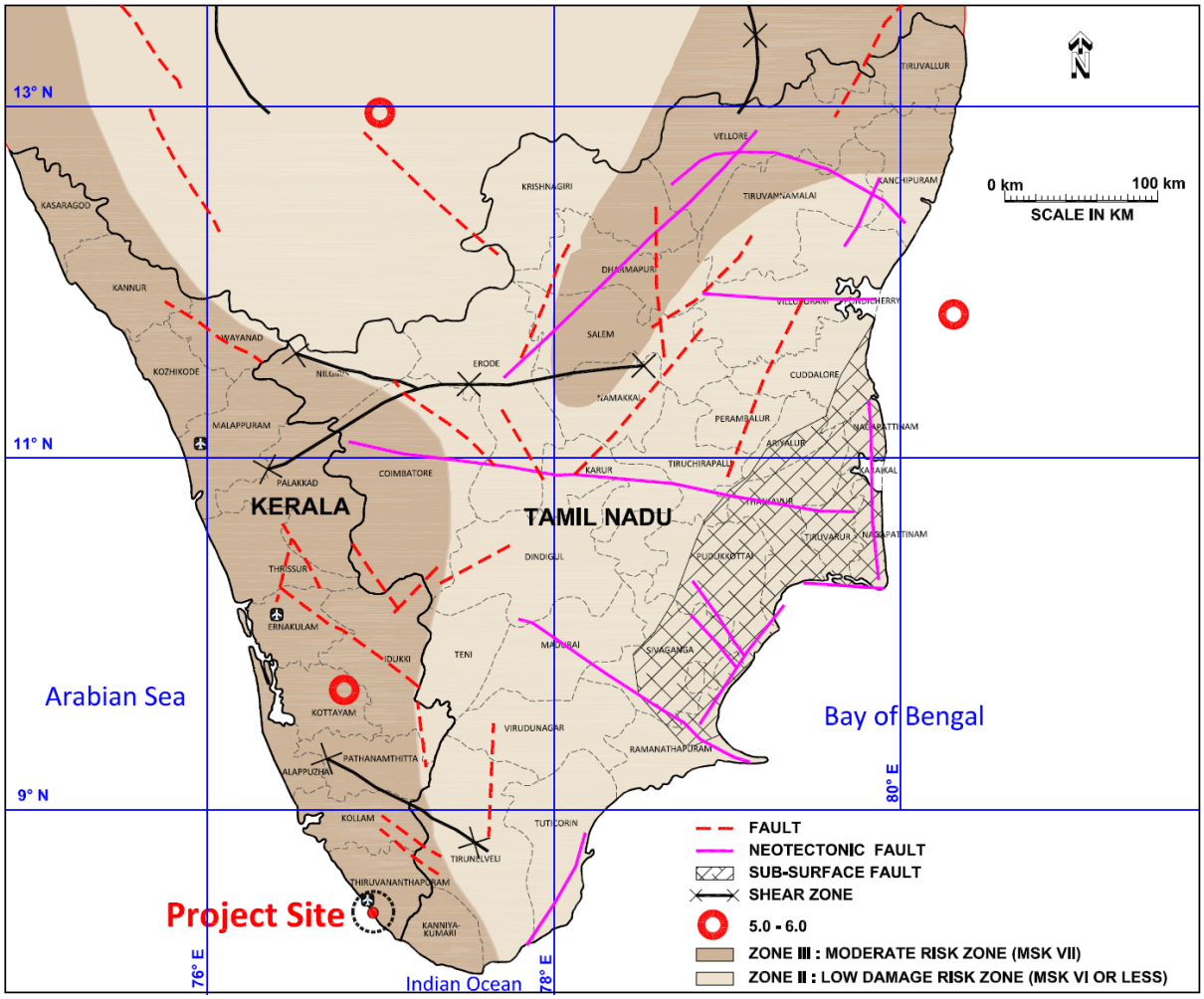
The environmental sensitive areas covering an aerial distance of 15 km radius from centre of the port is given in **Table 4-2**.

Table 4-2: Environmentally Sensitive Areas within 15 km from centre of the Port

S. No.	Areas	Name/Identity	Approximate Aerial Distance & Direction
1.	Areas protected under international conventions, National or local legislation for their ecological, landscape, cultural or other related value	Cave Temple - National monument protected under Ancient Monuments and Archaeological Sites & Remains Act, 1958	1.0 km
2.	Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests	Killi River Karamana River Vellayani Lake Neyyar River	8 km, NW 10 km, NW 4.2 km, NW 10 km, S
3.	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration	Nil	-
4.	Inland, coastal, marine or underground waters	Arabian Sea	Adjoining on West
5.	State, National boundaries	Tamil Nadu Boundary	13.5 km, SE
6.	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas	NH-47 Proposed NH-47 Bypass Southern Railway Mainline	8 km, NE 1.8 km, NE 9 km, NE
7.	Defence installations	Nil	-
8.	Densely populated or built-up area	Thiruvananthapuram	13 km, NW
9.	Areas occupied by sensitive man-made land uses (hospitals, schools, places of worship, community facilities)	<u>Places of Worship</u> Bhagavathi temple at Kottukal Old Vizhinjam Church Valiya Pali Mosque Great Mohyyudin Mosque Kodyil Kallupalli Mosque Siva temple (disused /abandoned condition)	 3.3 km, SE 0.5 km, NE 0.3 km, E 1.0 km, N 0.5 km, NW 0.5 km W
10.	Areas containing important, high quality or scarce resources, (ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)	<u>Fishing Villages in the vicinity of the Port</u> • Vizhinjam • Adilamulathurai • Chowara • Pulivilla • Karumkulam • Poovar • Punthura & Panthura <u>Tourist Destinations</u> • Kovalam • Puvar South	 1.0 km, NWW 3.0 km, SE 2.5 km, SE 5.2 km, SE 7.8 km, SE 10 km, SE 14 km, WNW 2 km, NW 10 km, SE
11.	Areas already subjected to pollution or environmental damage (those where existing legal environmental standards are exceeded)	Nil	-
12.	Areas susceptible to natural hazard which could cause the project to present environmental problems, (earthquakes, subsidence, landslides, erosion, flooding, or extreme or adverse climatic conditions)	Proposed project falls under Seismic Zone III (Very low Seismic disturbance up to 0-0.2) as per IS 1893 (Part I) of Indian Seismic Map. It is a cyclone prone area	-

4.1.5.4 Seismicity and Earthquake

The seismo-tectonic faults and earthquake zonation is shown in **Figure 4-15**. From the map it is evident that no major/regional seismically active faults, thrusts or trenches are present in the project area. The proposed project area is located in Zone III - the moderate damage risk zone. It is also evident that the project area did not experience any major earthquake in the past. The seismic scenario of Kerala is being monitored by Centre for Earth Science Studies (CESS), Thiruvananthapuram. CESS has established a digital Broadband Seismic Observatory (Station code: PCH) in the campus of the Kerala Forest Research Institute (KFRI) at Peechi since 1999. The seismic history of PIA district collected from CESS and the only earth quake observed was on January 11, 2008, Near Attingal (Approximately 40 Km from project site), with a magnitude of 2.5 (R)



(Building Materials and Technology Promotion Council (BMTPC), 2012)

Figure 4-15: Seismic and Earthquake Zones and Regional Faults in Kerala

4.1.6 Soil Quality

4.1.6.1 Soil Quality Monitoring Locations

The soil map of PIA district is given in **Figure 4-16**.

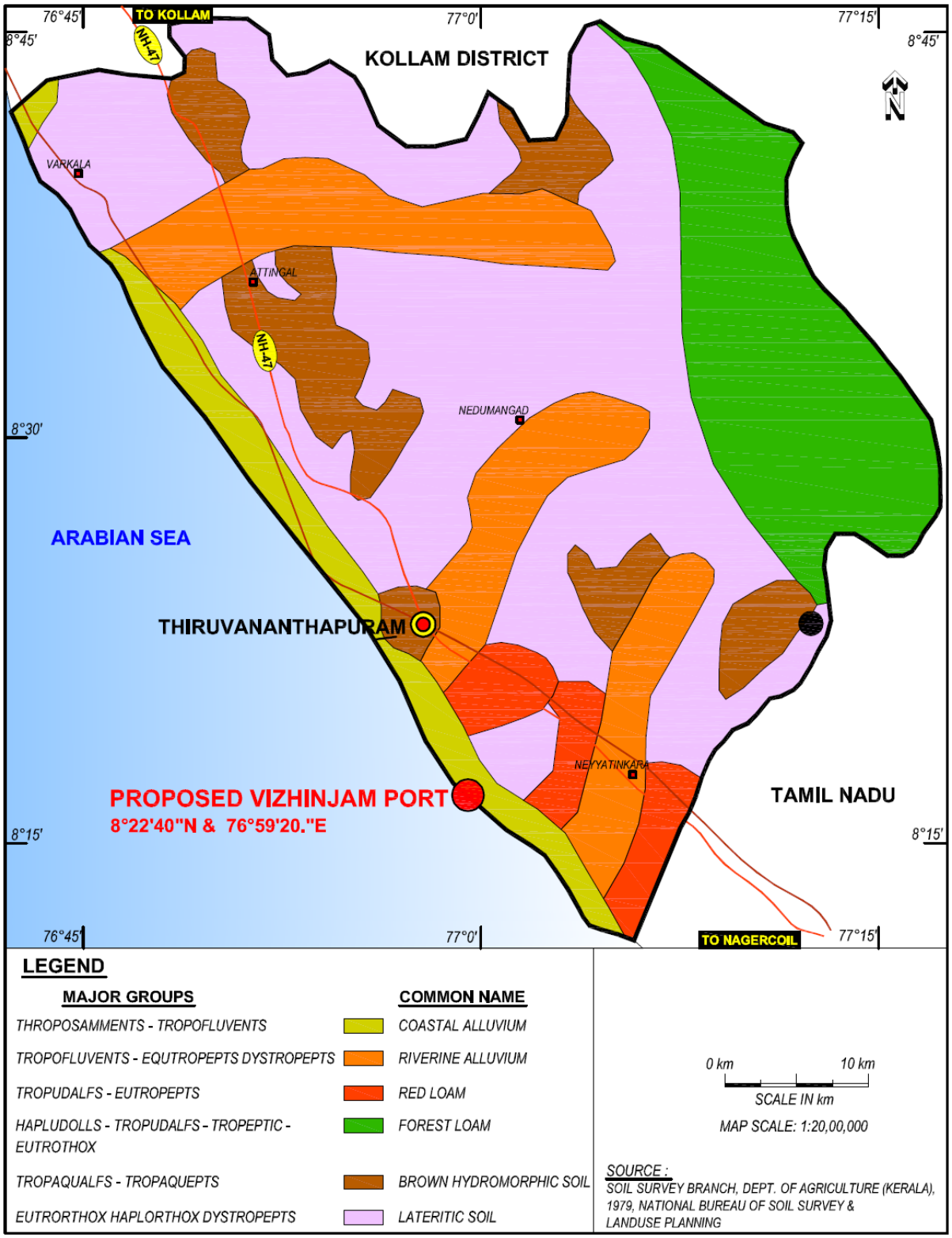


Figure 4-16: Detailed Soil Map of the PIA District

To assess the soil quality of the project area, the physico-chemical and fertility characteristics of the soils within the study area were examined by obtaining soil samples from selected points and subsequent analysis of the same. Samples were collected from *Five (05)* locations evenly distributed within the 10 km zone to understand the soil characteristics of the study area. The soil sampling locations are given in **Table 4-3** and the monitoring locations are given in **Figure FD0401**.

Table 4-3: Details of Soil Quality Monitoring Locations

S. No.	Location Code	Location Name	Distance (km) from Project area	Azimuth Directions
1.	S1	Nedumam	4.0	NW
2.	S2	Vizhinjam	1.4	NW
3.	S3	Mulloor	1.5	E
4.	S4	Karimkulam	8.2	SE
5.	S5	Nellimudu	5.6	E

4.1.6.2 Methodology of Soil Monitoring

A number of parameters, which are indicative of physical, chemical characteristics and fertility of the soil, were determined. Sampling and analysis were conducted as per established standard methods and procedures prescribed in IS:2720, Central Pollution Control Board (CPCB) and United States Environment Protection Agency (USEPA). The respective methods used for the analysis of soil samples and their minimum detection limit are given in **Table 4-4**.

Table 4-4: Analytical Method and its Detection Limit for Soil Quality Monitoring Parameters

S. No.	Parameter	Unit	Method	Minimum Detection Limit
1.	pH	–	IS: 2720 Part-26	1.00
2.	Electrical Conductivity	µS/cm	IS: 2720 Part-21	10.0
3.	Organic Matter	% by mass	IS: 2720 Part-22	0.01
4.	Organic Carbon			
5.	Phosphorous (as PO_4^{3-})	mg/kg	CPCB/P.K.Behra, P-105	5.0
6.	Total Kjehldal Nitrogen			20.0
7.	Potassium (as K)		USEPA-SW-846	10.0
8.	Sodium (as Na)			
9.	Texture	–	CPCB/P.K.Behra, P - 17	-
10.	Sand	%by mass		1.0
11.	Clay			
12.	Silt			
13.	Lead (as Pb)	mg/kg	USEPA-SW-846	10.0

4.1.6.3 Soil Characteristics in the Study Area

The soil samples were collected from five representative locations in four seasons namely winter 2011, post-monsoon 2011, winter 2012 and summer 2012. **Table 4-5** summarises the soil quality analytical results for all of the aforementioned seasons. No seasonal variation in the soil quality was observed. The characteristics of the soil and soil analysis results are given in **Appendix 4.1**.

Table 4-5: Summary of Soil Quality

Parameters	Sampling Locations									
	Vizhinjam		Mulloor		Nellimoodu		Nedumam		Karimkulam	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
pH	6.94	7.41	6.37	6.62	6.48	6.85	7.14	7.52	7.42	7.75
Electrical Conductivity (µS/cm)	162	210	195	252	110	152	201	252	107	154

Parameters	Sampling Locations									
	Vizhinjam		Mulloor		Nellimoodu		Nedumam		Karimkulam	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Organic Matter (% by mass)	0.80	0.90	0.88	1.10	1.10	1.50	0.37	0.70	0.49	0.70
Organic Carbon (% by mass)	0.45	0.50	0.43	0.60	0.62	0.73	0.21	0.40	0.27	0.40
Phosphorous (as PO_4^{3-}) mg/kg	4.92	18.8	10.70	18.30	3.48	11.80	3.57	11.80	0.70	15.60
Total Kjehldal Nitrogen (mg/kg)	54.79	68.98	39.78	65.23	48.34	63.40	48.6	56.5	26.55	52.63
Potassium (as K) (mg/kg)	142.3	161.5	36.9	41.8	35.82	48.3	15.3	29.5	12.9	21.7
Sodium (as Na) (mg/kg)	98.4	112.7	89.9	115.7	62.9	110.5	46.9	52.9	48.5	62.3
Texture	Sandy Clay Loam		Loamy Sand		Loam				Loamy Sand	
Sand (% by mass)	62.8	70.1	58.3	62.5	71.5	78.4	58.3	62.5	81.3	90.2
Clay (% by mass)	25.9	28.7	8.2	15.4	12.2	18.3	8.7	11.7	4.8	7.8
Silt (% by mass)	3.7	8.5	26.3	31.1	9.2	11.3	28.4	30	5	10.9
Lead (as Pb) (mg/kg)	BDL									

4.1.6.4 Results and Discussions

- Soil texture of the area varied from sandy clay loamy to loamy.
- Soil pH was observed to be neutral to slightly alkaline
- Electrical conductivity in all the stations and seasons varied from 107 to 252 µS/cm.
- Organic matter content in the soil samples, which indicates the soil fertility, was observed to be high in the Vizhinjam, Nellimudu and Mulloor area (0.80 – 1.50% by mass). In the Nedumam and Karimkulamarea, where it was observed to be comparatively low (0.37 – 0.70% by mass), indicate the poor fertility of the soil in these areas.
- Concentration of Nitrogen was in the range of 54.79 – 68.98 mg/kg, 48.34 – 63.40 mg/kg, 39.78 – 65.23 mg/kg, 48.60 – 56.50 mg/kg and 26.55 – 52.63 mg/kg in Vizhinjam, Nellimudu, Mulloor, Nedumam respectively. The concentration range of Nitrogen was similar in all the sampling locations.
- Concentration of Phosphorous was in the range of 0.7 – 18.8 mg/kg for all sampling locations
- Soil sample collected from Vizhinjam had moderate concentration of Potassium (142.3 – 161.5 mg/kg), in other areas, the concentration of Potassium is comparatively low (12.9 – 48.3 mg/kg).

The general quality of the soil in Vizhinjam was observed to be similar to that of reported by Karthikeyan and Selvaraj (2009), in which the coastal soil were analysed for its suitability to sustain varied fungal growth. Even though the variation trends in the parameters are similar, the concentration reported in the aforementioned paper is higher than the values obtained in this study. This might be due to the variation in sampling locations, as the sampling locations for the cited report was based on the fungal biodiversity.

4.2 Water Environment

4.2.1 Surface Water

The major surface water bodies present within the study area are the Karamana River and Vellayani Lake. Vellayani Lake is a fresh-water lake, which is the source of water for Vizhinjam and nearby areas. The water supply scheme designed by the Kerala Water Authority (DER, August, 2006) is for drawing 3.30 MLD of water from Vellayani Lake and to treat the same at a treatment plant located at Vizhinjam in the land available with the Harbour Engineering Department (HED). As per the report, 3.00 MLD of water will be available after treatment. Further, 2% (0.06 MLD) is required for backwash and 15% (0.45 MLD) is required for UFW (unusable flow water), resulting in a net availability of 2.49 MLD. The Port water requirement in the long term has been assessed as 1.00 MD as follows:

During construction	(1st 4 years)	0.10 MLD
Short term needs	(subsequent 4 years)	0.50 MLD
Medium term needs	(subsequent 3 years)	0.60 MLD
Long term needs	(subsequent years)	1.00 MLD

Further as per the G.O. cited (3), 0.05 MLD of water shall be supplied to the Vizhinjam Fishing Harbour (VFH) from the VISL treatment plant after realising, water charges from time to time. Distribution pipelines, sump/tank for the above supply to VFH will be constructed by the HED at their cost. Thus after considering the use for the proposed Vizhinjam Port (1.00 MLD) & existing VFH (0.05 MLD), 1.44 MLD will be available. This quantity was set part during the project design to meet the anticipated demand from floating as well as migratory population due to the development of the area around the proposed Vizhinjam port and to improve the supply position of the fishermen as well as other inhabitants in the Vizhinjam area.

The study area exhibits more or less a dendritic drainage pattern dipping towards the coast (**Figure 4-17**). As evident from the figure that, there are four small drains in the Project stretch, which opens into the sea. These are *nallah* kind of drains (**Exhibit 4-2**) formed along the local depression (low lying area), through which water during monsoon season and wastewater from domestic sources are drained into the sea.

Vellayani Lake: The Vellayani fresh water lake is the major source of drinking water for the people of Kalliyoor, Venganoor, and Vizhinjam gram panchayats. However, interventions in the form of paddy cultivation on its edges has drastically reduced the water spread area and also deteriorated the quality of water. The quantity of water in Vellayani Lake is given in **Table 4-6**. The area of the lake, which was 750 Ha in 1926, was reduced to 397.5 Ha by 2005.

Table 4-6: Quantity of Water in Vellayani Lake in 1999

Season	Volume (MCM)
Summer	1.22
Monsoon	5.44
Average	3.82

(Source: Vellayani – Detailed Study, CESS, 2000)

Karamana River: The Karamana River originates from the southern tip (Agastyar Koodam) of the Western Ghats. It flows through the PIA District and merges with the Arabian Sea at Panathura. Two well-known dams namely the Peppara dam and Aruvikkara dam are located on this river. The Drainage near in project region is shown in **Figure 4-17** and drainage near Mulloor in the Project Stretch is given in **Exhibit 4-2**.



Exhibit 4-1: Vellayani Lake the Main Water Source of the Region



Exhibit 4-2: Drainage near Mulloor in the Project Stretch

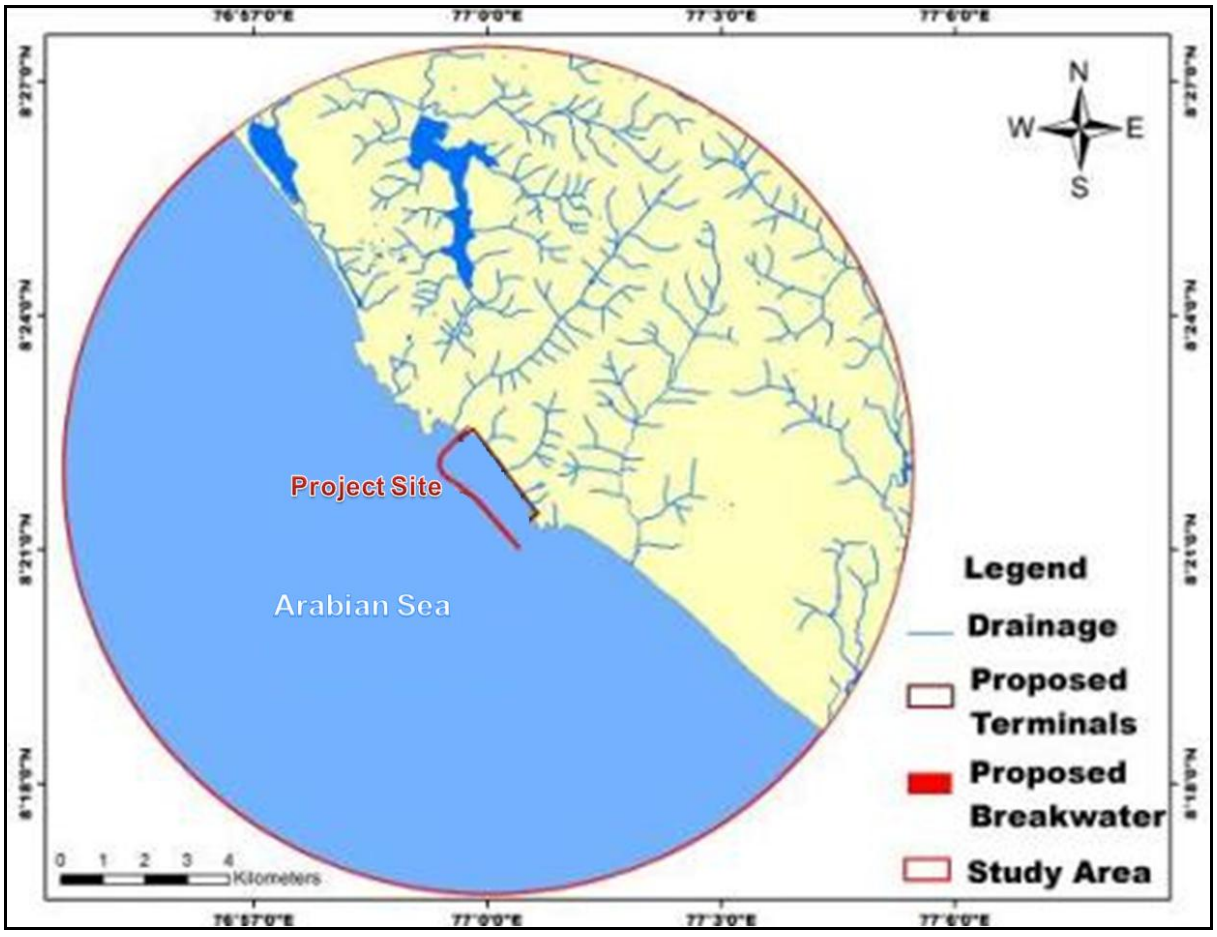


Figure 4-17: Drainage Pattern Map of the Study Area

4.2.2 Surface Water Quality

4.2.2.1 Surface Water Sampling Location

The location and brief description of the water quality monitoring locations are presented in **Table 4-7** and sampling locations are given in **Figure FD0402**.

Table 4-7: Details of Surface Water Quality Monitoring Stations

Location Code	Location Name	Position with respect to Project Site	
		Direction	Distance (km)
SW1	Poovar	SE	9.50
SW2	Pulluvila	SE	5.43
SW3	Vizhinjam	NW	1.78
SW4	Balaramapuram	NE	9.04
SW5	Punnamudu	ENE	7.49
SW6	Vellayani	N	6.50

4.2.2.2 Methodology for Surface Water Quality Monitoring

Water samples were collected once for each season from all the sampling locations during the study period. The samples were analysed for relevant physical and chemical parameters to determine the baseline surface water quality.

Analyses of the samples were carried out as per established standard methods and procedures given in Indian Standard Water and Wastewater – Methods of Sampling and Test (Physical and Chemical), Bureau of Indian Standards. The list of parameters analysed for surface water as well as groundwater, their respective method of analysis and their detection limits are given in **Table 4-8**.

Table 4-8: Water Quality Parameters and Respective Method of Analysis

S. No.	Parameters	Unit	Method	Minimum Detection Limit
1.	Turbidity	NTU	IS : 3025 (P-10)	1.0
2.	pH	-	IS : 3025 (P-11)	
3.	Total Hardness (as $CaCO_3$)	mg/l	IS : 3025 (P-21)	
4.	Conductivity	µS/cm	IS : 3025 (P-14)	
5.	Calcium (as Ca)	mg/l	IS : 3025 (P-40)	0.5
6.	Iron (as Fe)		IS : 3025 (P-53)	0.1
7.	Chloride		IS : 3025 (P-32)	2.5
8.	Fluoride		IS : 3025 (P-60)	1.0
9.	Total Dissolved Solids		IS : 3025 (P-16)	5.0
10.	Magnesium		IS : 3025 (P-46)	0.5
11.	Sulphate		IS : 3025 (P-24)	1.0
12.	Nitrate		IS : 3025 (P-34)	0.1
13.	Phenolic Compounds		IS : 3025 (P-43)	0.01
14.	Lead		IS : 3025 (P-47)	0.05
15.	Zinc		IS : 3025 (P-49)	0.5
16.	Chromium Total		IS : 3025 (P-52)	0.05
17.	Alkalinity		IS : 3025 (P-23)	1.0
18.	Boron		IS : 3025 (P-57)	0.25
19.	Phosphate Total		IS : 3025 (P-31)	0.05
20.	Potassium		IS : 3025 (P-45)	1.0
21.	Sodium		IS : 3025 (P-45)	
22.	Cadmium		IS : 3025 (P-41)	0.01
23.	Total Suspended Solids		IS : 3025 (P-17)	5.0
24.	Selenium		IS : 3025 (P-56)	0.01
25.	Mercury		IS : 3025 (P-48)	0.001

S. No.	Parameters	Unit	Method	Minimum Detection Limit
26.	Arsenic	mg/l	IS : 3025 (P-37)	0.01
27.	Cyanide		IS : 3025 (P-27)	
28.	Sodium Absorption Ratio	–	IS : 11624	1.0
29.	BOD (3 days at 27 Deg.C)		IS : 3025 (P-44)	0.2
30.	COD		IS : 3025 (P-58)	0.4
31.	Oil & Grease		IS : 3025 (P-39)	
32.	Free Ammonia		IS : 3025 (P-34)	0.5

4.2.2.3 Surface Water Quality Monitoring Results

The parameters such as Phenolic compounds, heavy metals (Lead, Chromium, Cadmium, Selenium, Mercury and Arsenic), cyanide, oil & grease and free ammonia were below detectable limits (BDL) in all the analysed water samples and for all seasons, which indicate the water was devoid of pollution. The summary of surface water quality parameters are given in **Table 4-9** and the Inland water quality results are presented in **Appendix 4.2**.

Table 4-9: Summary of Surface Water Quality Parameters

S. No.	Parameters	Units	Range Variations			
			Minimum		Maximum	
			Location	Conc.	Conc.	Location
1.	Turbidity	NTU	SW2 & SW3	2	15	SW6
2.	pH	-	SW6	7.1	8.23	SW1
3.	Conductivity	µS/cm	SW4	62	164	SW4
4.	Total hardness as $CaCO_3$	mg/l	SW5	191	338	SW3
5.	Calcium (as Ca)		SW2	1.6	24.51	SW1
6.	Iron (as Fe)		SW2	0.06	0.46	SW4
7.	Chloride (as Cl^-)		SW6	26.2	76.2	SW3
8.	Fluoride (as F^-)		SW2 & SW3	0.1	2.3	SW1
9.	Total Dissolved Solids		SW5	107	197	SW6
10.	Magnesium (as Mg)		SW2 & SW3	1.46	16.2	SW6
11.	Sulphate (as SO_4^-)		SW5	4.7	36	SW5
12.	Nitrate (as NO_3^-)		SW4 7 SW6	1.23	7.1	SW2
13.	Phenolic Compounds		Below Detectable levels			
14.	Lead (as Pb)					
15.	Zinc (as Zn)		SW5	0.1	1.2	SW1
16.	Chromium Total (as PO_4)		-	BDL	BDL	-
17.	Alkalinity(as $CaCO_3$)		SW3 & SW6	62	159.3	SW2
18.	Boron (as B)		SW5	0.08	0.15	SW4 & SW1
19.	Phosphate Total		SW3 & SW5	0.064	2.1	SW4
20.	Potassium		SW3 & SW5	1.8	13	SW1 & SW4
21.	Sodium		SW1	8.3	58.4	SW2
22.	Cadmium		Below Detectable levels			
23.	Selenium					
24.	Mercury					
25.	Arsenic					
26.	Cyanide					
27.	BOD		SW2	4.8	25.3	SW6
28.	Oil and Grease		Below Detectable Levels			
29.	Free Ammonia					

From the **Table 4-9** it is evident that irrespective of variation in stations, the concentration of the aforementioned parameters increased during post-monsoon period and decreased during winter season. The evident increase in the levels of water quality parameters is due to the dissolution of salts and minerals in the water body from the surface runoff containing sediments in monsoon. Due to the slow and continuous replenishment of the surface water with fresh water, the concentrations have decreased during winter season. There was no major significant change in the concentration of water quality parameters during the study period.

As per the standards prescribed in Criteria for Raw Water Used for Organised Community Water Supplies (Surface and Ground Water) Primary Parameters as per Annexure 4 of MoEF EIA guidance manual for Ports and Harbours, MoEF, 2010, the water is suitable for community use after conventional treatment (Sedimentation, Filtration, Coagulation and Chlorination).

4.2.3 Groundwater

The hydro-geological map of PIA district is given in **Figure 4-18**, it can be inferred that the area around the project site consists of both hard rock and soft rock. The northern part of site is made up of hard rock and the southern part is underlined by soft rock. The yield of groundwater from soft rock (up to 3 lps) is higher than that of hard rock (up to 1.0 lps).

The groundwater levels in the project area during pre-monsoon and post-monsoon seasons are shown in **Figure 4-19** and **Figure 4-20**. From the figures it is evident that the groundwater table is recharged during monsoon. The groundwater level of the project site was recorded 5 m bgl in pre-monsoon and 2 – 5 m bgl in post-monsoon period. However, the groundwater in project area is being over exploited **Figure 4-21**. This is due to high population density and indiscriminate extraction of groundwater for domestic and agricultural purpose through bore wells and dug wells.

The groundwater capacity of Thiruvananthapuram (Rural) block is 14.90 MCM whereas the gross groundwater draft of the block is 11.23 MCM (Central GroundwaterBoard (CGWB), 2011). Therefore, there is a possibility to recharge and develop the groundwater resource. The CGWB has proposed surface spreading techniques such as check dams, gully plugs and nala bunds to develop the groundwater resource of the region.

4.2.4 Groundwater Quality

4.2.4.1 Groundwater Sampling Locations

The location and brief description of the groundwater quality monitoring locations are given in **Table 4-10** and the sampling locations are given in **Figure FD0402**.

Table 4-10: Details of Groundwater Quality Monitoring Stations

Location Code	Location Name	Position with respect to Project Site	
		Direction	Distance (km)
GW1	Nellimudu	E	5.72
GW2	Balaramapuram	NE	9.08
GW3	Nedumam	NW	4.08
GW4	Vizhinjam	NW	1.78
GW5	Puluvilla	SE	5.42

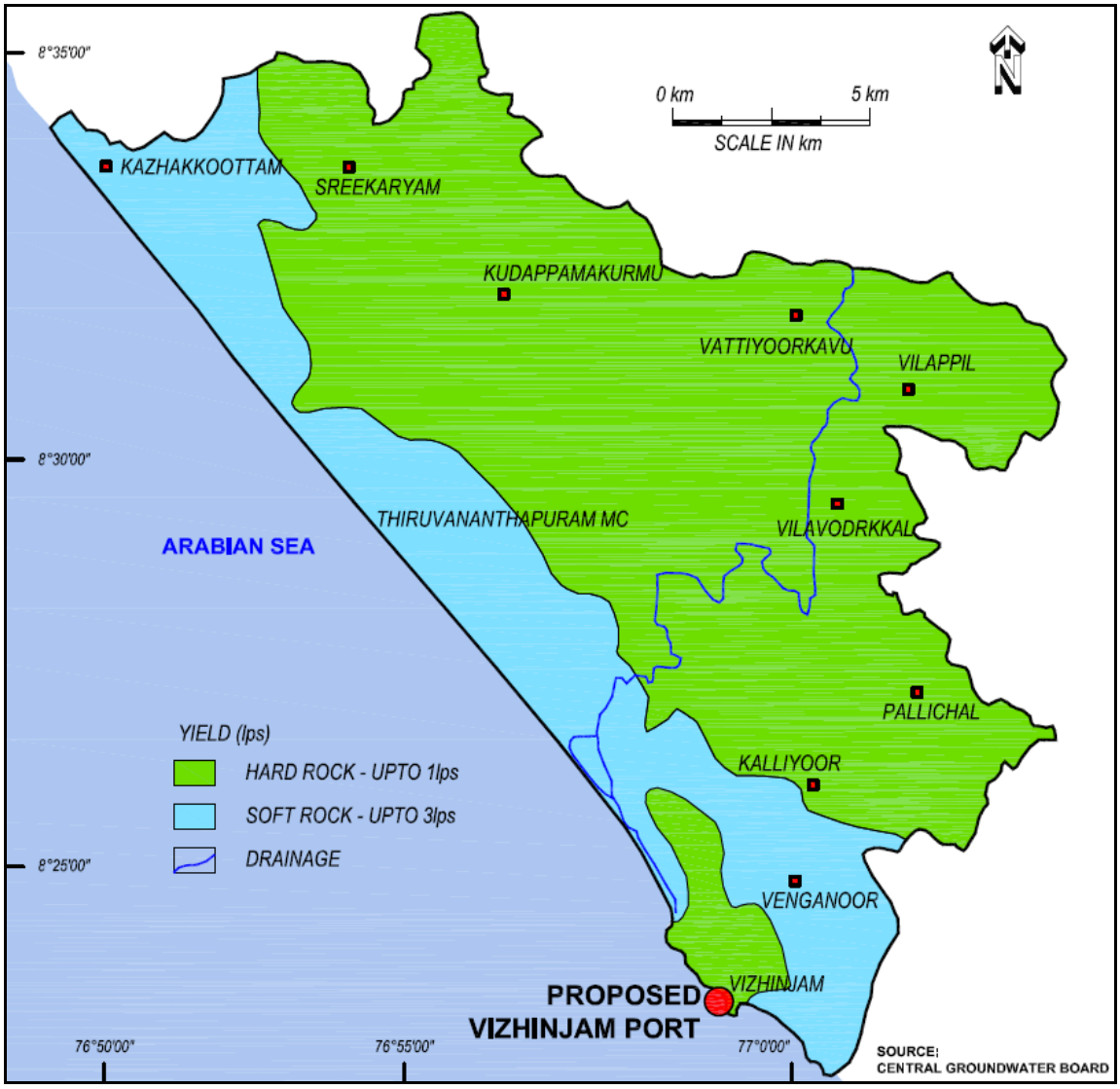


Figure 4-18: Hydrogeological Map of PIA District

4.2.4.2 Groundwater Quality Monitoring Results

The groundwater samples were collected from wells, which were being used by the local people for their consumption. The groundwater quality results of all the stations were compared with the permissible limits of Criteria for Raw Water Used for Organised Community Water Supplies (Surface and Ground Water) Primary Parameters as per Annexure 4 of MoEF - EIA guidance manual for Ports and Harbours, MoEF, 2010. The summary of groundwater quality parameters are given in **Table 4-11** and groundwater quality results for all the sampling locations for each season is given in **Appendix 4.2**.

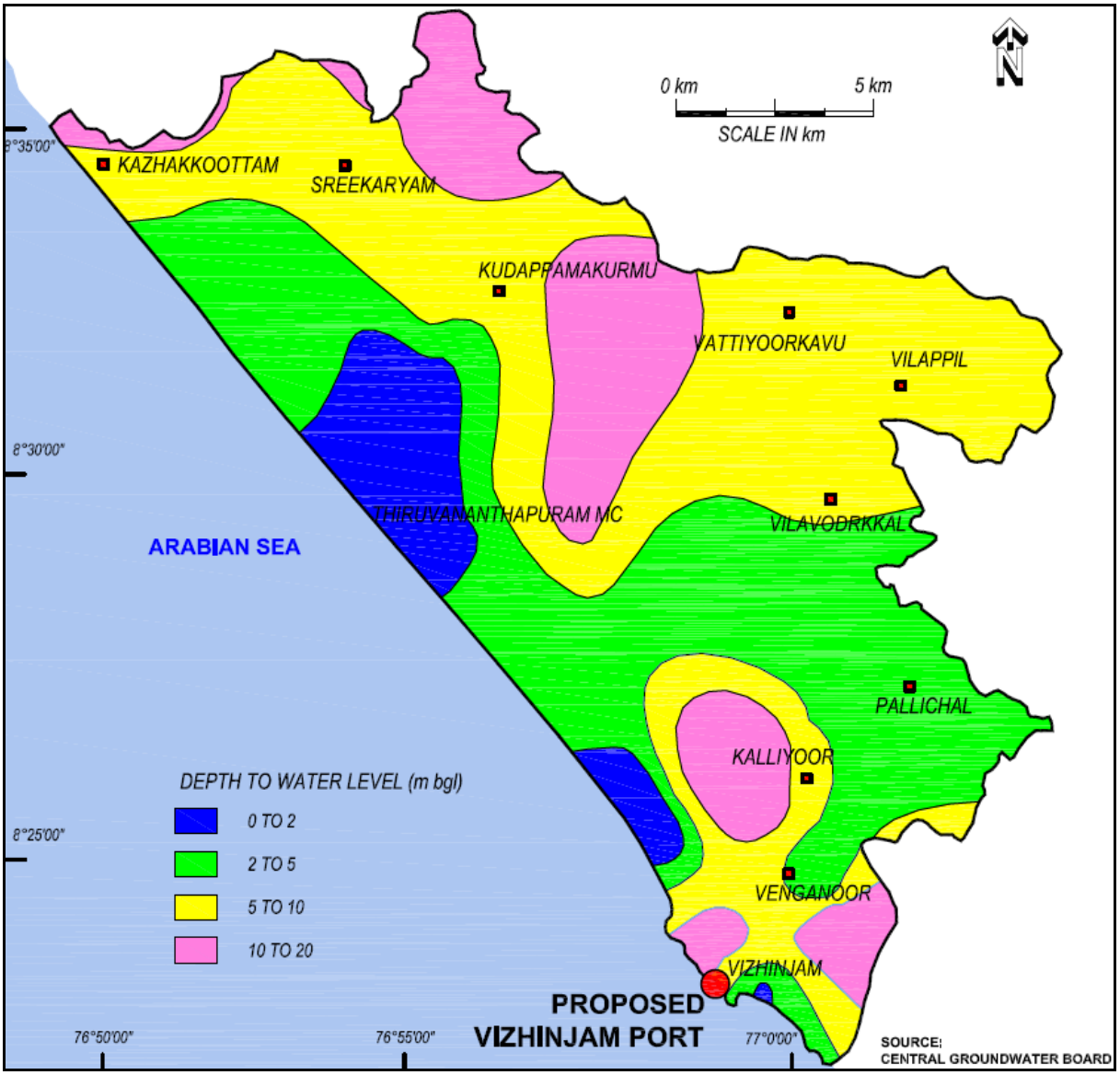


Figure 4-19: Depth of Groundwater Level in PIA District during Pre-Monsoon Season (April, 2009)

Table 4-11: Summary of Groundwater Quality Parameters

S. No.	Parameters	Units	Range Variations			
			Minimum		Maximum	
			Location	Conc.	Conc.	Location
1.	pH	-	GW3	6.23	8.9	GW3
2.	Turbidity	NTU	GW5	2.1	3	GW4
3.	Total hardness as $CaCO_3$	µS/cm	GW1	7.8	197	GW3
4.	Conductivity	mg/l	GW1	226	1106	GW3
5.	Calcium (as Ca)		GW4	3.21	68	GW3
6.	Iron (as Fe)		GW2	0.09	0.25	GW3
7.	Chloride (as Cl^-)		GW1	28.5	145	GW3
8.	Fluoride (as F^-)		GW1	0.1	0.72	GW3
9.	Total Dissolved Solids		GW1	144	720	GW3
10.	Magnesium (as Mg)		GW1	1.7	36.7	GW3
11.	Sulphate (as SO_4^-)		GW1	3.2	101.3	GW5
12.	Nitrate (as NO_3^-)		GW4	4.17	45.5	GW3
13.	Lead (as Pb)		-	BDL	BDL	-

S. No.	Parameters	Units	Range Variations			
			Minimum		Maximum	
			Location	Conc.	Conc.	Location
14.	Zinc (as Zn)		GW3	0.11	0.4	GW3
15.	Chromium Total		-	BDL	BDL	-
16.	Boron (as B)		GW5	0.08	0.1	GW3
17.	Phosphate Total		GW1 & GW4	0.03	0.15	GW3
18.	Potassium		GW1	1.4	54.3	GW3
19.	Sodium		GW1	8.4	101.3	GW3
20.	Cadmium		Below Detectable levels at all locations			
21.	Total Suspended Solids					
22.	Selenium					
23.	Mercury					
24.	Arsenic					
25.	Cyanide					
26.	Phenolic Compounds					
27.	Total Coliforms	MPN/100 ml	-	Absent	<2	-
28.	E.Coli		-	Absent	Absent	-

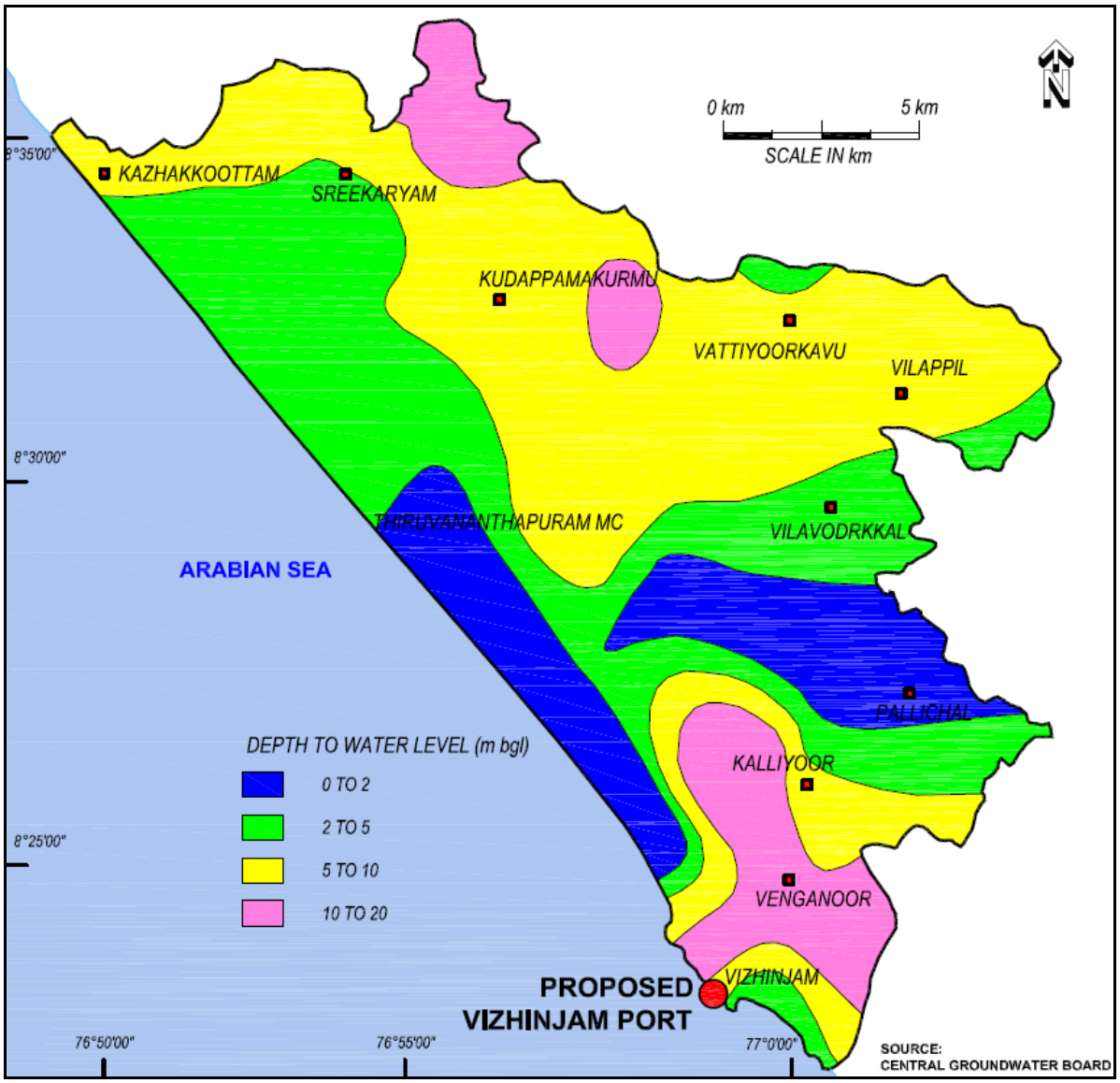


Figure 4-20: Depth of Groundwater Level in PIA District during Post-Monsoon Season (October, 2009)

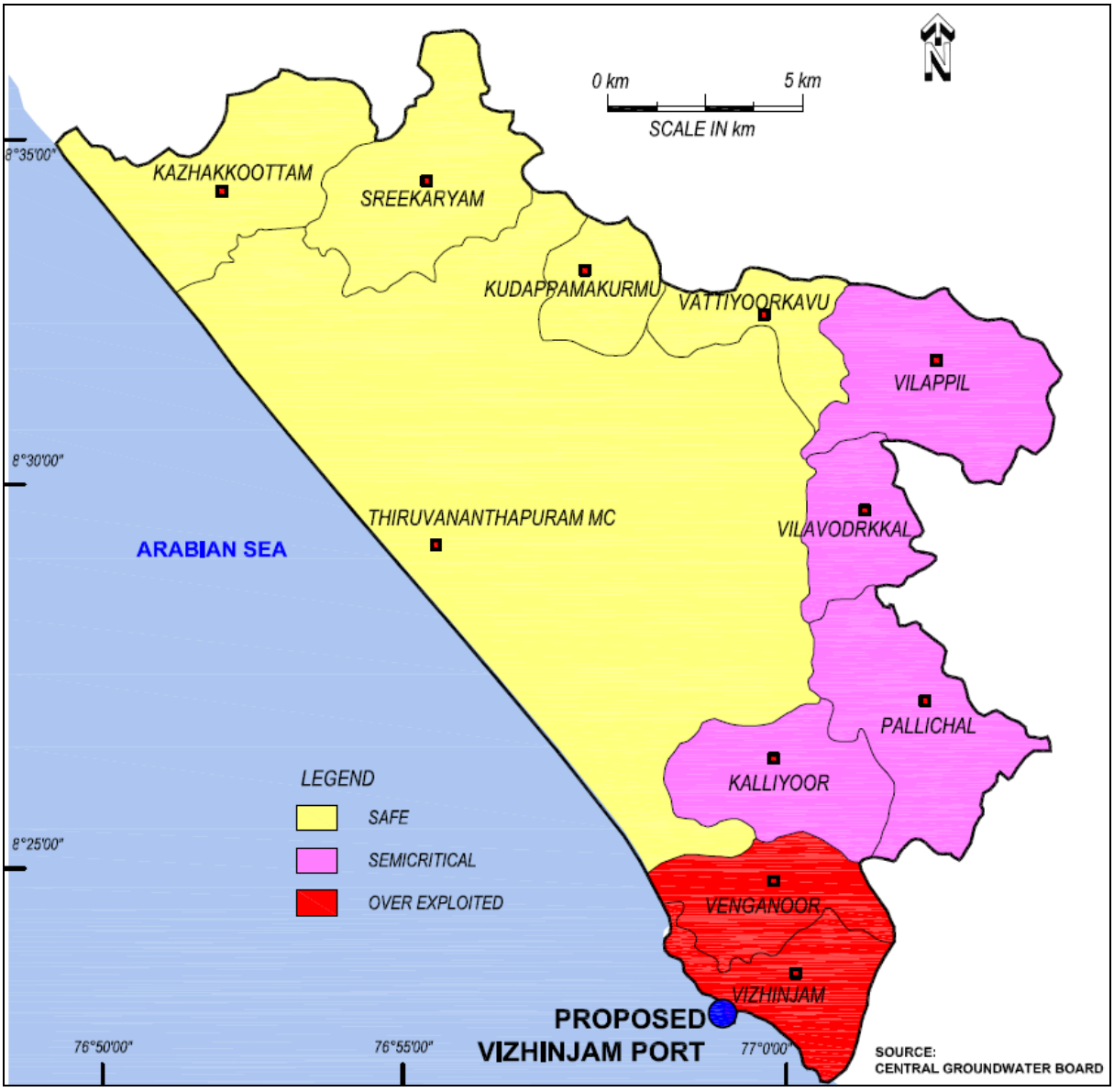


Figure 4-21: Groundwater Vulnerability Map of PIA District

The concentration of Heavy metals such as Cadmium, Selenium, Arsenic, Mercury, Lead, and Chromium were below the detectable level in all samples collected from all monitoring locations and for all seasons. Similarly cyanide and phenolic compounds were also below the detectable value. The below detectable level of heavy metals and aforementioned parameters signify that the groundwater is devoid of pollution due to industrial effluents.

Total coliform and E. coli were absent in all the sampled water, which signifies that the water was devoid of bacteriological/sewage contamination.

The concentration of nitrate, phosphate, sulphate, and chloride were within the permissible limits of 50 mg/l, 0.7 mg/l, 250 mg/l and 300 mg/l respectively.

The electrical conductivity was below the limit of 2000 µS/cm, among the sampling locations Vizhinjam and Pulluvila had high values of electrical conductivity (Vizhinjam: 1106 µS/cm; Pulluvila: 969 µS/cm).

The groundwater samples can be used for potable purposes after conventional treatment (Sedimentation, Filtration, Coagulation and Chlorination).

The obtained results are in line with the report published by CGWB, entitled 'Groundwater Scenario in Major Cities of India' (2011) in which, the groundwater of Vizhinjam is reported with high pH (up to 9.0) and EC (up to >1000 µS/cm).

4.3 Costal Hydrology/Geomorphology

4.3.1 Bathymetry

The bathymetry map is presented in **Figure 2-1**. The depth contour lines are generally parallel to the shore. The seabed within the Project area is gently sloping down towards the South-west.

The bathymetry of the project stretch was also analysed by Fugro Geotech Pvt. Ltd. in 2011, while carrying out the geotechnical survey of the project site (Geotechnical Report, 2011). No significant bathymetric undulations were recorded within the survey area, (Vizhinjam to Adimalathura) except for some local rock outcrops. The Water depths within the survey area range between a minimum of 0.0 m and a maximum of 22.5 m

4.3.2 Wave

The wave, tide and current measurements for the proposed project site are carried out by EGS-NIOT in February, 2013. These results are considered as inputs for mathematical model studies carried out by LTR, May 2013.

EGS Survey Pvt Ltd (EGS) was contracted by VISL to collect wave, current data off Mulloor and tidal data near the project site (i.e. inside fishing harbour). Current measurements for three seasons during summer (Jan-May), during monsoon (June-Sept) and during post monsoon (Oct-Dec) are being collected at 3 (CM1, CM2 and CM3) locations for a period of 30 days each. Google earth image showing the locations of the wave and current observations is shown in **Figure 4-23** and the co-ordinates are presented in **Table 4-12**.

Table 4-12: Location Co-Ordinates for the Current Measurements

Location Name	Easting	Northing
CM1	720043	925377
CM2	719621	925034
CM3 (wave)	719013	924545

Wave measurements collected at CM3 at 23 m water depth during February – April 2013 was provided by the client and the same has been used for the validation study. The measured wave height (m) and wave direction (Deg.) is shown in **Figure 4-23** and **Figure 4-24**. It may be noted from the Figure 2-9 that there is an increase in wave height during 14 – 26th of February due to local meteorological disturbance and the same was reported in the EGS periodic survey report. The predominant wave approach direction is from SSW during this period and wave approach angle remains nearly the same throughout the period of observation. However, some changes in wave approach direction were noticed, which may be due to local meteorological disturbances.



Figure 4-22: Current Measurements Location Map

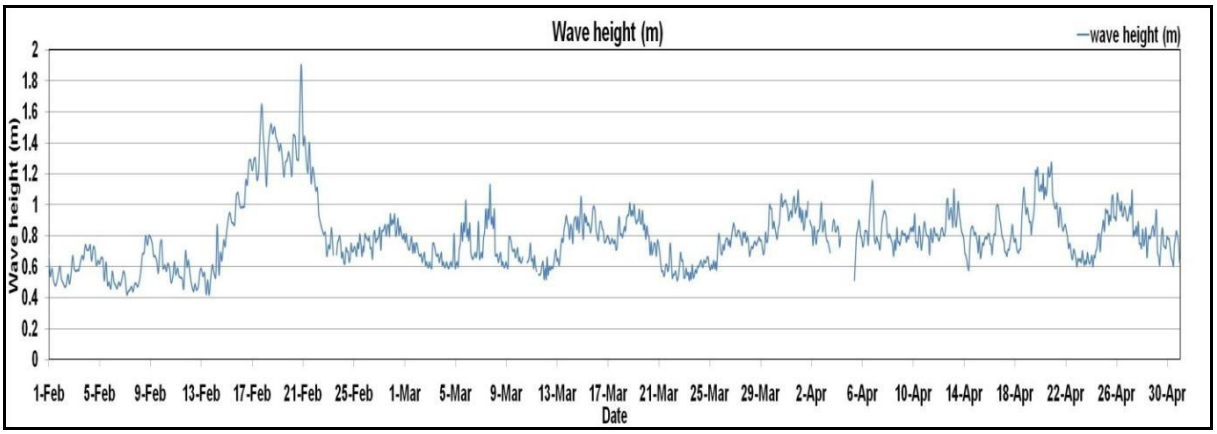


Figure 4-23: Measured Data - Wave Height (m)

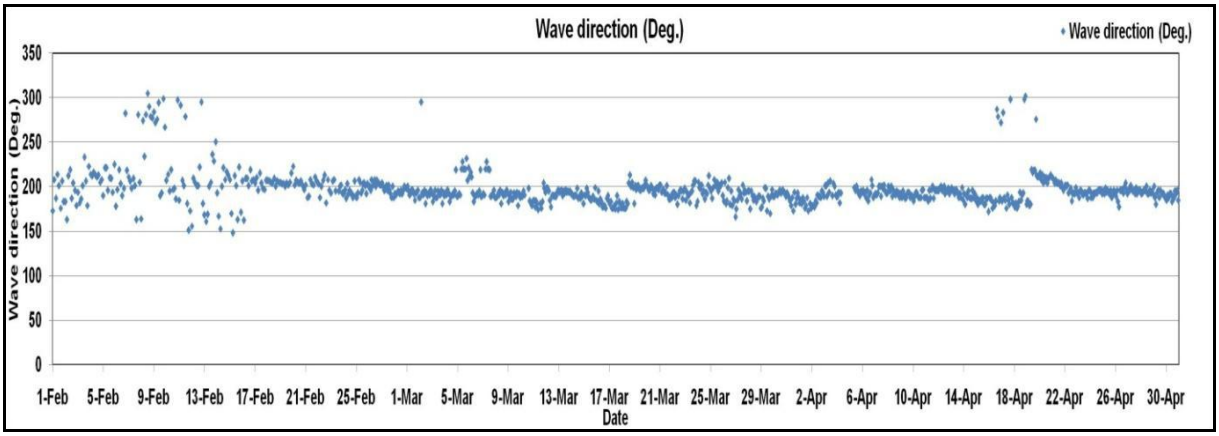


Figure 4-24: Measured Data - Wave Direction (Deg)

4.3.3 Tide

Tide measurement was carried out by EGS from 22nd January to 23rd February 2013, same was provided by the client for validation with the simulated results. Client also provided tide data collected by NIOT for the period from 03rd November to 07th March 2013. The measured tide data of EGS has been compared with NIOT tide and same is shown in Figure 4-25. It is noted that there is a datum shift and time lag in EGS data when compared to NIOT data. The difference in water levels and the presence of the time lag may due to sensor errors.

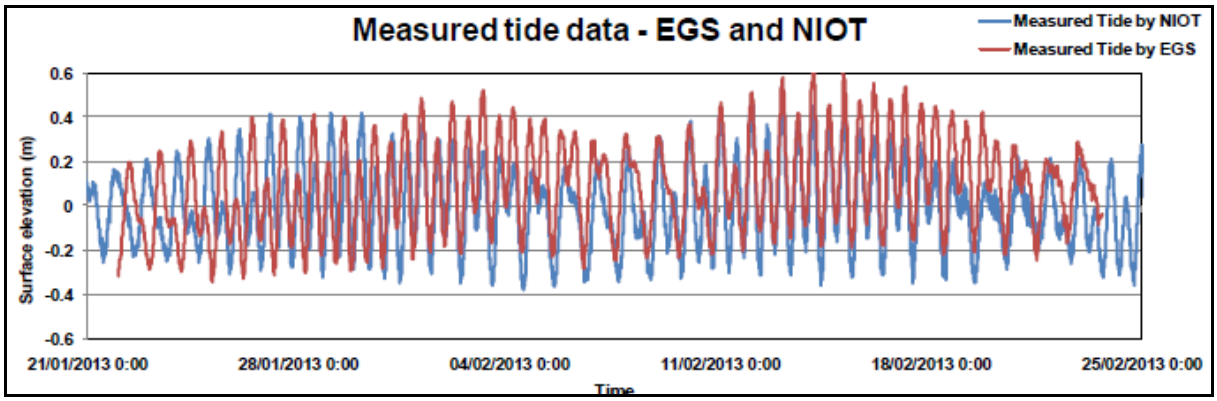


Figure 4-25: Measured Tide – EGS and NIOT

4.3.4 Current

The currents measurements were carried out at CM1 and CM2 during January – February 2013 and CM3 measurement was carried out during January - April 2013, same was provided by client for validation. The measured current speeds and current direction for various locations (CM1, CM2 and CM3) is shown in **Figure 4-26** to **Figure 4-32**.

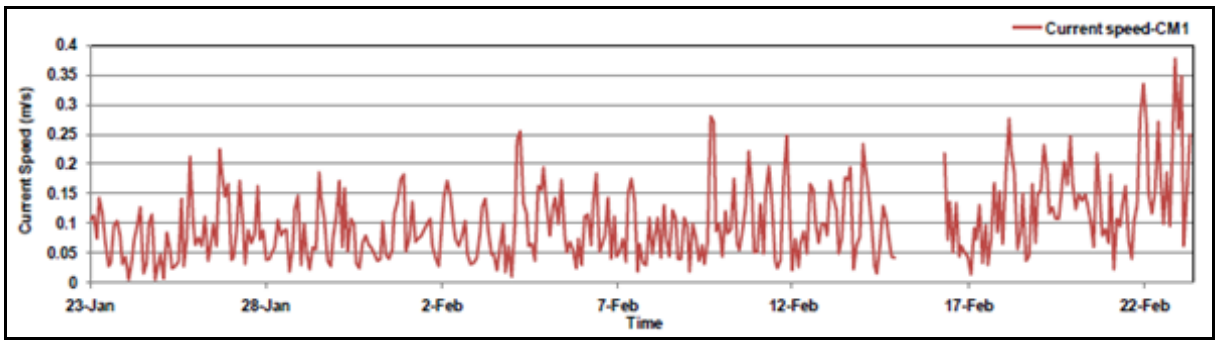


Figure 4-26: Current Speed at Location CM1

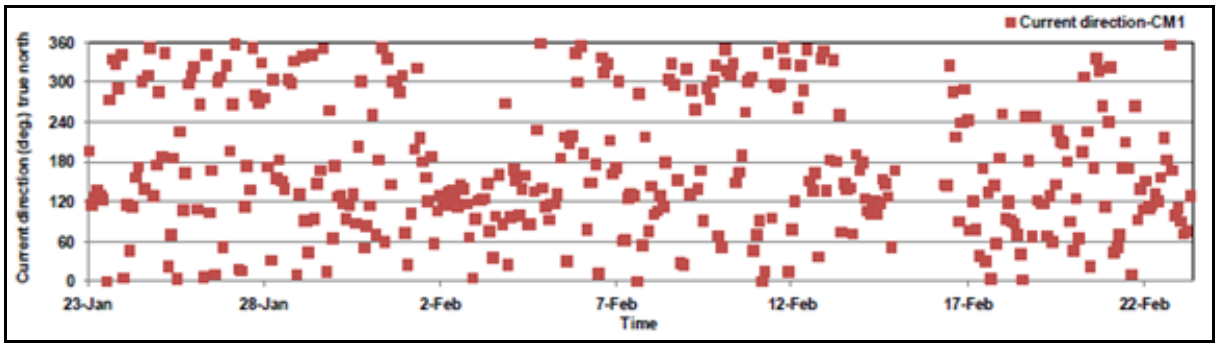


Figure 4-27: Current Direction at Location CM1

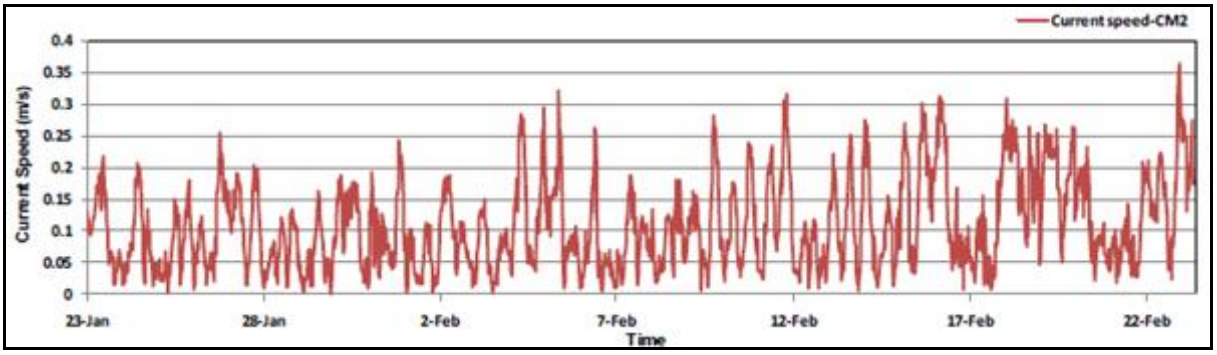


Figure 4-28: Current Speed at Location CM2

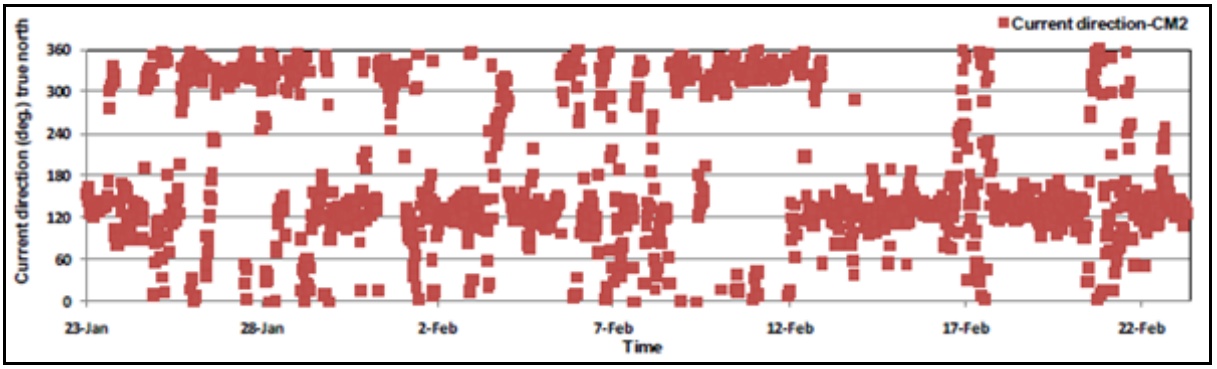


Figure 4-29: Current Direction at Location CM2

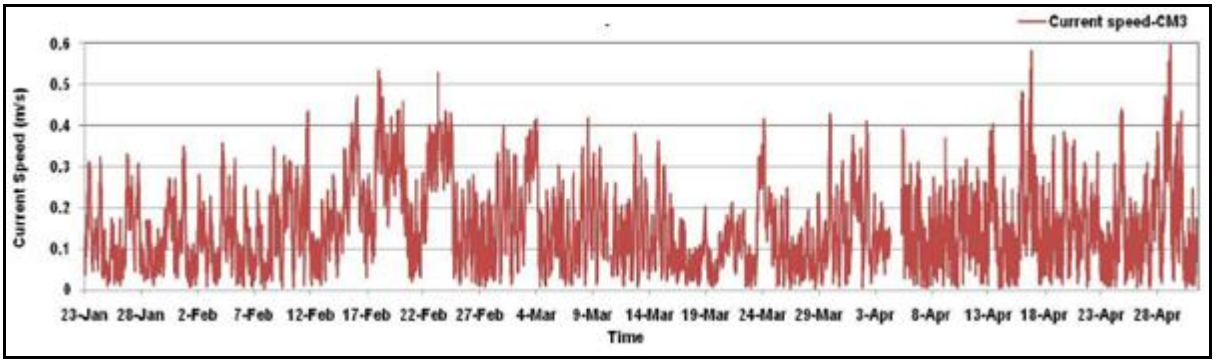


Figure 4-30: Current Speed at Location CM3

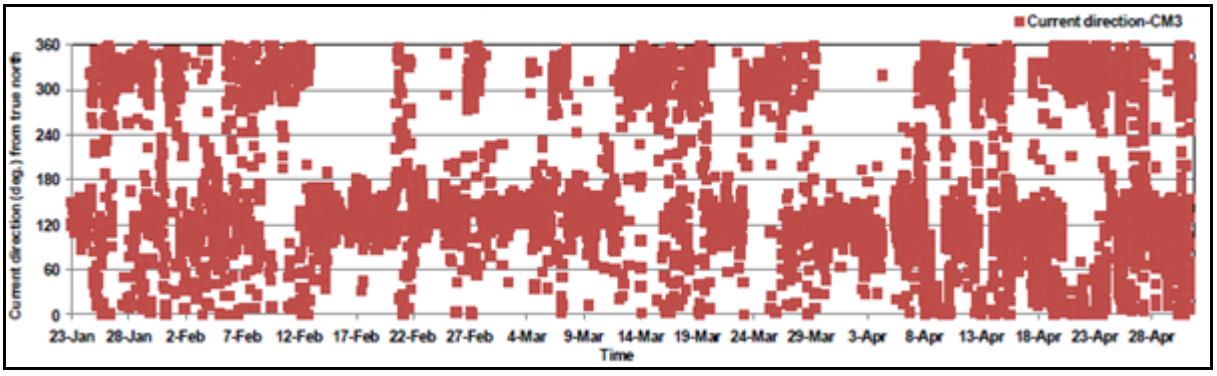


Figure 4-31: Current Direction at Location CM3

Table 4-13: Seawater Current Speed and Direction in the Project Area

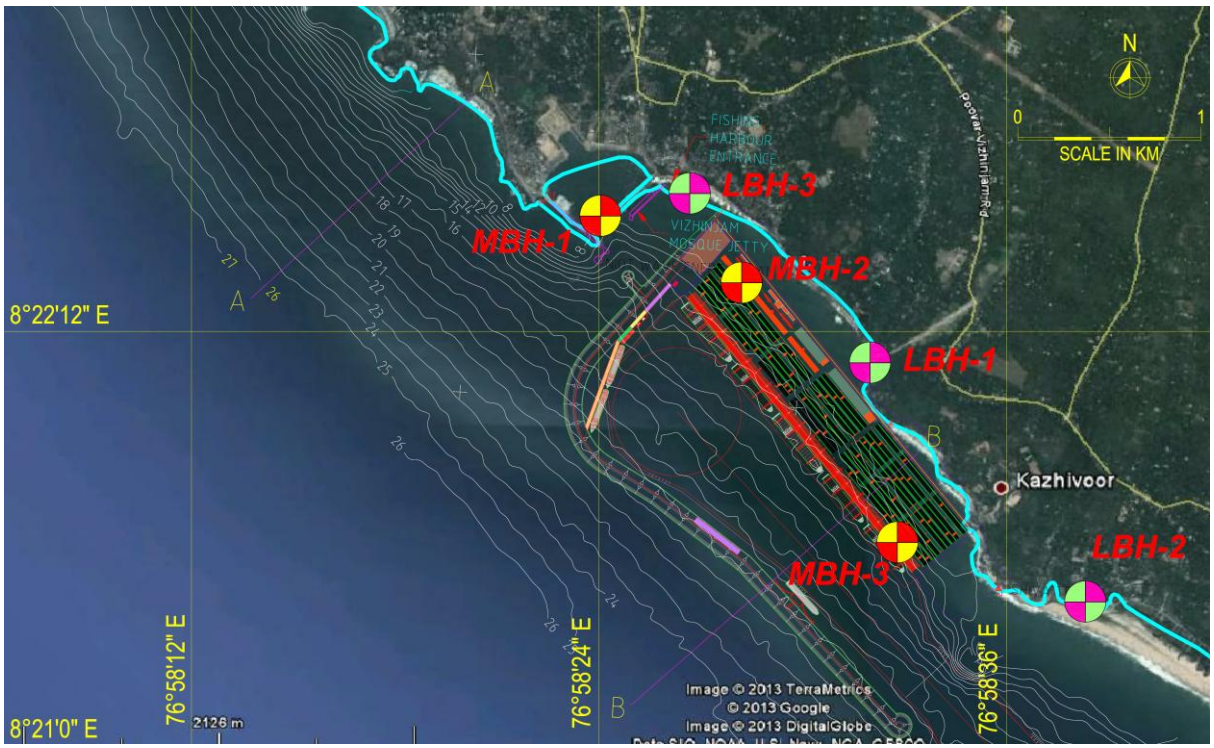
Month	Current Speed (Knot)	Direction
November to January	1	North West
February to May	1	South East
June to October	2	South East

4.3.5 Seabed, Type and Features

Three onshore boreholes (LBH-1 to LBH-3) and three marine boreholes (MBH-1 to MBH-3), were examined (**Figure 4-32**). A side scan sonar survey was also performed to identify possible underwater rock outcrops. The reference level (RL)for Land boreholes (LBH) is surface level and that for Marine boreholes (MBH) is CD The outcome of the study is summarised in **Table 4-14**.

Table 4-14: Seabed Features in the Project Stretch

Location Land boreholes (LBH)	Feature	Depth with respect to RL (m)
LBH-1	Rock	-2.0
LBH-2	Rock	-4.0
LBH-3	Weathered rock	-7.8
MBH-1	Weathered rock	-28.3
MBH-2	Rock	-15.0
MBH-3	Rock	-14.0



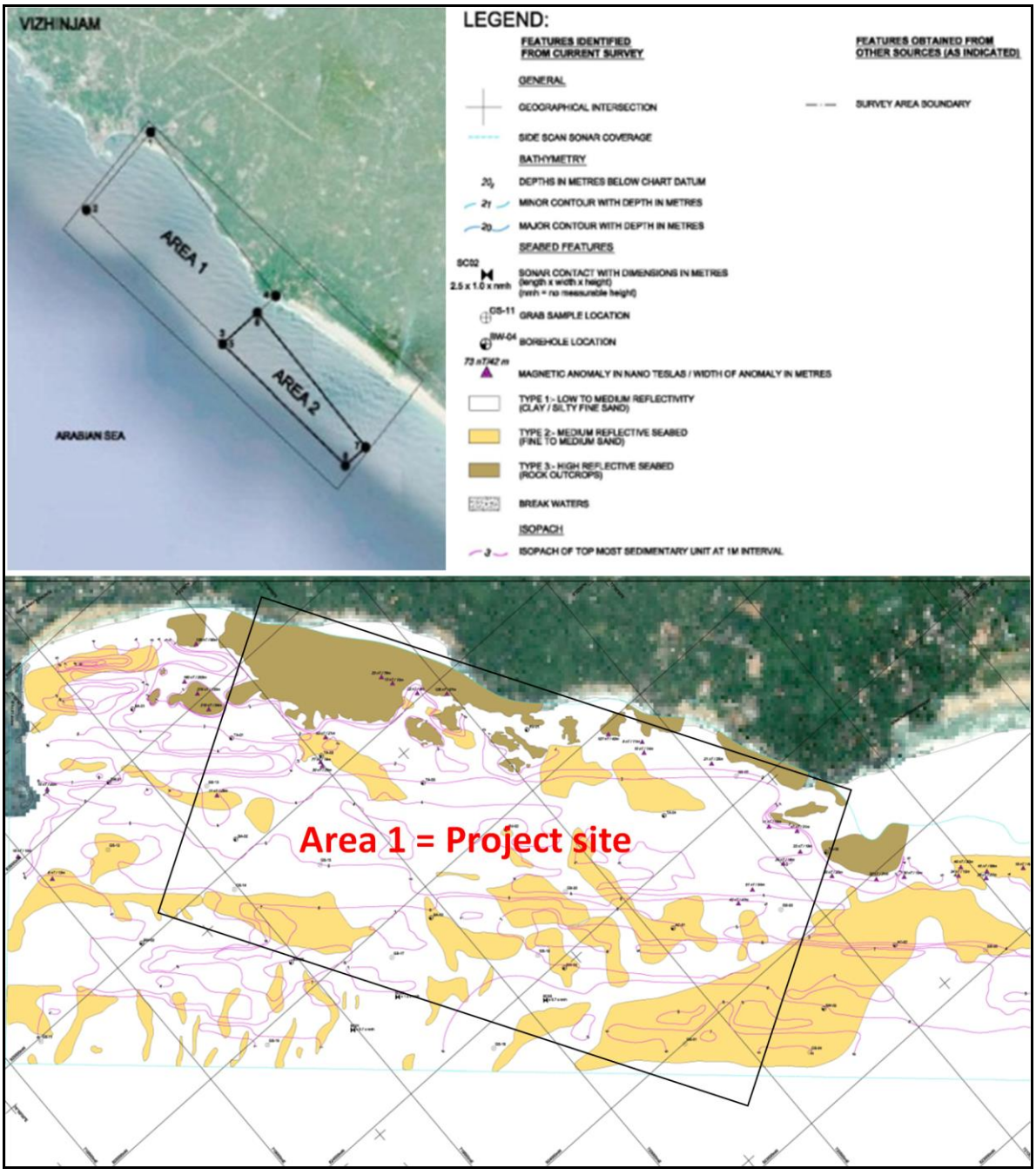
(Source: Preliminary Project Plan Report, RH, 2010)

Figure 4-32: Marine and Landside Borehole Locations

A detailed and recent geophysical survey of the seabed in the Project area was conducted by Fugro Geotech Pvt. Ltd. in 2011. The seabed features were identified using sonar reflectivity. During the survey, three different types of seabed reflectivity were observed on the side scan sonar records, they are:

- Type 1: Low to medium reflective seabed (clayey / silty fine sand)
- Type 2: Medium reflective seabed (fine to medium sand)
- Type 3: High reflective seabed (Rock outcrops)

Type 1 and Type 2 sediments were predominant within the survey area. Rocky outcrop (Type 3) was predominant near the shoreline. No other significant seabed features were identified in the Project area. **Figure 4-33** shows the map obtained after the sonic survey of the project area at 300 kHz using sonic multi beam echo sounder. The rocky outcrop near the shoreline is apparent from the map.



(Source: Fugro Geotech, 2011)

Figure 4-33: Coastal Geomorphology of the Project Area with Rock Outcrops in Dark Brown

4.3.6 Sediment Characteristics in the Proposed Dredging Area

The dredging area for the proposed project is given in **Figure 4-34**. The borehole MBH3 falls under the dredging area. The sampling depth of this borehole was 1.0 m - CD. The sand was found to be medium dense, yellowish grey to light grey in colour and had fine sand with occasional shell fragments.

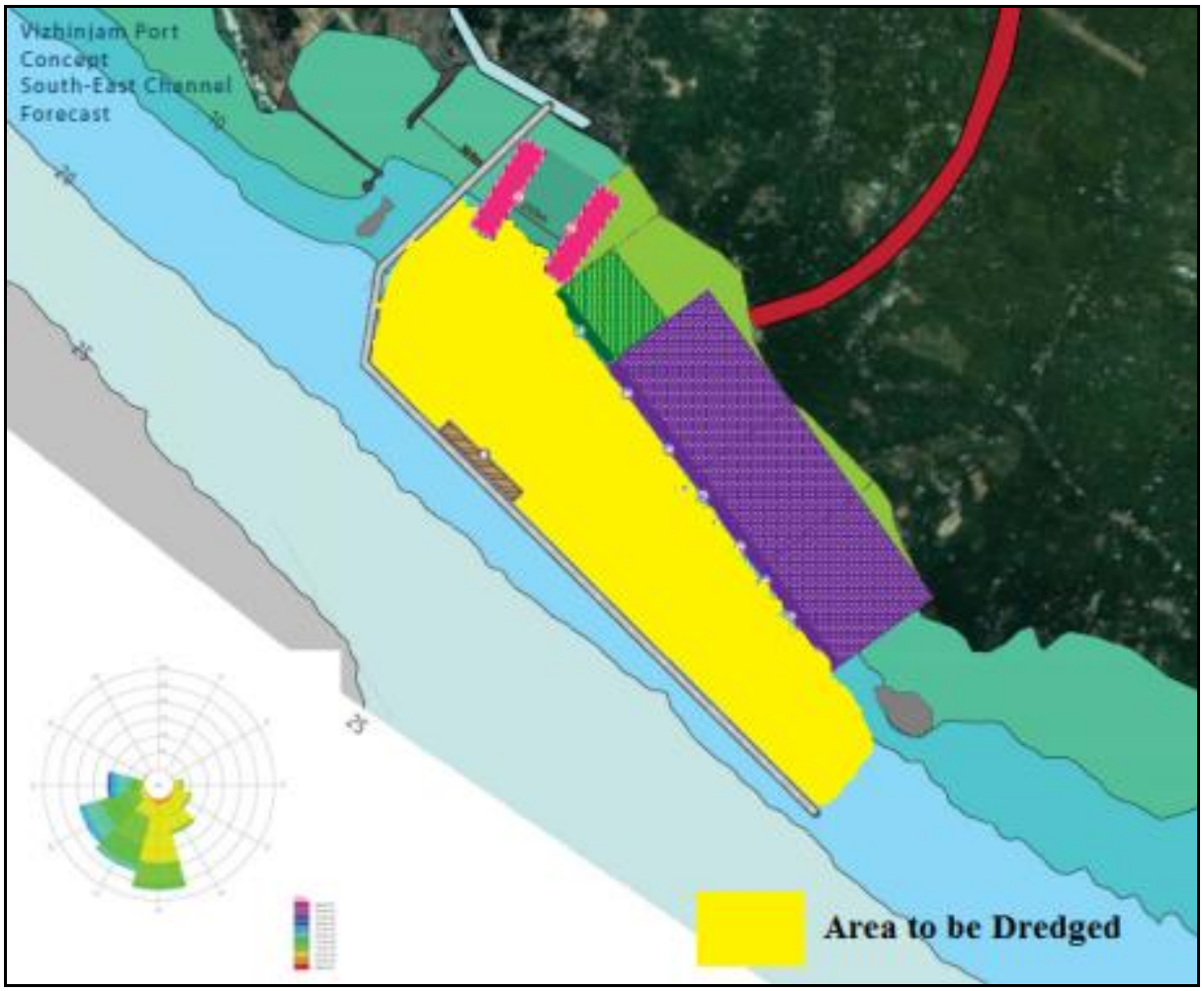


Figure 4-34: Map Showing Dredging Area (Excluding Approach Channel)

Fugro Geotech Pvt. Ltd. has carried out a Geotechnical investigation in the proposed project site and has submitted a Geotechnical Report in 2011. In this study, they have analysed geomorphological conditions of *Sixteen (16)* locations in the project site, out of which *Five (05)* are located in the area demarcated for dredging. *Three (03)* locations are located in the approach channel and *Two (02)* in the turning circle. **Figure 4-35** shows the location of the boreholes situated in the proposed dredging area.

The sampling points at the approach channel were analysed at a depth of up to 7.45 m -CD. Up to that depth medium dense to very dense dark grey to grey silty sand with occasional shell fragments was observed. The physico-chemical characteristics of dredged material are given in **Table 4-15**. This layer is underlained by soft sandy clay/silty, dense in nature. A chemical analysis revealed that the soil contained:

- 0.14 to 0.24% of chloride

- 0.0069 to 0.0206% of SO_3
- Calcium Carbonate ($CaCO_3$) was not detected
- P^H of the sediment was near neutral as it ranged from 7.82 to 7.98.

At the sampling points in the turning circle, the borehole analysis was carried out till -10.45 m -CD, showing medium dense to dense clayey sand with shell fragments with occasional silt. The following concentrations were observed:

- SO_3 in the range of 0.0137 to 0.0206%,
- chloride in the range of 0.140 to 0.148%
- Calcium carbonate - 13%.
- The sediment was near neutral in nature as the pH ranged from 7.68 to 7.80.

The heavy metal concentration in the sediment from the primary data is collected for *Two (02)* locations falling in/near the dredging area.

The sediment was found to be sandy in nature with percentage of sand ranging from 97 to 99%. Mercury (Hg) and Dibutyl Tin (DBT) were found to be below the detection limit (detection limit for Hg and DBT is 0.05 ppm and 0.2 ngSn/g). The concentration of Chromium, Copper, Nickel, Lead and Zinc were in the range of 5.32 -11.22 ppm, 1.16 – 1.40 ppm, 0.05 - 0.49 ppm, 1.37 – 2.68 ppm and 2.89 – 5.04 ppm respectively.

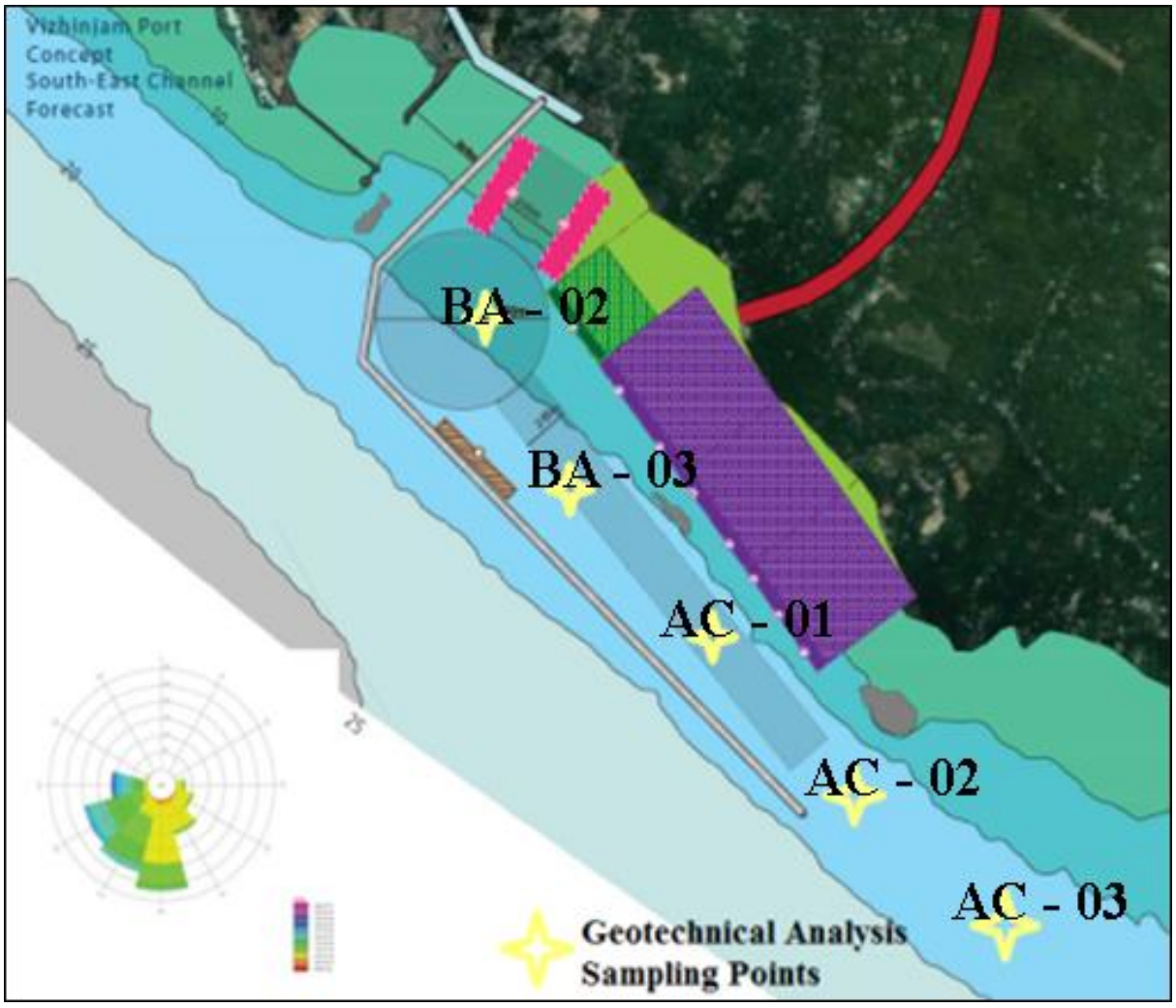


Figure 4-35: Geotechnical Analysis Sampling Points Located in the Proposed Dredging Area

Table 4-15: Physico-Chemical Characteristics of Dredged Material

	BH. No.	Test Depth (m) below Existing round Level	Classification Tests							Chemical Test of Soil Samples			
			Sp Gravity	Atterberg Limits (%)			Particle Size						
		Depth		W_L	W_P	L_P	Clay	Silt	Sand	Gravel	SO_3 (%)	Chloride Content (%)	pH	$CaCO_3$
Approach Channel	AC-1	2.00-2.45	2.671	NP			-	2	95	3	-	-	-	-
		6.00-6.45		34	21	13	11	48	41	0	0.0206	0.24	7.98	Nil
	AC-2	1.00-1.45		NP			-	1	99	0	-	-	-	-
		5.00-5.45		NP			-	1	96	3	-	-	-	-
	AC-3	3.00-3.45	2.667	NP			2	15	81	2	-	-	-	-
		4.00-4.45		-	-	-					0.0069	0.14	7.82	Nil
		6.00-6.45		NP			-	1	99	0	-	-	-	-
Turning Circle	BA-2	3.00-3.45		NP			2	16	78	4	-	-	-	-
		9.00-9.45		52	21	31	14	7	79	0	-	-	-	-
	BA-3	5.00-5.45		NP			2	5	91	2	-	-	-	-
		10.00-10.45		21	11	10	12	14	74	0	-	-	-	-

(Source: Geotechnical Investigation and Geophysical Survey Works for Vizhinjam port, FugroGeotechPvt. Ltd., 2011)

4.3.7 Shoreline Erosion

The project area is characterised by different coastal geomorphological features like pocket beaches, rocky coasts, headlands, bays, medium and low cliffs. The shoreline is not a fixed line and its position is dynamic as the change in the shoreline is a natural phenomenon because of the suspension of sediment and transportation of the same due to current (littoral drift) during the monsoon season and deposition in calm non-monsoon season. If this natural cycle is disturbed by anthropogenic intervention, an unbalanced sediment transport cycle will occur, which may lead to an unusual and irreversible shoreline behaviour.

Since 1950, the shoreline erosion problem in the coast of Kerala has been a major issue for the State. Various studies conducted on the shoreline erosion of the State have been reviewed and historical satellite images were analysed to assess the shoreline condition of the project area over the years. Documents reviewed are listed below:

- Report prepared on Shoreline erosion of Kerala coast by U.S. Army Coastal Engineering Research Center in 1964 (Two reports have been prepared one in January 1964 and other one in June 1964).
- Study report on the shoreline erosion of the Kerala coastline by the Public Works Department (PWD) of Kerala in 1970.
- M. Tech.thesis entitled 'The performance of the shore protection works along the coast of Kerala' by Appukuttan Pillai in 1976.
- Report on Shoreline Change Assessment for Kerala Coast published by National Center for Sustainable Coastal Management (NCSCM), Ministry of Environment and Forest (MoEF) in 2011.
- Project specific shoreline assessment report titled "Assessment of Long Term Shoreline Changes in and Around Vizhinjam Proposed Port, Kerala" by (LTR) & Indian National Centre for Ocean Information Services (INCOIS), in 2012.

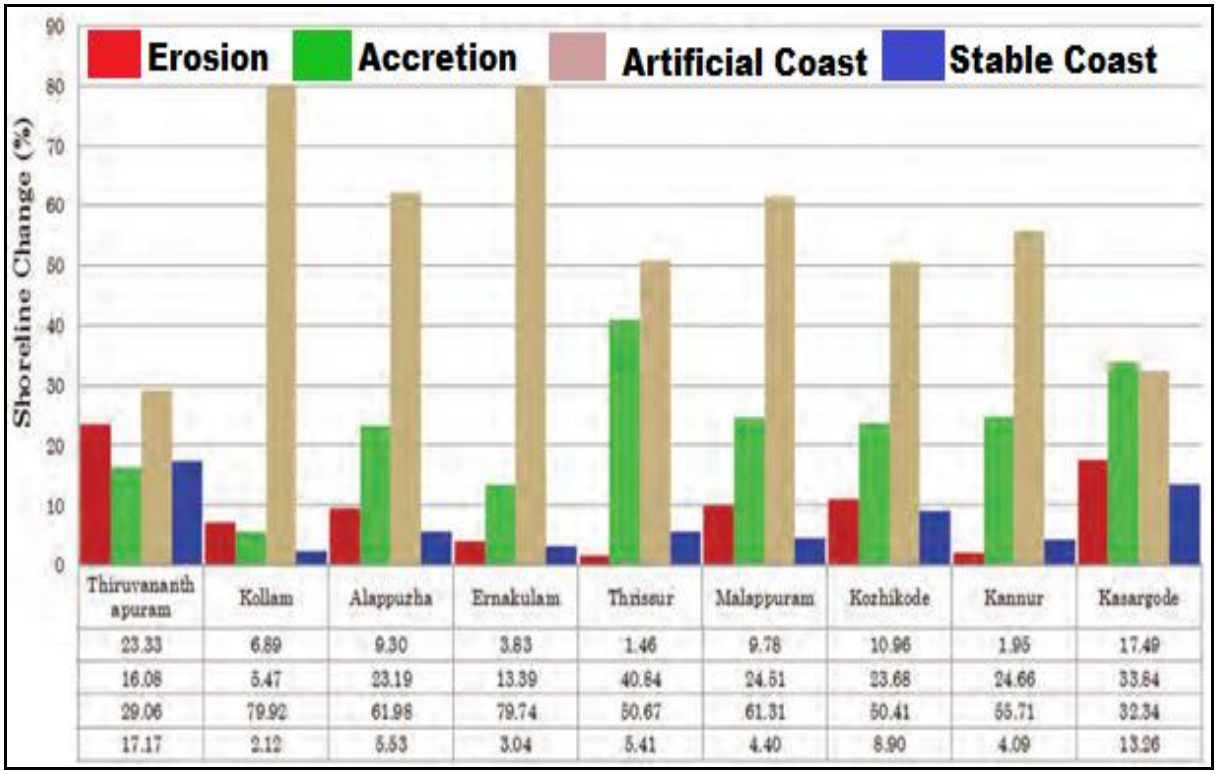
The issue of erosion of the coast of Kerala dates back to ancient time, In Thiruvananthapuram, the Varkala cliff erosion is an evident fact for the shoreline erosion over the years (Appukuttan, 1976). In 1960, during the South West monsoon the beaches receded to 0.05 km and during the non-monsoon season they advanced of 0.04 km, which lead to an average loss of 0.01 km per year (PWD, 1970). In 1970, the length of eroded coastline was 321.87 km to 563.27 km (PWD, 1970).

From 1900 to 1970, shore protection structures were constructed in about 100 km of coastal stretch of Kerala (Appukuttan, 1976). In 2010, the length of the shoreline with protection structures increased to 310 km, which means about 53% of Kerala's coast is artificial (NCSCM, 2011).

A comparison of erosion, accretion, presence of the artificial coast and stable coast in various coastal district of Kerala (NCSCM, 2010) given in **Figure 4-36**, shows that the percentage of shoreline erosion is comparatively higher in PIA district. The district has the lowest percentage of artificial coast and highest percentage of stable coast, when compared to other districts. The geological formation and rocky outcrop might be the reason of lowest percentage of artificial coast in PIA district, which made it safer than the rest of the districts of the State.

With respect to the proposed project location, shore protection works have been carried out from 1900 onwards at the following locations in Thiruvananthapuram coast:

- At Chilakkur near Varkala area (about 50 km towards the North West direction from the proposed project site), 18 groynes were constructed in 1900 to protect the narrow beach from erosion (George, 1964).



Thiruvananthapuram	Kollam	Alappuzha	Ernakulam	Thrissur	Malappuram	Kozhikode	Kannur	Kasargode
23.33	6.89	9.30	3.83	1.46	9.78	10.96	1.95	17.49
16.08	5.47	23.19	13.39	40.84	24.51	23.68	24.66	33.64
29.06	79.92	61.98	79.74	50.67	61.31	50.41	55.71	32.34
17.17	2.12	5.53	3.04	5.41	4.40	8.90	4.09	13.26

Figure 4-36: Shoreline Condition of the Coastal Districts of Kerala (Source: NCSCM, 2010)

- At Valiyathura near Thiruvananthapuram (about 12 km towards the NW direction from the proposed project site), a pier (Two rows of 0.40 m square piles) was constructed in 1956. In 25 years of its construction, prominent accretion (expansion of land area) was observed in the pier site. The shoreline profile of this area from 1952 to 1956 showed considerable evolution (Appukuttan, 1976).
- At Poonthura (about 9.0 km towards the NW direction from the proposed project site), construction of a seawall commenced in 1970 but could not be completed (PWD 1970). In 1976, severe erosion in the sandy beach damaged the beach side dwelling houses.
- From Kovalam (about 2 - 3 km towards the NW direction from the proposed project site) to Karamana River, 3.0 km of protection work has been carried out. Two short groynes present near the river show accretion in the southern side (LTR and INCOIS, 2012).

A period of 38 years (1973 to 2011) was considered for the detailed analysis of shoreline changes using satellite imagery in the coastal stretch of the study area (ACE, 2012). The objective of the study was to assess the condition and nature of the shoreline in the Project stretch (**Figure 4-37**). The objective of this satellite image analysis was to see the trend of shoreline change in this coast. The shoreline of the Kovalam beach and southern side of the Project site were also analysed for the same period (**Figure 4-38**). Shoreline changes at Multi temporal area, which was repeatedly mentioned by the localities as an example of an anthropogenic intervention of the coastline, was also analysed by using satellite imageries dated 1973 (LANDSAT MSS), 1990 & 2002 (LANDSAT TM 4-5) and 2011 (LISS III).

In the project stretch, over the period of 38 years, the shoreline has eroded approximately 80-160 m, refer **Figure 4-39**. Insignificant level of accretion (5-15 m. approximately) is noted in few beach pockets in the Project stretch.

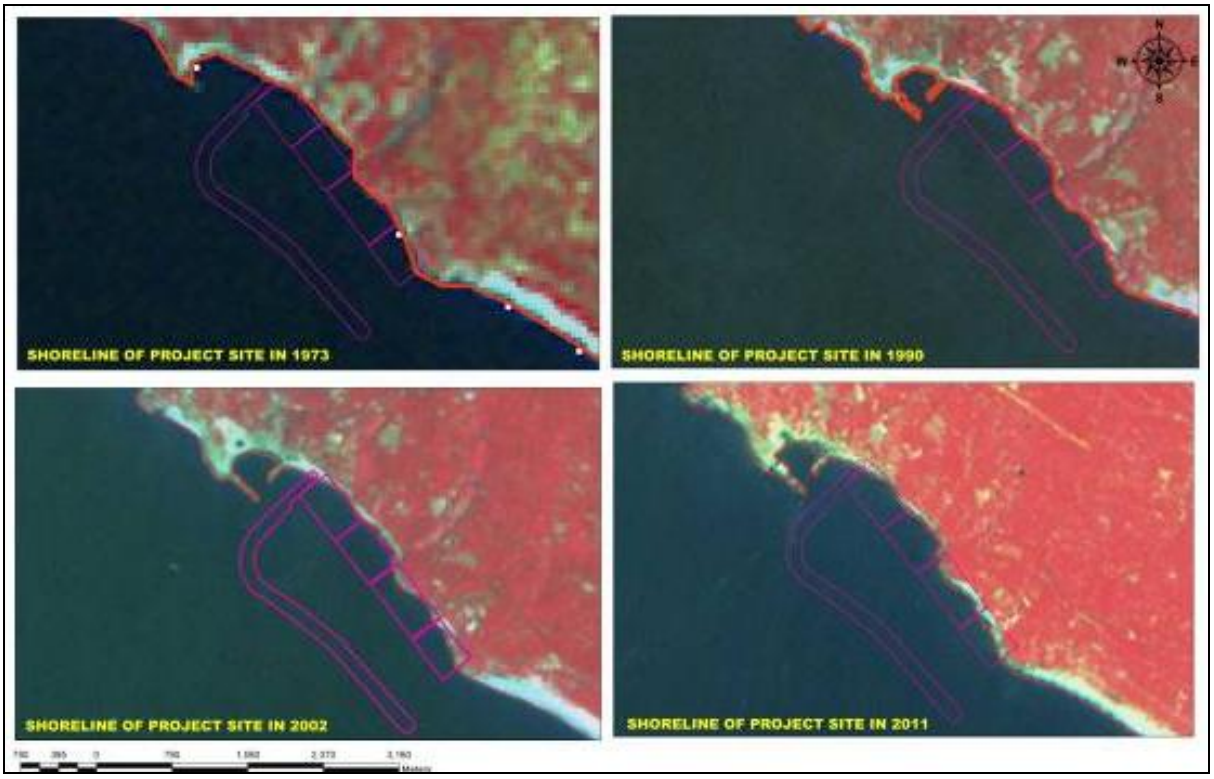


Figure 4-37: Satellite Images of the Shoreline of the Project Site in 1973, 1990, 2002 & 2011

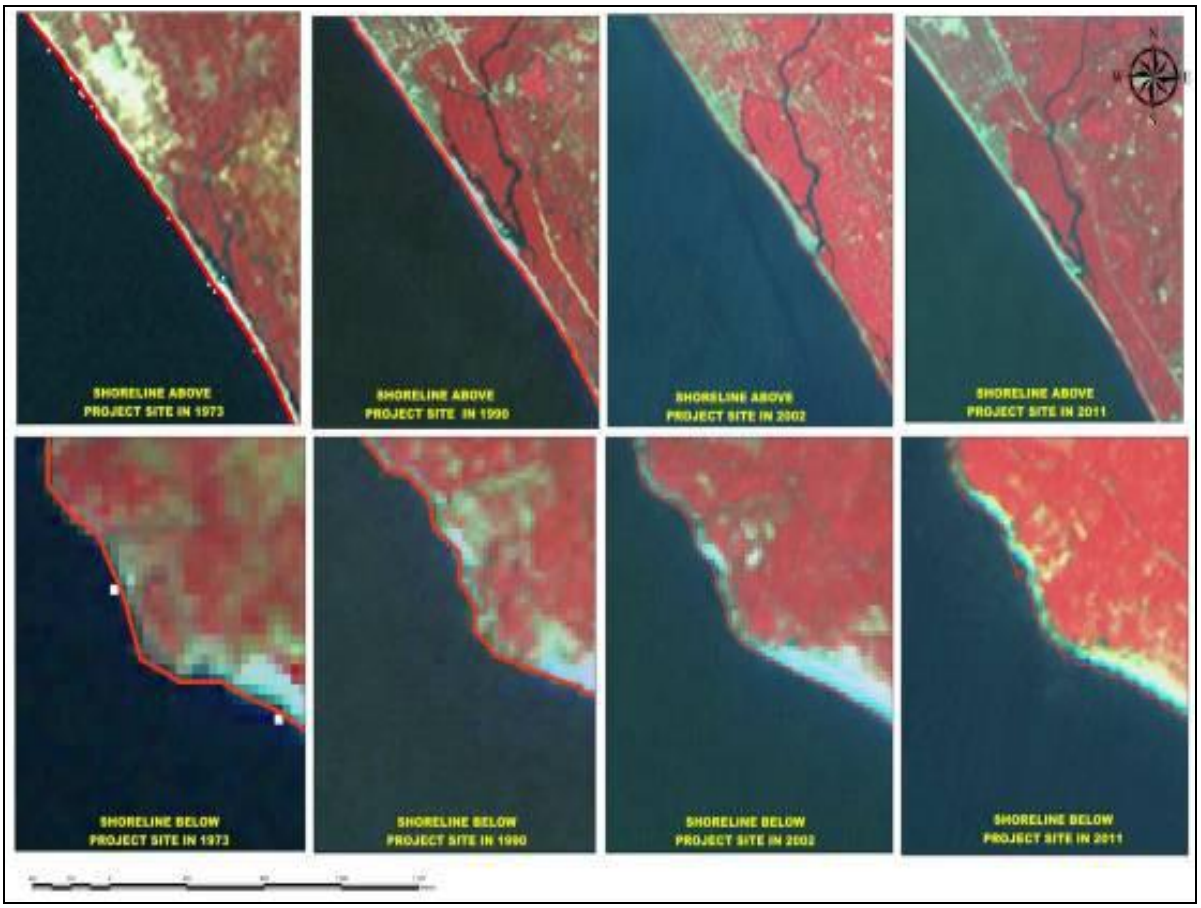


Figure 4-38: Satellite Images of the Shoreline of the Project Site in 1973, 1990, 2002 & 2011

The northern side of the project (Kovalam) has naturally eroded (approximately 50 – 200 m) over the years (1973 to 2011). Even though a few accretion pockets are also found North of the Project site, but erosion is dominant in the 5.0 km area around the project site.

The southern side of the project stretch (Adimalathura) is an almost straight long stretch of beach, which has been accreting over the years. The northern end of the Adimalathura shoreline is capped by a rocky headland. Approximately 100-220 m of outward shift of shoreline was observed from 1973 to 2011. The intense accretion may be due to the blockage of northerly littoral transport by the rocky headland.

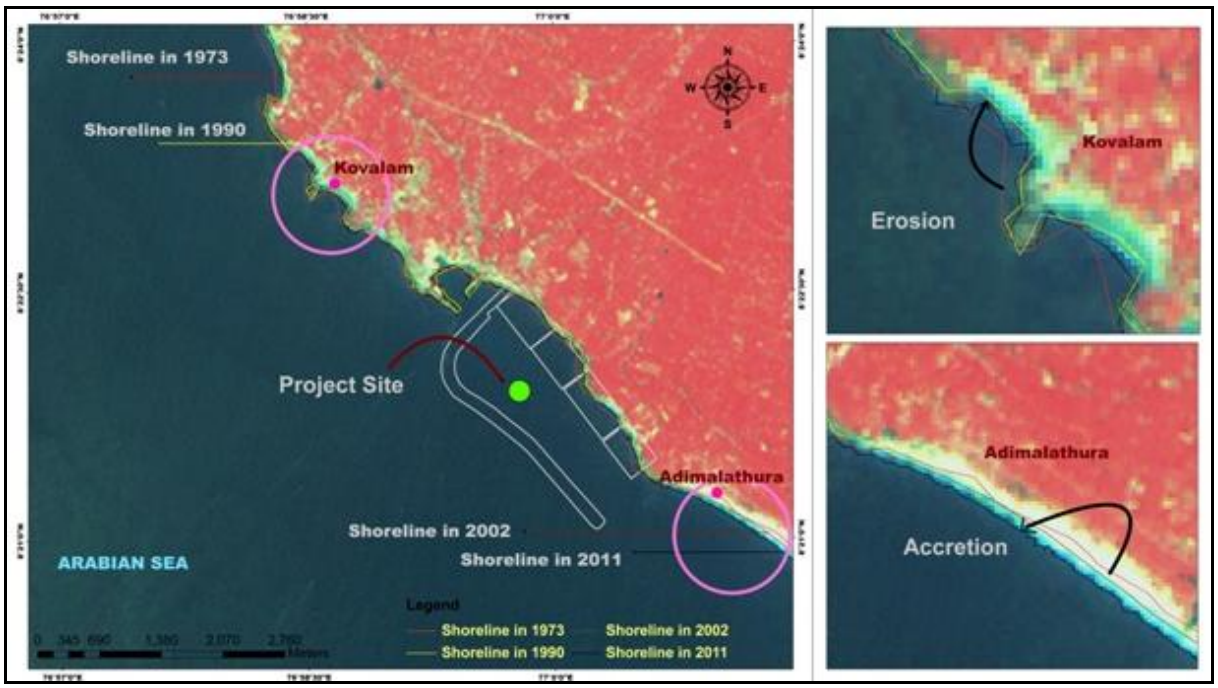


Figure 4-39: Comparison of Shorelines over the Span of 38 Years (1973-2011)

4.3.7.1 Depiction of Siltation Using Satellite Image

Satellite imagery has been used to understand the shoreline changes. Clear water has the tendency to absorb infrared waves fully; hence, deep water appears dark in the infrared band. When there is some impurity like silt etc. in the water, it appears a little brighter in the infrared band. So the brightness value in an infrared band is directly proportional to the amount of impurity present in it; as the amount of impurity increases, brightness of water also increases and vice versa.

Four points in the Project stretches were taken for a silt concentration analysis (**Figure 4-40**). The change in the silt concentration is depicted in **Figure 4-41**.

Near Point 1, it can be inferred that there is a sharp increase in the DN value from 1973 to 1990, which means silt concentration has increased over this period and the shoreline near Point 1 shifted inwardly, which implies erosion.

In the 2002 satellite image, near Point 1 the silt concentration decreased negligibly and the shoreline near Point 1 remained almost same in between 1990 and 2002. The analysis of 2011 image revealed that, near the aforementioned point, the concentration of silt decreased and the shoreline erosion was

almost negligible from 2002 to 2011. Similar observations were noticed for Point 2, Point 3 and Point 4. So indicating that silt concentration in near shore waters has increased between 1973 and 1990, whereas from 1990 to 2011 it has decreased.

4.3.7.2 Results and Discussion

From the shoreline change study it was concluded that the shoreline near the above mentioned point 1 to 4 has been eroding from 1973 to 1990 and remained stable from 1990 to 2011.

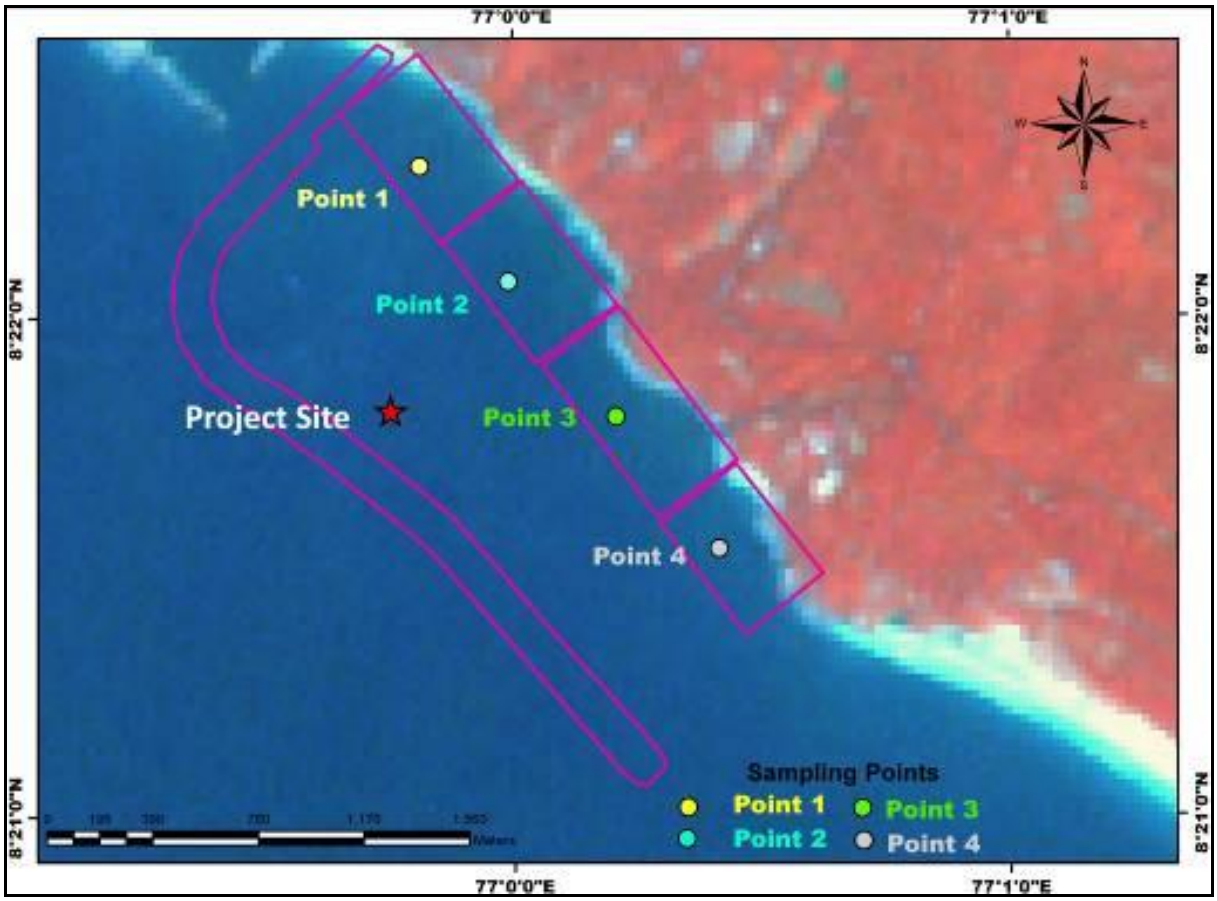


Figure 4-40: Sedimentation Pattern Analysis

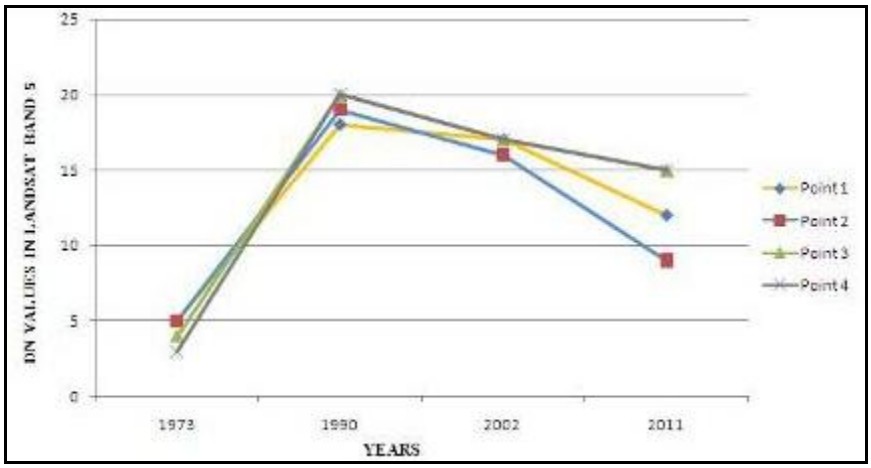


Figure 4-41: DN Values in Infrared Band

During 2012, LTR and INCOIS had also carried out a shoreline assessment study based on historical data for a period of two decades (1992 – 2011). The study area extends to about 15 km North and South of the project site. The outcome of the study is summarised in **Table 4-16**. **Figure 4-42** shows the superimposed satellite imagery over the period of time (1992-2011) with shoreline change rates. The comparison of the shoreline over a period of 19 years shows that on a long term, the shoreline of the project site is mostly stable. The northern side of the project site shows a slight tendency for erosion whereas a little tendency for accretion in the southern region.

Table 4-16: Shoreline Change Rate (SCR in m) in and around the Project Site

Period	15 km North of Project Site	Project Site	15 km South of Project Site
1992-1997	Dominance of erosion SCR: -2 to +2 and -2 to -5	Dominance of accretion SCR: +5 and -2 to +2	Stable SCR: -2 to +2
1997-2001	Dominance of accretion SCR: +5 and +2 to +5	Little dominance of accretion	Dominance of accretion SCR: +5 and +2 to +5
2001-2006	Dominance of erosion SCR: -5 and -2 to -5	Dominance of erosion	Stable SCR: -2 to +2
2006-2011	Stable with tendency for erosion SCR: -2 to +2 and -2 to -5	Stable SCR: -2 to +2	Dominance of erosion among some stable areas SCR: -2 to -5
1992-2011	Dominance of stability with little areas of erosion, SCR: -2 to +2 and -2 to -5	Stable SCR: -2 to +2	Dominance of stability with little areas of accretion, SCR -2 to +2 and +2 to +5

a. Shoreline Change in Muthalapozhy Fishing Harbour

Muthalapozhy fishing harbor is located 8º 37’ 54.86” N latitude and 76º 47’ 08.93” E longitude (about 37 km in the NW direction from the Project site). The local habitants, in the proposed Project area of concern, stated that the shoreline of Muthalapozhy is changing and is following a particular trend.

To understand the change in shoreline of Muthalapozhy before and after the construction of the fishing harbour, an assessment of the shoreline change of the Muthalapozhy fishing harbour was carried out by RH/ACE team with satellite images for a span of 38 years. The satellite images were procured for the years 1973, 1990, 2002 and 2011 is given in **Figure 4-43**. The construction of breakwaters commenced on May 2002. Thus the major focus is to analyze the rate of change of the shoreline before and after the construction of Muthalapozhy fishing harbor.

In **Figure 4-44**, the shoreline change near the fishing harbour is studied to address the issues like erosion and accretion. The southern side of Muthalapozhy fishing harbour has naturally eroded (100 – 180 m) over the years (1973 to 2002). The harbour construction started in May 2002. The analysis from 2002 to 2011 depicts that the southern side of the fishing harbour is accreting (approx. 200-350 m) due to the groin effect of the breakwater which traps the sediments south of the inlet.

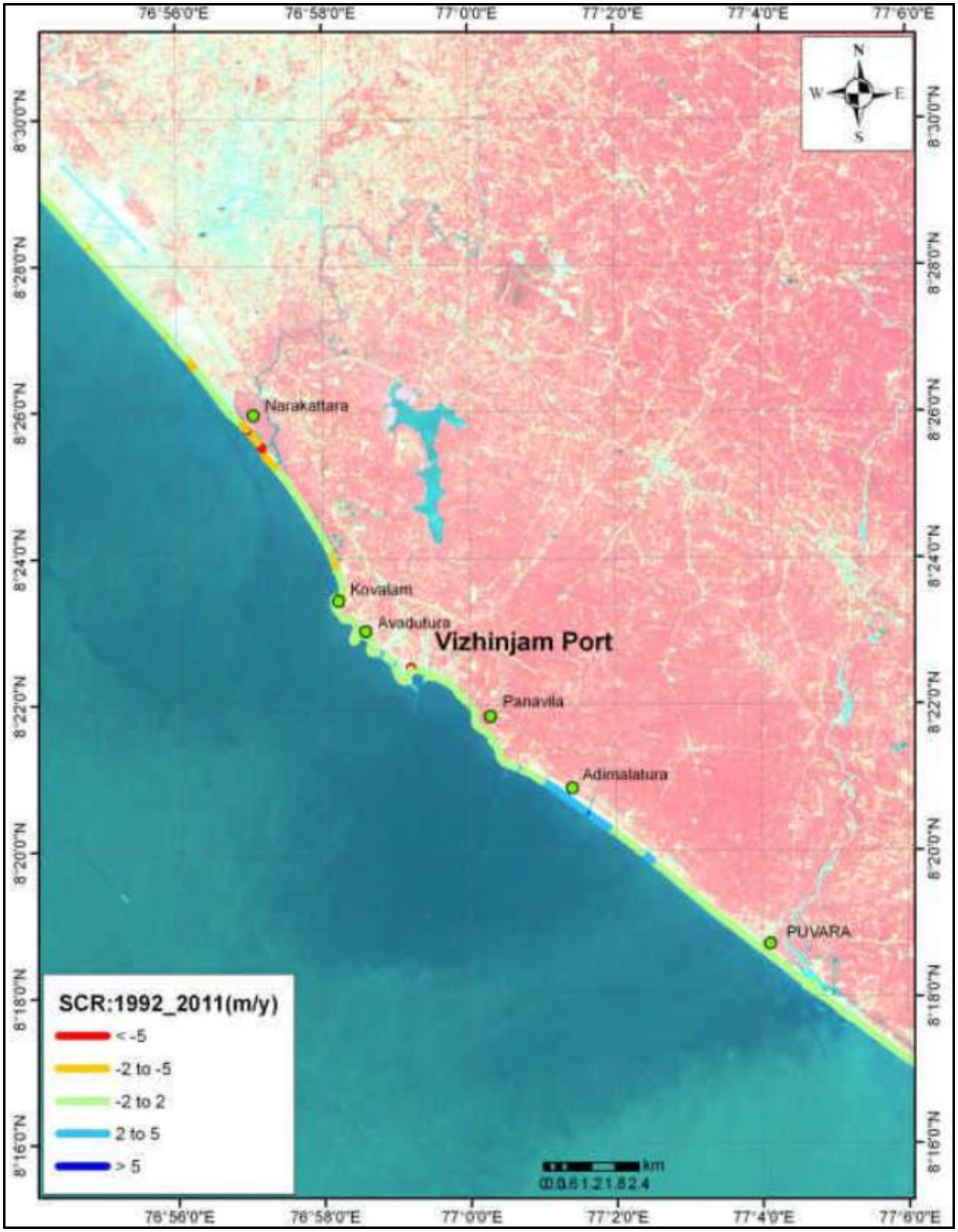


Figure 4-42: Map showing the Shoreline Change Rate during 1992-2011

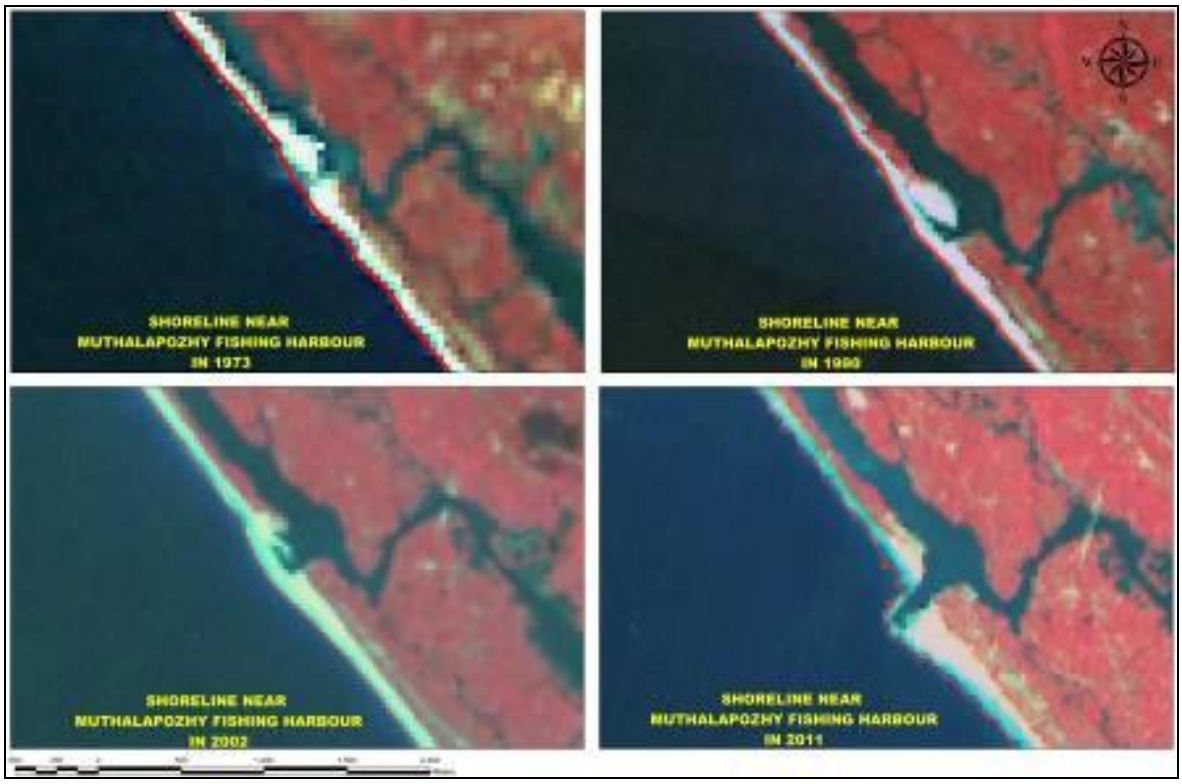


Figure 4-43: Muthalapozhy Satellite Imageries (1973, 1990, 2002 and 2011) of the Shoreline

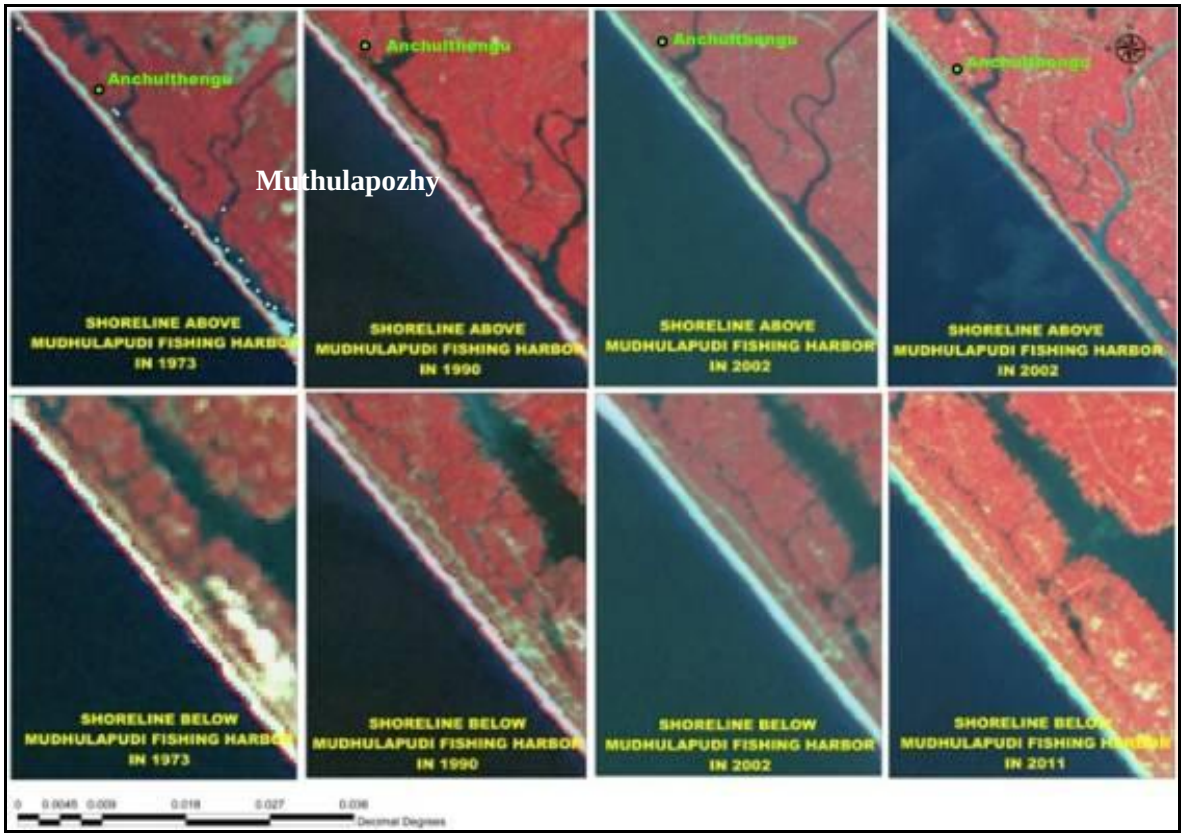


Figure 4-44: Shoreline Above and Below the Muthalapozhy Harbour up to 5 km Extent for the year 1973, 1990, 2002 and 2011

4.4 Marine Water and Sediment Quality

Monitoring of the marine water, sediment and ecological parameters was carried out by the Central Marine Fisheries Research Institute (CMFRI), Vizhinjam Research Centre. The monitoring was carried out for three seasons Post-monsoon (October 2011 to January 2012), Pre-monsoon (February to May 2012) and Monsoon (June to September 2012). The details of marine monitoring locations are given in **Table 4-17** and shown in **Figure FD 0403**.

Table 4-17: Marine Water and Sediment Sampling Stations

Zone	Station	Latitude	Longitude
Direct foot print zone	Karimpallikkara	8°22'18.03"N	76°59'22.14"E
(Zone-1: 0 - 2 km from the project site)	Mulloor	8°22'3.39"N	76°59'59.43"E
Potential impact zone	Kovalam	8°22'15.08"N	76°57'58.68"E
(Zone-2: 2 - 5 km from the project site)	Karichal	8°20'34.67"N	76°59'18.75"E
Control zone	Panathura	8°24'21.17"N	76°57'20.23"E
(Zone-3: 5 - 10 km from the project site)	Puthiyathura	8°19'16.48"N	77°2'28.71"E

4.4.1 Marine Water Quality Analysis Methodology

The marine water samples were collected after anchoring the fishing boat (**Exhibit 4-3**), using a Nansen reversing water sampler [Hydrobios (Nansen type) with transparent sampling tube of polycarbonate; grease free ball valves with Teflon seals (Capacity 1.7 l)]. The water samples were transferred to oxygen bottles and clean black polythene bottles of 1.0 litre capacity. Temperature, pH, turbidity etc. were measured on board using Portable multi probe Water Quality Analyser (WQA) and Nephelometer.



Exhibit 4-3: Marine Monitoring Off Karichal Coast, January 2012



Exhibit 4-4: Sediment sampling during marine monitoring (Off Panathura, January 2012)

4.4.2 Marine Water Quality Analysis Results

The pH, salinity and dissolved oxygen concentration in the marine water were in the range of 8.0 to 8.2, 34.0 to 35.5 ppt and 3.8 to 6.9 mg/l respectively. Total nitrogen value ranged from 0.20 to 0.35 mg/l, 0.11 to 0.43 mg/l and 1.48 to 5.18 mg/l in pre-monsoon, post-monsoon and monsoon season respectively. Total coliform were found in all the sampled locations and the values were in range of 0.6 $\times 10^4$ to 3.0×10^6 (CFU/ml), which indicate sewage contamination of water body and it is also signified

by low dissolved oxygen levels in the water. Due to absence/partial operation of sewerage system in the coastal villages, the untreated sewage is discharged directly into the sea. The analytical results of Marine water quality are given in **Appendix 4.3**.

The concentration of total phosphorous was in the range of 0.0285 to 0.0521 mg/l, 0.0127 to 0.0451 mg/l and 0.0370 to 0.543 mg/l in the pre-monsoon, post-monsoon and monsoon seasons respectively. The concentration of nitrogen and phosphorus in the water was found to increase during monsoon season. This might be due to the contaminated water body by the storm water runoff, which consists of dissolved impurities like nitrates, phosphates etc. As per the standards given in National Coastal Condition Report II, USEPA, 2004 (USEPA, 2004), nitrogen and phosphorous concentration greater than 0.5 mg/l and 0.05 mg/l respectively, signifies pollution/contamination, which is evident in the monsoon season based on the results. In other seasons, the water quality is in 'fair' category, i.e. without significant pollution.

The concentration of chlorophyll in pre-monsoon, post-monsoon and monsoon seasons were in the range of 2.01 to 3.51 mg chlorophyll/m^3, 2.045 to 2.946 mg chlorophyll/m^3 and 1.983 to 3.84 mg chlorophyll/m^3 respectively. With respect to the chlorophyll concentration, as high chlorophyll concentration will lead to depletion of dissolved oxygen, which will affect other aquatic organisms.

Heavy metals namely mercury, chromium, lead and tributyl tin were below the detectable range in the sampled water in all seasons and locations. The sampled water from the location 'off Karichal' coast did not contain heavy metals in all the sampled seasons.

In post-monsoon, no heavy metal was identified in the samples obtained from Mulloor, Karichal and Panathura. Zinc (0.01 ppm) was identified in marine water off the coast of Karimpallikkara, Kovalam and Puthiyathura. Arsenic was identified in the water collected from Kovalam (0.03 ppm) in all three seasons. Zn in three stations, Karimpallikkara, Puthiyathura and Kovalam (0.01 ppm) were found to be in detectable level during post-monsoon. Nickel (0.02 ppm) and Copper (0.01 ppm) were detected in marine water collected from in front of Mulloor during monsoon season.

Poly Aromatic Hydrocarbons (PAHs) namely, acenaphthylene, bromo-naphthalene, acenaphthene, fluorene, pyrene, benzo (a) pyrene, dibenzo (a, h) anthracene and indeno (1, 2, 3) pyrene were below detectable range in the water collected from all the sampled locations during the monsoon season.

In post-monsoon, PAHs were detected in the water collected from, Karimpallikkara, Mullor and Kovalam as follows:

- **Karimpallikkara:** Anthracene (0.229 µg/ml), Phenanthrene (0.220 µg/ml) and Benzo (ghi) perylene (0.118 µg/ml)
- **Mulloor:** Phenanthrene (0.067 µg/ml) and Anthracene (0.082 µg/ml)
- **Kovalam:** Anthracene (0.008 µg/ml) and Fluoranthene (0.026 µg/ml)

Total Petroleum Hydrocarbons (TPHs), except hexacosane and octacosane were detected in samples collected from all the seasons and all locations. The concentrations of decane, dodecane, hexadecane, octadecane, tetradecane, eicosane, docosane and tetracosane were in the range of 0.065 – 7.344 µg/ml, 0.058-12.194 µg/ml, 0.009 – 0.393 µg/ml, 0.008 – 0.454 µg/ml, 2.265 – 8.213 µg/ml, 0.105 – 0.156 µg/ml, 0.113 µg/ml and 0.278 µg/ml, respectively.

Some of the possible sources of PAHs, TPHs and heavy metal are:

- Land-based sources (urban runoff, ship vessel repair etc.);

- Fuel combustion emissions and leaks from out board engine fitted fishing vessels and other vessels and ships;
- Atmospheric fallout;
- Natural seeps.

When compared with the Water Quality Standards for Coastal Waters (Annexure 5 of EIA guidance manual for Ports and Harbours, MoEF, 2010), the water quality in the marine stretch of the proposed project area is identical to the SW 1 category of Annexure 5, which is suitable for Saltpans, Shell fishing, Mariculture and good for Ecologically sensitive zones. Certain parameters, which have been analysed has not been listed in this standard.

4.4.3 Marine Sediment Quality Monitoring Methodology

Sediment samples were collected using a Van-Veen grab sampler (**Exhibit 4-4**). The grab is lowered vertically from the stationary boat till it touches the bottom. Sediment samples were collected and preserved for sediment texture analysis and physico-chemical analysis.

4.4.4 Marine Sediment Quality Monitoring Results

Results of the physico-chemical analysis of the sediment samples are given in **Appendix 4.3**.

The analysed sediment samples were sandy (93 – 99% sand) in nature. The concentration of Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Zinc and Tributyl tinin the sediment were in the range of 0.27 - 1.85 ng/g, 0.02 - 0.78 ng/g, 4.06 - 29.73 ng/g, 0.23 - 4.20 ng/g, 0.05 - 3.15 ng/g, 1.37 - 11.73 ng/g, 1.18 - 19.77 ng/g and 1.10 - 3.20 ng/g. The heavy metals detected were within the rage of the standard limits prescribed by USEPA (USEPA, 2004).

Poly Aromatic Hydrocarbons (PAHs) were below the detectable limit in all sampling locations for all the three seasons. Among the Total Petroleum Hydrocarbons (TPHs) only Decane, Dodecane, Tetradecane and Hexadecane were identified in the sediments. The aforementioned TPHs, Decane, Dodecane and Tetradecane were found in the range of 0.603 - 2.837 µg/ml, 1.531 - 3.630 µg/ml and 1.221 - 3.071 µg/ml in the sampled locations. The presence of TPHs might be due to land-based sources (urban runoff, mechanics shops) and fuel leakage from fishing vessels.

4.5 Marine Ecology

4.5.1 Plankton

Plankton net of 30µ and 300µ (zooplankton) fitted with a flow meter [Digital Flow meter: KC Denmark-Diameter of propeller/counter body: 70/32 mm, length 185 mm, 5-digit counter]) was towed horizontally from the boat for 10 minutes for the collection of phytoplankton and zooplankton. While making the collections, the speed of the vessel was maintained at one to two nautical miles per hour. After the 10 minutes haul, the net was taken out of water and washed from outside by jetting seawater to bring down all the plankton into the collecting bucket. After all the excess water was drained off from the net and through the window of the collecting bucket, the bucket was carefully removed from the net and the plankton along with water is poured into a wide mouthed polythene bottle of 250 ml capacity. The reading on the flow meter was also noted. The collected sample was preserved in Lugol solution.

Phytoplankton: The volume of samples was estimated using the sedimentation volume method. Depending on the cell concentration, either the whole sample or a part (1ml) of it was counted in a Sedgwick-Rafter counting chamber under a compound research microscope (Leica DM 1000) to determine the numerical abundance of phytoplankton for each sample. The values for the whole were computed for cells/ m^3 of water.

The results of phytoplankton abundance and diversity are depicted in **Figure 4-45** and **Figure 4-46** respectively. Comparing the results from Sharon diversity index and total abundance in the *Six (06)* locations clearly shows that the productivity of the phytoplankton is highest during the monsoon season in the Control Zone. The productivity during post monsoon follows the monsoon period and is found to be highest in the Potential impact zone comprising of Kovalam and Karichal.

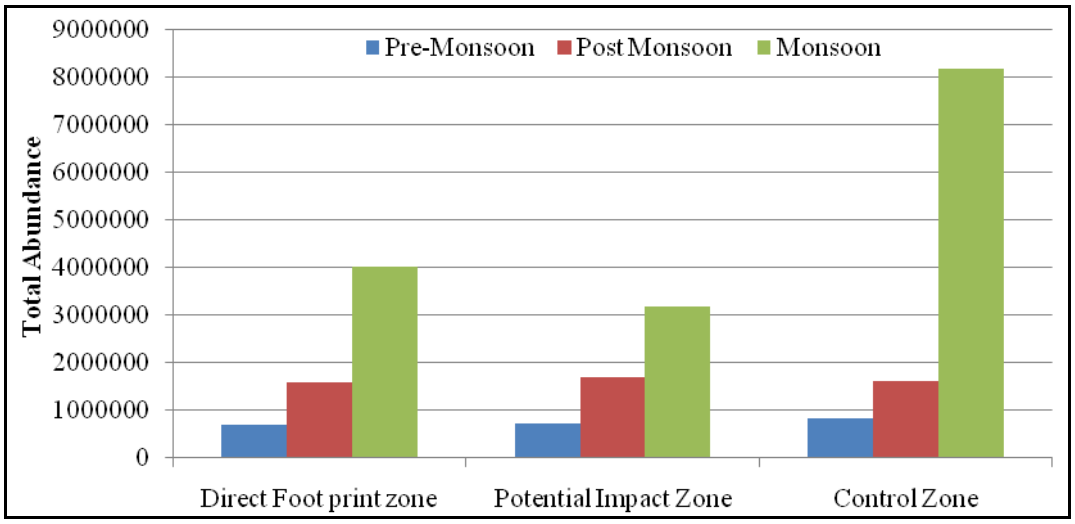


Figure 4-45: Phytoplankton Abundance

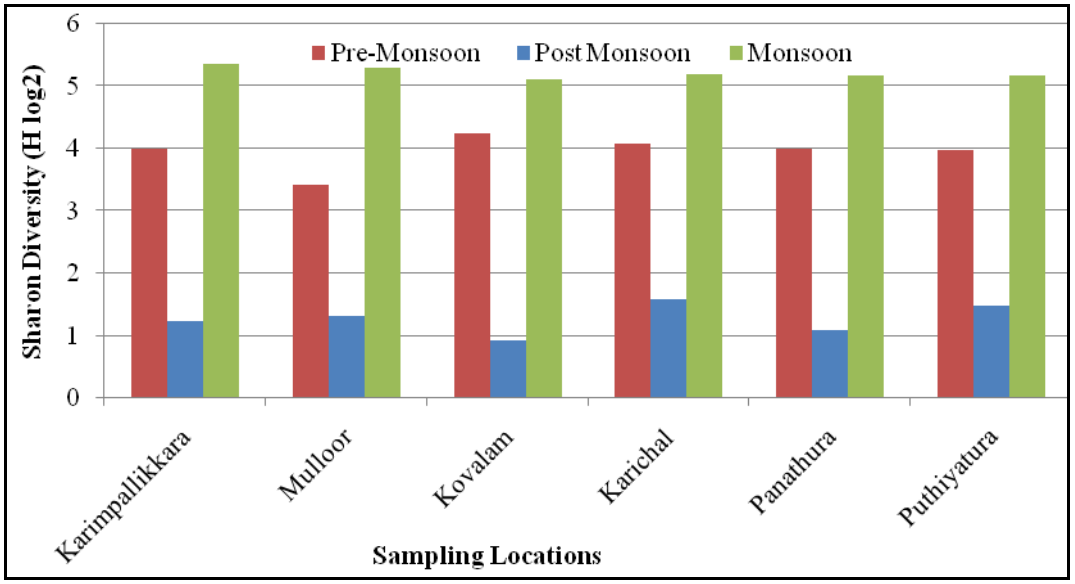


Figure 4-46: Phytoplankton Species Diversity

Zooplankton: For quantitative estimation of zooplankton in the sample, the displacement method was used and the zooplankton volume was determined. The sub-sampled plankton was fully analysed by counting in a plankton counting chamber under a stereozoom microscope Leica S6. Wherever

required a compound microscope (Leica DM1000) was used for the confirmation of species. The biomass was estimated based on the volume filtered. The zooplankton were identified as per Wickstead (1965), Newell and Newell (1977) and Raymont (1983).

Statistical Analysis was carried out using SPSS 12 software. The numerical abundance data of zooplankton and benthos samples were used to calculate the various biodiversity indices. Analyses were performed to calculate species richness, diversity and evenness index values for each site, using the PRIMER 5 (Plymouth Routines in Multivariate Ecological Research) software package developed at the Plymouth marine Laboratory, UK. PRIMER software package, multivariate techniques (hierarchical clustering) were used to evaluate both among-site patterns in overall biodiversity. The technique serves to classify the sites into groups having mutually similar biodiversity pattern.

During Monsoon Season maximum number of zooplankton was observed (69415/m^3) at Kovalam and minimum at Puthiyathura (27409/m^3). During Pre-Monsoon Season maximum number of zooplankton was observed (37193/m^3) at Kovalam and minimum at Puthiyathura (23432/m^3). During Post-Monsoon Season maximum number of zooplankton was observed (14786/m^3) at Kovalam and minimum at Mulloor (5114/m^3). The Most widely observed Zooplankton species was Copepods at Karimpalikkara and Mulloor (91307/m^3). The least observed Zooplankton species was stomatopod larvae (1/m^3) at Kovalam and at post monsoon season only. The most dominant zooplankton group was copepods (47%) followed by Cladocerans (30%) and cirripede (barnacle) larvae (9%). The details of phytoplankton and zooplankton are given in **Appendix 4.3**.

4.5.2 Benthos

Samples of macro benthic fauna from *Six (06)* locations were collected. The sediment was sieved through a 500-micron sieve and animals were collected and preserved in 10% buffered formalin and stained with a Rose Bengal on board. The preserved benthic samples were sorted in the laboratory under a microscope, stored in 10% buffered formalin and enumerated at group level for density estimation. The benthos samples collected were identified as per Day (1967) and Fauvel (1953).

During post-monsoon maximum number of benthos was observed during January (181630/m²) and a minimum during October (964324/m²) in Zone 1. Similarly a maximum number of benthos was observed during January (239344 - 814128/m²) and a minimum during October (147246 - 622530/m²) in Zone 2. A maximum number of benthos was observed during January (80080 - 243040/m²) and a minimum during October (54263 -178423/m²) for zone 3.

During pre-monsoon maximum number of benthos was observed during May (1753272 -1975942/m²) and a minimum during March (1233054 - 1817808/m²) in Zone 1. For zone 2 a maximum number of benthos was observed during May (1090194 - 1808579/m²) and a minimum during February (958112 - 1675824/m²). When zone 3 was analysed, a maximum number of benthos was observed during May (519117-1260966/m²) and a minimum during February (395856 - 1033960/m²).

During monsoon Zone 1 (project zone) is dominated with foraminifers (60.81%) followed by diatoms (37.84%), nematodes (8.2%) and bivalves (9.4%). In Zone 2 (potential impact) the dominant pattern of benthos is foraminifers (47.24%) followed by diatoms (24.8%), polychaetes (6.8%), copepods (8.6%) and nematodes (3.3%). In zone 3 (control zones) the dominancepattern of benthos is foraminifers (45.58%) followed by gastropods (18.4%), diatoms (18.1%), bivalves (10.7%). and nematodes (14.4%). The details of benthos are given in **Appendix 4.3**.

4.5.3 Fish and Fishery

The baseline data was gathered on the fish and fishery state of the Project area which covers Tuna and Oil Sardine, Mussel and Oceanic squid. The data for the marine fishery of the project area have been taken from Kerala Marine Fisheries Statistics - 2007, 2009 and 2010. As per the latest available fisheries statistics, contribution of the coastal part of PIA district as a whole was 45930 MT in 2010, which accounts 8.05% of the total production, i.e., 570013 MT of Kerala State as a whole.

A comparison of last five years (2005-2010) of marine fisheries statistics shows that fish catch from the coastal water of PIA district has been decreasing since 2006-2007 through 2008 – 2009 and 2009 – 2010 at 2.39%. The marine fish production of PIA district is given in **Figure 4-47**.

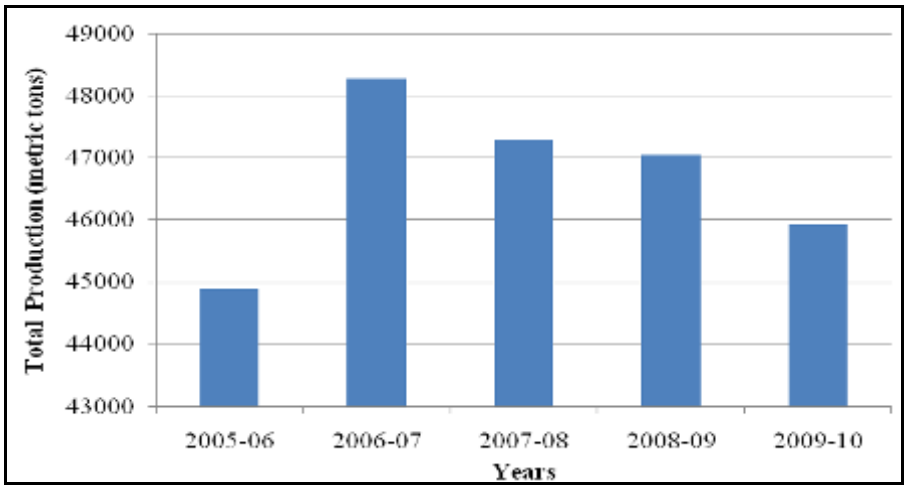


Figure 4-47: Marine Fishery Production in PIA District

About Thirteen *(13)* major and minor fish landing centres are present in the study area (**Figure 4-48**). The dominant fish species and their contribution to the total catch are presented in **Table 4-18**. The fish catch data of fishing harbour for the last five years are discussed in fishing harbour section.

Table 4-18: Dominant Fish Species and their Percentage Contribution to the Total Catch (2011-2012)

S. No	Fish Species	Common Name	Percentage Contribution
1	*Selar crumenophthalmus*	Bigeyescad	8.59
2	*Rastrelliger kanagurta*	Indian Mackerel	24.88
3	*Sardinella longiceps*	Malabar sardine	3.78
4	*Leiognathus* spp.	Striped Ponyfish	5.27
5	*Euthynnus affinis*	Mackerel Tuna	12.37
6	*Caranx* spp.	Trevallies	2.84
7	*Coryphaena hippurus*	Mahi-mahi or common Dolphin fish	1.55
8	*Sardinella spp.*		8.35
9	*Decapterus russelli*	Indian scador Round scad	2.19
10	*Sphyraena jello*	Banded Barracuda	0.93
11	*Sepia pharaonis*	Pharaoh Cuttlefish	1.37
12	*Auxis rochie*	tuna	0.06
13	*Sarda orientalis*	OrientalBonito	0.90
14	*Decapterus macrosoma*	Layang scad	0.744



Figure 4-48: Marine Fishery Production of the Fish Landing Centres in the Study Area (Oct 2011 – May 2012)

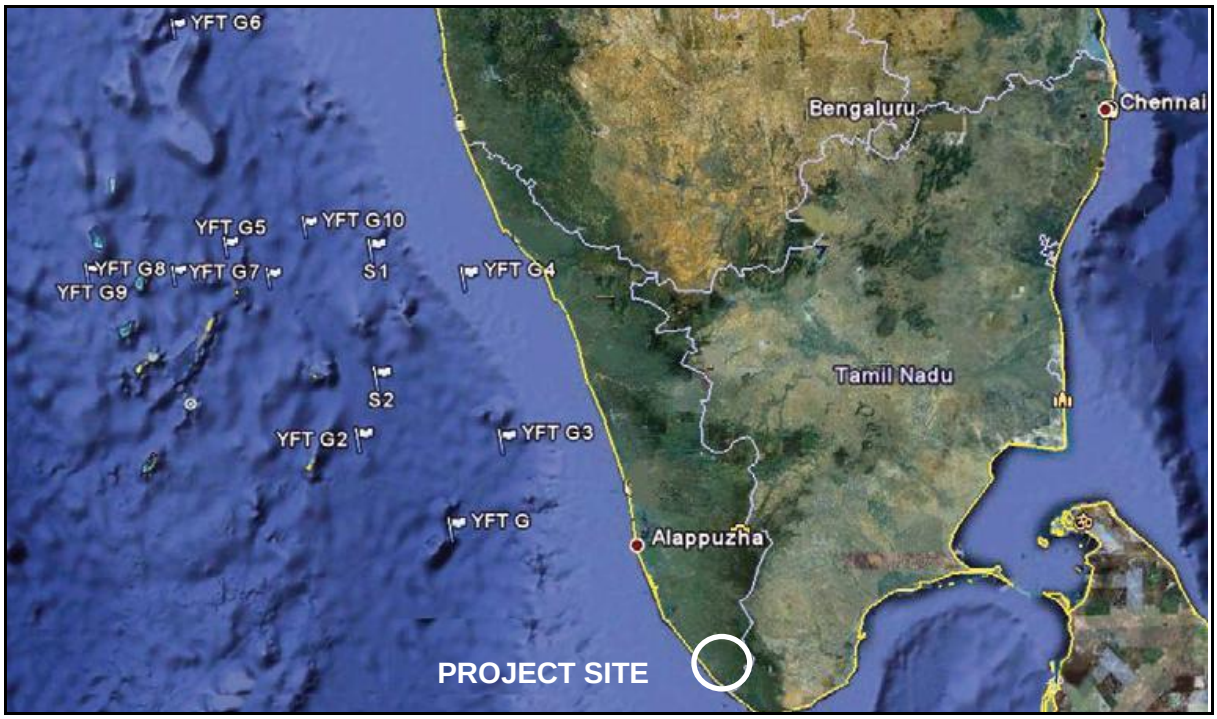
The list of fish species and their contribution to the overall catch volume of the two important fish landing centres of the Project area, i.e., Adimalathura and Vizhinjam, are given in **Table 4-19**. Indian Mackerel (*Rastrelliger kanagurta*) and Mackerel Tuna (*Euthynnus affinis)* are the main catch from the area.

Table 4-19: Species Wise Contribution to the Marine Fisheries of the Project Area (2011-2012)

Landing Centre	Dominant Species	Landing (in MT)	Contribution to the Total Catch (%)	Total catch (MT)
Adimalathura	*Rastrelliger kanagurta*	7.75	0.849	14.02
	Euthynnus affinis	3.15	0.345	
	Leiognathus spp	3.12	0.342	
	Rastrelliger kanagurta	112.87	12.370	311.99
	Euthynnus affinis	46.87	5.139	
	Selar crumenophthalmus	22.50	2.466	

Landing Centre	Dominant Species	Landing (in MT)	Contribution to the Total Catch (%)	Total catch (MT)
Vizhinjam	*Coryphaena hippurus*	10.00	1.096	
	Decapterus russelli	10.50	1.151	
	Sphyraena jello	10.00	1.096	
	Sepia pharaonis	16.75	1.836	
	Auxis rochie	82.50	9.045	

Fish, which are reported in the study, cannot be rated as rare as these are available all along the southern coast of Kerala and none of them have a restricted distribution. Yellow fintuna is one of the commercially important species at this stretch of coast. The nearest tuna fishing ground is located approximately 250 km from the project site (**Figure 4-49**). Shoals of oil sardine were reported to be frequently noted along the Vizhinjam coast in March-April (Pillai et al 2003).



(Source: CMFRI, 2011)

Figure 4-49: Fishing Ground for Yellow Fintuna

Unlike other fishery resources mussel and lobsters are the two components in the fishery which are likely to be affected directly by the construction of the proposed deep water Port since significant part of both these items are fished from the direct foot print zone.

4.5.3.1 Mussel Collection

Mussel and lobster landing take place only at Vizhinjam, and crab landing takes place only at Puthiathura, whereas squid is common to all three fish landing centres[7]. The details of squid, crab and mussel landing and their contribution to the total catch in the aforementioned landing centres are given in **Table 4-20**.

[7]This information is pertaining to the designated fish landing center, not unofficial landing places like nellikunnu, mulloor, etc. (Source: CMFRI)

Table 4-20: Landing statistics of Mussel, Squid and Crab (2011-2012)

Landing Centre	Species	Landing (in MT)	Percentage Contribution
Puthiathura	*Portunus sanguinolentus* (crab)	1.87	0.139
	Loligo spp.(squid)	0.50	0.037
Vizhinjam	*Loligo* spp. (squid)	10.60	0.788
	Panulirus homarus (lobster)	0.18	0.013
	Perna indica (mussel)	168.05	1.253
Poonthura	*Loligo* spp. (squid)	0.37	0.027

Mussel collection is one of the major fishing activities in the project stretch is given in **Exhibit 4-5**, usually done by skin diving operated from a catamaran. The peak season is from August to October. Gastropods are also collected along with mussels, which form a small fishery in this rocky area. The peak season of operation is December to February. The statistics of mussel collection units in the project stretch is given in **Table 4-21**.

The mussel fishery of Vizhinjam area (**Exhibit 4-6**) is constituted by a single species namely Perna indica or Indian brown mussel with a total annual catch of 1161.84T. This is about 12.2% of the total annual mussel catch of Kerala (9500 T). Estimated value of mussel catch from Vizhinjam is about INR 35 Million (₹ 3.5 crore) per Annum.



Exhibit 4-5: Mussel collection in Mulloor



Exhibit 4-6: Mussel catch in Vizhinjam

4.5.3.2 Lobster Collection

Lobster fishing is also one of the major fishing activities during post-monsoon months on the same stretch coast as the mussel fishing. Usually the season starts from August and last up to January with a peak collection period between August to November. Lobster collection is mainly carried out by lobster traps (**Exhibit 4-7**).

One unit contains five to eight traps. Bottom set gill nets (roll net) are also used for lobster fishing. Usually this net has a mesh size of 150-200 mesh and is about 300 m long with mesh size (width). Lobster fishery is constituted by a single species Panulirus homarus (2.2 T) and formed 2.5% of the total lobster landing of Kerala (99 T). Estimated value of lobster from Vizhinjam is about ₹ 2.2 million/annum (₹ 22 lakhs) per annum.

Table 4-21: Estimated Mussel Picking Units during Post-monsoon (2011) and Pre-monsoon (2012) at Vizhinjam

Months	No. of Units
October 2011	3025
November 2011	2695
December 2011	2686
January 2012	2275
February 2012	1775
March 2012	1383
April 2012	1125
May 2012	938



Exhibit 4-7: Lobster Trap

4.5.3.3 Oceanic Squids

As per the survey conducted by CMFRI in 2010-2011 (CMFRI Annual Report, 2010-2011) there is no fishing ground of squid near the project site. The oceanic squids are found to be abundant in the area between the islands of Kalpeni and Agatti, where maximum abundance of greater than 5.0 tonnes/km^2. Areas west off Ratnagiri also showed high abundance. **Figure 4-50** shows the oceanic squid abundance area in the Arabian Sea. The nearest location of the squid abundance from the Project site is around 120 km. The squid spawning ground was also identified in the same survey (**Figure 4-51**). The major spawning ground of squids was found around the Lakshadweep Islands, which is approximately 930 km away from the project site.

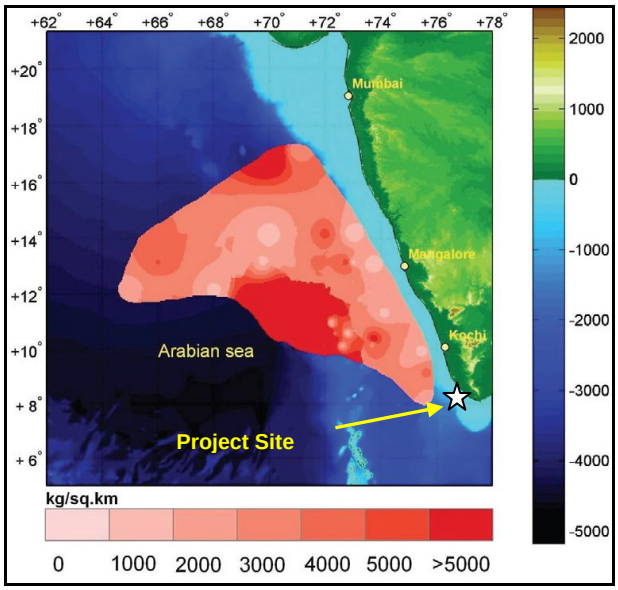


Figure 4-50: Location of Oceanic Squid Abundance

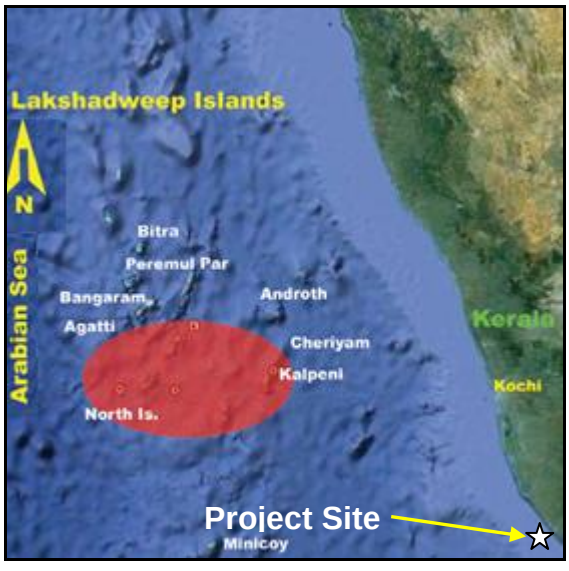


Figure 4-51: Spawning Ground for Oceanic Squids

The squid mentioned in the present report are not oceanic squids. (Gears which catch squids/cuttlefish and their area of operation is given in the section of fishing methods). Though the squid catch is landed in landing centres around the project area it is caught from a radius of 5-20 km

from the project area. Construction of the port is therefore not likely to have an effect on their landings. Hence, the proposed project will not have any impact on the spawning or abundance of the oceanic squid.

4.5.3.4 Sample Fishing

Sample fishing was performed during different seasons to collect the primary data on species availability in the Project coast. Sample fishing was conducted using gillnets[8], operated for 60 minutes. Fish collected via sampling methods were identified to the lowest possible taxon. The fish sampling details are given in **Appendix 4.4**.

Post-monsoon: A total of 32 species of fishes were recorded from the experimental fishing in three zones during post-monsoon period.

Direct Zone	• A total of 26 species of fishes were observed • A maximum catch was recorded during December (0.021MT) and a minimum during January (0.014 MT) • For a total number per catch a maximum was recorded during January (171 no) with a dominance of Sardinella fimbriata (56 nos.) and a minimum during November (84 nos.)
Potential Impact Zone	• A total of 25 species of fish were recorded; • A maximum catch during December (0.021 MT) and a minimum during January (0.007 MT) • For a total number per catch a maximum was recorded during December (173 no) and a minimum during January (60 nos.)
Control Zone	• A total of 22 species of fishes were recorded • A maximum catch was recorded during November (0.012 MT) and a minimum during December (0.006 MT) • For a total number per catch a maximum was recorded during January (158 no) and a minimum during December (47 nos.)

Pre-monsoon: A total of 40 species of fish were recorded from three zones during pre-monsoon period.

Direct Zone	• A total of 35 species of fishes were recorded • Maximum catch was recorded during February (0.021 MT) and a minimum during April (0.010 MT) • Total number per catch was maximum in May (628 nos.) with a dominance of Stoliphorus commersonnii (359 nos. nos.) and a minimum during February (336 nos.)
Potential Impact Zone	• A total of 23 species of fishes were recorded • Maximum catch was during May (0.016 MT) and minimum during February (0.007 MT) • Total number per catch was maximum during May (604 nos.) with a dominance of Sardinella longiceps (217 nos.) and minimum during March (299 nos.) with a dominance of Sardinella longiceps (198 nos.)
Control Zone	• A total of 29 species of fishes were recorded • Maximum catch was during May (0.021 MT) and minimum during April (0.006 MT) • Total number per catch was maximum during May (593 nos.) with a dominance of Sardinella longiceps (320 nos.) and a minimum during February (157 nos.) with a dominance of Leiognathus sp. (77 nos.)

Monsoon: A total of 28 species of fishes were recorded from the experimental fishing in three zones during monsoon period.

[8]Size 200 m x 3 m, monofilament nets with five panels of varying mesh sizes (20 mm to100 mm-in mesh).

Direct Zone	• A total of 26 species of fishes were observed; • Maximum catch was recorded during June (19.61 kg) and minimum during September (11.52 kg)
Potential Impact Zone	• A total of 27 species of fishes were recorded; • Maximum catch was during September (16.95 kg) and minimum during July (11.2 kg)
Control Zone	• A total of 28 species of fishes were recorded; • Maximum catch was during September (14.58 kg) and minimum during June (12.32 kg).

4.5.3.5 Fishing Method and Gears Used in the Project Stretch

Mainly two types of fishing methods, i.e., traditional and mechanised are practiced in the Project stretch by the local fishermen upto five nautical miles from shore.

Mechanised Fishing: The mechanised fishing in the study stretch can be further classified as Gill Netting, Hook and Line.

Gill Net: Mainly three types of gillnets are used by the local fishermen in different seasons depending on the catch they are targeting. The Details are given below:

Mackerel Gill Net (*Ayila Vala or Echam Vala*): Mainly this gear is used during day time for the tuna and mackerel fishing. The size of a typical Mackerel gill net varies from 100 to 120 m in length and 15 m. (approx.) in breadth with mesh size of 62 mm. Such a net has one head rope of 3.0 mm. thickness with small floats attached at every 3.5 m length and for every float a stone sinker of 150 g is attached. In addition to the small floats at every tenth float 5.0 litre empty oil can or large spherical shaped float is attached. About 30 spherical floats are used in each gill net.

It was observed that fishermen change the distance of floats according to their suitability depending on the visibility. For example, during May to September when the sea becomes turbid fishermen adjust the float line to about 3.0 m distance and during October to April as well as during full moon phase when sea is calm and visibility is more, float lines were used about 15 m interval and again in new moon phase in same period the float lines reduced to 7.0 to 8.0 m length.

The duration of netting varies depending on the availability of catch. Usually fishermen set for fishing around 3.00 PM and gear is operated till they get good catches, usually actual fishing takes place between 6.00 PM to 9.00 PM. When the fishing trip starts in the early morning at 4.30 - 5.00 AM, the fishermen return to the shore between 9.00 AM to 12.00 PM. The fishing is carried out up to five nautical miles (9.0 km) from shore.

Monofilament Gill Net *(Kangoose Vala)*: This gear is operated from a catamaran and mainly for catching mackerel. The float line is attached with 150 numbers of three inch floats arranged at an interval of about 2.0 m and small stone sinkers corresponding to each float that are tied to the foot rope of the gear. The end of the net is also tied with a float line of 45 m on which two floats (five litre volume empty plastic cans are usually used by the fishermen) or floats and on the foot rope end a four-five kilogram stone sinker is attached.

a) Sardine Gill Net (*Chala Vala / Mathivala*):

This net is operated both from boats and catamarans by two to three fishermen. A typical Sardine gill net will have a length of 100 to 150 m. with a width of eight to 10 m and mesh size of 30 mm. The float

line is 15 m in length made up of 3.0 mm (thickness) rope and the foot rope of 2.0 mm thickness. The float line is attached with small floats at every 3.0 m, and for every six floats, empty oil cans are used to keep the net afloat. In each net a total of 14 to 18 oil cans are used. For each float a 350 g stone sinker is attached in the foot rope**.** A typical Sardine Gill Net used in the project stretch is shown in **Exhibit 4-8**.



Exhibit 4-8: Sardine Gill Net

Generally sardine fishing operations take place in the early morning or evening. Generally it starts at 4.30-5.00 AM and extends up to 7.00 to 8.00 AM. Fishing was also observed during evening during 5.00 to 7.00 PM. May to August is the peak fishing season along the Vizhinjam coast.

b) Drift Gill Net (*Valiyavala/Ozhukkuvala/Store Vallam Vala):*

This net is usually used from a thirty two (32) footer boat for single day fishing into deep sea beyond five nautical miles (9.0 Km) up to 25 nautical miles (45.0 Km) offshore. Alternatively it can be done from a forty footer boat into the deep sea beyond 50 to 60 nautical miles with a man power of four fishermen for five to six days. During November to March fishing is conducted up to 50 to 60 nautical miles and during June to September fishing is carried out up to 5 to 25 nautical miles (9.0 km to 45.0Km).

This net is operated throughout the year here. The gear has 9.0 m breadth made with 100 mm sized mesh. 120 mm sized floats are attached on the 4.0 mm thick float line at a gap of 2.5 m. One five litre empty oil can is used as large floats after every 15 m small floats and these floats all remain tied with 1.5 to 2.0 m long rope. A one kg stone sinker is tied at both ends of the net.

The fishing area is from Kanyakumari to Varkala. Usually the voyage starts at 2.00 PM and the boats reach the fishing ground by 5.00 to 6.00 pm and after shooting the gear it is hauled after five hours. The fish caught with these gears are larger tuna, seer fish, sharks, rays, ribbon fish, etc.

c) Bottom Set Gill Net (Thathuvala)

This gear has 3.0 m breadth and is made up of 62 mm mesh size mono filaments. Float line is made of 3.0 mm thickness rope and every three meter a small float is attached. Two foot ropes of 1.5 mm thickness are used for attaching small lead sinkers (20 g) at 40 cm interval and the second rope is used for attaching the net.

This gear is operated up to three nautical miles from the shore and usually operates within 1.0 to 1.5 nautical miles from the shore. Three to eight fishermen will be involved in fishing from a boat. In this gear, the disentangling of the fish caught can be highly time consuming and labour intensive. This

gear operates from 5.00 to 9.00 AM. Catch includes flat fish, crabs, prawns, croakers, skate, rays and chanks.

d) Trammel Net *(Disco ValalKonchu Vala)*

This gear is made up of three layered netting with approximately 300 m length. The mesh size of the inner net is 48 to 50 mm and the outer two layers netting is of 100 to 120 mm. Head and foot ropes are of 2 mm thickness. The breadth of the gear is 2.0 m. The float line measures 30 m. At both end of the gear, three numbers of five litre empty oil cans were tied as floats. Besides, sinkers weighing 3.0 kg was also attached at the end of foot rope. At every 0.40 m of the foot rope a lead sinker of 50 g size, and also every three meter of a head rope a small float is attached. The gear is characterised with two head ropes and two foot ropes. A single trammel net unit requires 3.6 kg (3 pieces of 1.2 kg) netting. Trammel nets were operated from 6.00 AM to 7.00 PM. Usually four to seven fishermen go for this fishing in a single boat and gear is hauled at every 30 minutes.

The area of fishing is 12 km from the shore or at 23 m depth. Fishermen from Vizhinjam and nearby areas go up south up to Enayam and north up to Varkala. Fish caught by these gears include sole, croakers, prawns, crab, etc.

e) Roll Net

Bottom set gill nets also known as roll net of 300 m length (150-200 mesh size) were also used for catching lobsters using non-mechanised catamaran operated by two fishermen. Peak season along Vizhinjam coast is from August to October.

Hook and Line:

a) Hand line (Aachil)

This fishing device is characterised by a main line which is made up of nylon monofilament twines with a length ranging from 15 to 20 m with many branch lines. The branch lines are tied at an interval of 1.5 m distance along the main line and are attached with hooks at their distal end. At the end of the main line 0.5 kg iron sinker is attached. The 15 m long line is used during night time and a 7.0 m line are typically used during daytime.

The monofilament twines are categorised into numbers (40, 60, 80 etc.) based on their thickness. Similarly different types of hooks are also categorised into numbers. Hooks used during day fishing ranged from No. 8 to No. 13 and hook No. 15 is used for night fishing using light.

The hand lines are operated from 28 foot fibre glass coated plywood boat (FPB) fitted with 9.9 HP outboard engines (usually they go with two outboard engines). Three to four fishermen go for fishing and each of them operate a hand line. Fuel consumption is estimated at about 7.0 litres/hour and with an oil usage of 300 ml/10 litres of kerosene. For light fishing, four tube lights are used in a vessel; two on either side of the boat. Each tube light costs around ₹ 1,500 which also requires a storage battery costing ₹ 6500/-. The requirement of petrol is worked out as two to three l on a daily basis. Of late, Portable gaslight of 2.0 kg fuel capacity is also used for light fishing and the cost of the liquefied gas is ₹ 80/litre. About 1.0 kg of liquefied gas is required for 12 hours fishing with four gas lights for light fishing.

Apart from FPB boats, catamarans are also employed for the hand line operation. A catamaran is made by four pieces of 6.0 m long logs and is powered traditionally by a sail (cotton) kept upright using a bamboo pole as mast. Small outboard engines are also used. One to three fishermen go for hand line fishing in catamarans and operations are carried out throughout the year.

Fish caught by light fishing method were mainly Decapterus spp., mackerel, scads, lesser sardine and tuna. Fish caught during day was mainly tuna. Other fish like Decapterus spp., mackerel, lesser sardines, squids and cuttlefishes were also caught during day fishing.

b) Hand lines - Squid and Cuttlefish Jigs

One of the most important gears used for squid fishing along this coast is hand lines with jigs. These fishing gears are made up of size No. 80 monofilament twines (main line) having 28 m length with 1.0 m branch lines made of No.60 monofilament twines attached to it. Six to ten branch lines with jigs are tied at an interval of 1.0 to 1.5 m along the main line.

Motorised FPB boats fitted with outboard engines are the craft used for jigging with a man power of six to seven. Occasionally few numbers of catamarans are also employed for squid fishing. The fishing operation is carried out during day and night.

Most of the cuttlefish catches at Vizhinjam area are by hand lines. The peak season for operation of this gear is October to November. Fish Aggregating Devices (FAD) is extensively used for catching cuttlefish (Sepia pharaonis). The FAD is made by tying 8-10 coconut spadixes together using nylon rope. Each of this unit is attached to sand filled synthetic bag or stones for anchorage. Several units of FADS are placed within 15 to 30 m depths by the local fishermen. The FADs are located using GPS at regular intervals for catching cuttlefishes. Fishing is conducted in areas ranging from 5.0 to 15 km from the shore. FAD operations are concentrated along Poovar to Varkala. Fishing for Cuttlefish using FAD is carried out only during daytime.

Crabs are used as bait for catching cuttlefish. Nandu vala' (crab-entangling net) is a type of bottom set (gill) net of 500 m length and 3.0 m width used for capturing crabs. Series of floats and sinkers respectively are attached at 5.0 meter distance along the float line/head rope (2mm thickness) and on the foot rope of this gear. At both ends of the net, foot and head rope are tied together by 5.0 mm rope of 30 m length and a big float and sand filled sac as sinker are attached. About 15 to 20 pieces of squid or cuttlefish tentacles tied to the net as bait. The fishing for bait (crab) is conducted during 12.00 to 6.00 am. Approximately one to two baskets of crabs is usually caught with such gear.

A jig like device made of a long thin steel rod attached with four hooks is used for capturing cuttlefishes. The crab is tied at the middle of the rod as bait. Alternatively Spindle shaped lead weight covered using glittery ribbon with attached hooks can be used. Once the cuttlefish gets entangled in hook, the lines are lifted to collect the catch. Hand jigging is employed both day and night.

c) Long Line Fishing

Long line is made using thick monofilament nylon twine with a very long main line running up to a kilometre in length and with several branch lines with attached hooks. They are used to capture mostly predatory fishes.

i. Traditional tuna long line (*Choora Mattu/Ayiram choonda*)
ii. Long line for large scads (*Vathamatu*)
iii. Reef long line (*Paruamatu*)
iv. Shark long line (*Shravu Mattu*)

Traditional Fishing**:** It is estimated that there are about 50,000 traditional crafts under operation along the coast of Kerala. This includes Dugout Canoes, Plank Built Canoes, Marine Plywood Canoes, Catamaran and large Kettuvalloms. Out of these, more than 20,000 crafts are fitted with OBMs. The common types of gear used are gill nets, purse seines and shore seines. The operations of traditional crafts are confined within a range of 20 km off the coast. But some large Kettuvalloms, which are about 20 meter in length and fitted with two or three OBMs of 25 to 40 HP operate beyond

20 km. The non-motorised crafts are now being motorised with the assistance from financial institutions.

A total of about 2361 households' practice direct fishing from the sample surveyed; of those in more than 94% households up to two members are involved in this occupation. In these households 556 have family members indirectly involved in fishing. Most frequent month for fishing is December. Average pre-monsoon fish catch is 733 kg per month, in monsoon this is 628 kg per month, post-monsoon 465 kg per month and in other seasons catch is very low. In the other seasons the catch get meagre (on an average less than 10 kg) amount of fish. More than 85% mentioned that availability of fish is decreasing over the years; majority (54.3%) is of the opinion that there is a decreasing trend of number of people engaged in fishing.

About 41% use motorised rented vessels and mostly use up to two vessels. It was communicated that on an average 13 fishermen depend on one vessel. They travel about 12 km into the sea for fishing. More than 83% use sea beach as landing place in pre-monsoon period and about 76% in post-monsoon period. During monsoon about 64% use the fishing harbour as their landing place. During the low season the fishermen look for other work to supplement their income for instance by work in agriculture, auto rickshaw driving, construction related job, daily wage, coolie work. Alternatively they adjust their expenditure, or use money from savings, or borrow money from some source like banks, relatives, neighbours, etc.



Exhibit 4-9: Shoreline Fishing Net (Vizhinjam)



Exhibit 4-10: Shore Seine Fishing (Kovalam)



Exhibit 4-11: Shore Seine Fishing in Puthiathura



Exhibit 4-12: Fishing Near Kochuthura

Shore Seine Fishing: It is the traditional gear, which is used in the area. It is a bag net with long wings on either side. Long ropes are attached to both the wings to drag the net ashore. Usually 20 to 40 people operate the net. The shore sein fishing net is about 150 - 200 feet long and the rope is about 400 feet long. The entire fishing is being carried out within two (2.0) kilometres from the shore. The mussel /shoe crab fishing is directly in the foot print zone of the proposed port

Shore seine operation starts either after sighting a shoal in the near shore waters or it may be a blind operation. The net is operated from a boat; operation begins with handing over of the rope attached onone side to a group of fishermen and the boat with net proceeds to the sea and surrounds the shoal or the area and hands over the rope attached to the other end of the net to the second group. Then the net is pulled towards the shore from both the ends by the groups of fishermen pulling the net closer. As the net is pulled to the shore a few fishermen jumps into the sea to prevent the fish from escaping by keeping the foot and foot rope in position and scare the fish to prevent their escape..

The catch typically includes anchovies such as *Stolephorus indicus, S. andhraensis*, *Encrasicholina devisi;* silver bellies such as *Leiognathus bindus, L. brevirostris, L. leuciscus, Secutor insidiator,* carangids such as *Carangoides armatus, Caranx sexfasciatus, C. heberi, C. malabaricus, Alectis indica, Alepes djedaba, Decapterus russelli;* mackerel, *Rastrelliger kanagurta*; mullet *Liza macrolepis;* hair tail *Trichiurus lepturus*; parrot fish, *Chlorurus sordidus*; rabbit fish, *Siganus canaliculatus*, *Siganus javus*; snapper, *Lutjanus fulviflamma;* Spotted sickle fish, *Drepane punctata;* Pharaoh Cuttlefish*, Sepia pharaonis*; squids *Sepioteuthis lessoniana, Doryteuthis singhalensis,* etc.

The data on type of fishing gear used at different fish landing centres in the project area is given in **Table 4-22**.

Table 4-22: Fishermen Gear used in the Fish Landing centres

Month	Name of the Landing Centre	Gear	Motorised	Non Motorised	Shore Seine
October	Vizhinjam	Gillnet	5000	375	175
		Hooks & Line	2500	125	
	Poonthura	Gillnet	2500	750	125
	Poovar		1875	750	100
	Karimkulam		125	625	75
	Kochuthura		50	125	50
	Puthiathura		1750	1250	125
	Pallom		500	500	75
		Hooks & Line	75		
	Erayamanthura	Gillnet	375	625	100
	Chempakaramanthura		500	625	100
	Puthiathura II		625	750	50
	Adimalathura		175	1000	125
November	Vizhinjam		7000	500	150
		Hooks & Line	2000	125	
	Poonthura	Gillnet	2500	750	125
	Poovar		1750	750	100
	Karimkulam		250	750	75
	Kochuthura		50	125	50
	Puthiathura		1500	1250	125
	Pallom		500	500	75

Month	Name of the Landing Centre	Gear	Motorised	Non Motorised	Shore Seine
	Erayamanthura		500	625	100
	Chempakaramanthura		500	625	100
	Puthiathura II		625	750	50
	Adimalathura		300	1000	125
December	Vizhinjam		3750	250	125
		Hooks&Line	5000		
	Poonthura	Gillnet	2250	1000	125
	Poovar		1500	1250	100
		Hooks&Line	750		
	Karimkulam	Gillnet	250	500	75
	Kochuthura		50	50	25
	Puthiathura		2500	1000	100
	Pallom		500	500	75
	Erayamanthura		250	750	50
	Chempakaramanthura		375	750	75
	Puthiathura II		500	1000	75
	Adimalathura		250	750	125
January	Vizhinjam		4500	250	75
		Hooks & Line	3750	0	0
	Poonthura	Gillnet	2000	1000	125
	Poovar		1500	500	125
		Hooks & Line	750		
	Karimkulam	Gillnet	250	500	100
	Kochuthura		50	125	50
	Puthiathura		2000	625	100
	Pallom		625	500	50
	Erayamanthura		250	625	100
	Chempakaramanthura		375	625	75
	Puthiathura II		375	750	125
	Adimalathura		250	625	125

4.5.3.6 Secondary Data on Marine Ecology

The secondary data has been acquired for other species that might potentially be affected by the construction of the Port for completeness of the study.

Marine Biodiversity: Prominent research has been carried out on ornamental fish (aquarium fish) in Vizhinjam by the Department of Aquatic Biology & Fisheries, University of Kerala, Thiruvananthapuram and Central Marine Fisheries Research Institute, Vizhinjam. The list of ornamental species present in the Vizhinjam area is given in **Table 4-23**.

Shrimp: Rare landing of large quantity of shrimps and fin fishes in Vizhinjam was recorded during June 22-24 with peak landings on June 24, 2007. During that period a mud bank like phenomenon was observed (Anil et al 2008). The reason for the sudden upwelling of shrimps and fin fishes was not explored.

Table 4-23: Marine Ornamental Species in the Vizhinjam Bay Area

S. No.	Family	Species	Remarks
1	Plotosidae	*Plotosus lineatus*	Reef-associated[9], amphidromous
2	Antennariidae	*Antennarius nummifer*	Reef-associated
3	Holocentridae	*Myripristis murdjan* (Forsskal)	
4	Holocentridae	*Sargacentron rubrum*	
5	Serranidae	*Cephalopholis boenak* (Bloch)	Reef associated, Non-migratory
6	Serranidae	*Epinephelus diacanthus* (Valenciennes)	Demersal
7	Serranidae	*Epinephelus longispinis*	Reef-associated
8	Serranidae	*Epinephelus merra*	
9	Serranidae	*Epinephelus radiatus*	Demersal
10	Priacanthidae	*Priacanthus hamrur* (Forsskal)	Reef-associated
11	Apogonidae	*Apogon aureus*	
12	Apogonidae	*Apogon fasciatus*	
13	Apogonidae	*Apogon novemfasciatus*	
14	Apogonidae	*Archamia fucata* (Cantor)	
15	Carangidae	*Naucrates ductor*	
16	Carangidae	*Trachinotus baillonii*	
17	Lutjanidae	*Lutjanus decussatus*	
18	Lutjanidae	*Lutjanus fulviflamma* (Forsskal)	Reef associated, Brackish and Marine
19	Lutjanidae	*Lutjanus madras*	
20	Lutjanidae	*Lutjanus russellii* (Bleeker)	
21	Lutjanidae	*Lutjanus vitta*	
22	Pomacanthidae	*Centropyge multispinis*	Reef associated, Non-migratory
23	Pomacanthidae	*Pomacanthus semicirculatus Quoy & Gaimard*	
24	Pomacanthidae	*Pomacanthus imperator*	
25	Terapontidae	*Pelates quadrilineatus*	Brackish and Marine
26	Terapontidae	*Terapon jarbua* (Forsskal)	Eurihaline, Demersal, Catadromous
27	Terapontidae	*Terapon theraps*	Brackish and Marine
28	Terapontidae	*Terapon puta*	
29	Ambassidae	*Ambassis ambassis* (Laceped)	Eurihaline, Demersal, Oceanodromous
30	Pomacentridae	*Abudefduf saxatilis* (Linnaeus)	Reef associated, Non-migratory
31	Pomacentridae	*Abudefduf lacrymatus*	Reef associated, Non-migratory
32	Pomacentridae	*Chromis dasygenys*	
33	Pomacentridae	*Neopomacentrus filamentosus* (Macleay)	
34	Pomacentridae	*Neopomacentrus violascens* (Bleeker)	
35	Pomacentridae	*Neopomacentrus nemurus*	
36	Pomacentridae	*Pomacentrus caeruleus* (Quoy and Gaimard)	
37	Pomacentridae	*Stegastes nigricans* (Lacepede)	
38	Labridae	*Cheilinus chlorurus* (Bloch)	Reef-associated
39	Labridae	*Halichoeres hortulanus* (Lacepede)	
40	Labridae	*Hemigymnus fasciatus*	
41	Labridae	*Labroides dimidiatus*	Reef-associated, non-migratory
42	Labridae	*Thalassoma lunare* (Linnaeus)	Reef associated
43	Labridae	*Xyrichthys bimaculatus Ruppell*	Demersal
44	Scaridae	*Scarus ghobban* (Forsskal)	Reef associated, Brackish and

[9]Usually found associated with the coral reefs. In Vizhinjam Bay area these species are found along with the hard corals and rocky pools present at the marine bed.

S. No.	Family	Species	Remarks
			Marine
45	Uranoscopidae	*Uranoscopus guttatus cuvier*	Demersal
46	Blenniidae	*Petroscirtes mitratus*	Reef-associated
47	Siganidae	*Siganus canaliculatus*	
48	Siganidae	*Siganus javus* (Linnaeus)	Reef associated, Oceanodromous
49	Siganidae	*Siganus sutor* (Valenciennes)	Reef associated, Brackish and Marine
50	Zanclidae	*Zanclus cornutus* (Linnaeus)	Reef associated
51	Acanthuridae	*Acanthurus dussumieri valenciennes*	
52	Acanthuridae	*Acanthurus lineatus* (Linnaeus)	
53	Acanthuridae	*Acanthurus nigrofuscus* (Forssksl)	
54	Haemulidae	*Plectorhinchus gibbosus*	Reef-associated, freshwater, brackish,marine
55	Haemulidae	*Pomadasys maculatum Bloch*	Reef-associated, amphidromous
56	Mullidae	*Mulloides flavolineatus*	Reef-associated
57	Mullidae	*Parupeneus indicus*	Reef-associated, brackish, marine
58	Drepanidae	*Drepane punctata*	
59	Chaetodontidae	*Chaetodon auriga Forsskal*	Reef associated, Non-migratory
60	Chaetodontidae	*Chaetodon collare Bloch*	Reef associated
61	Chaetodontidae	*Chaetodon decussatus cuvier*	
62	Chaetodontidae	*Chaetodon vagabundus*	
63	Chaetodontidae	*Heniochus acuminatus* (Linnaeus)	Reef associated, Brackish and Marine
64	Chaetodontidae	*Heniochus singularius*	
65	Baslistidae	*Odonus niger* (Ruppell)	Reef associated, Oceanodromous
66	Baslistidae	*Pseudobalistes flavimarginatus* (Ruppell)	Reef associated
67	Baslistidae	*Sufflamen fraenatus* (Latreille)	Reef associated, Oceanodromous
68	Monacanthidae	*Cantherhines pardalis*	Reef associated
69	Tetradontidae	*Arothron aerostaticus*	Reef associated, Brackish and Marine
70	Tetradontidae	*Arothron hispidus* (Linnaeus)	
71	Tetradontidae	*Arothron immaculatus* (Bloch & Schneider)	
72	Tetradontidae	*Lagocephalus inermis Temminck & Shlegal*	Reef associated
73	Diodontidae	*Diodon hystrix Linnaeus*	

(**Source: Department of Aquatic Biology &Fisheries, University of Kerala, Thiruvananthapuram)**

Corals: The presence of patchy growth of hard corals in the Vizhinjam bay area have also been reported (Jasmine et al 2009). The corals were mainly found on the concrete and granite surfaces. But the coral growth in the Vizhinjam area has been reported to be poor and sparse. Nine species of hard corals were recorded from this area, the genus *Pocillopora* being dominant with five species. Considering relative abundance *Pocillopra verrucosa* and *P. meandrina* were categorised under 'Dominant' species; *P. damicornis* as 'Abundant', *P. woodjonesi*, *Montipora aequituberculata*, *M. millepora* and *M. verrilli* as 'Common' and *P. eydouxi* and *Porites lutea* as 'Uncommon' (Jasmine et al 2009).

Wadge Bank: A wadge bank is a fertile fishing ground in the vast ocean/sea.It is rich in biodiversity[10] similar to a Biodiversity Hotspots in a terrestrial environment. The water depth in a wadge bank area is usually limited and the current is low. Usually there is limited wave action. A wadge bank area is rich in nutrients and fish food, and consequently has a congregation of varieties of fish and other aquatic organisms in large quantities compared to other fishing grounds. It is also a favourable spawning and breeding ground for fish and other marine animals.

Throughout the world there are about 20 wadge banks, out of which, one is situated in the south west direction from the coastline of Kanyakumari District, India. This is about 40 km away (South Western side) from the project site. **Figure 4-52** shows the location of wadge bank near to the Indian coast. It lies between latitudes 7°10' N and 8°00' N and longitudes 76°40' E and 78°00' E[11] (Source: Exchange of Letters Constituting an Agreement between the GoI and the Government of Sri Lanka on the Wadge Bank Fisheries, March 23, 1976).

The depth of this area varies from 50 to 200 m. The proposed port of Vizhinjam is primarily a transhipment port (Phase-I > 80% of container throughput is transhipment). This means that traffic in the area is mainly rerouted to the port other than generated by the port. The additional traffic of the port of Vizhinjam is in relation to the existing traffic on the International route is marginal. Most important part of the study is that international shipping route crosses the wadge bank south of Vizhinjam.

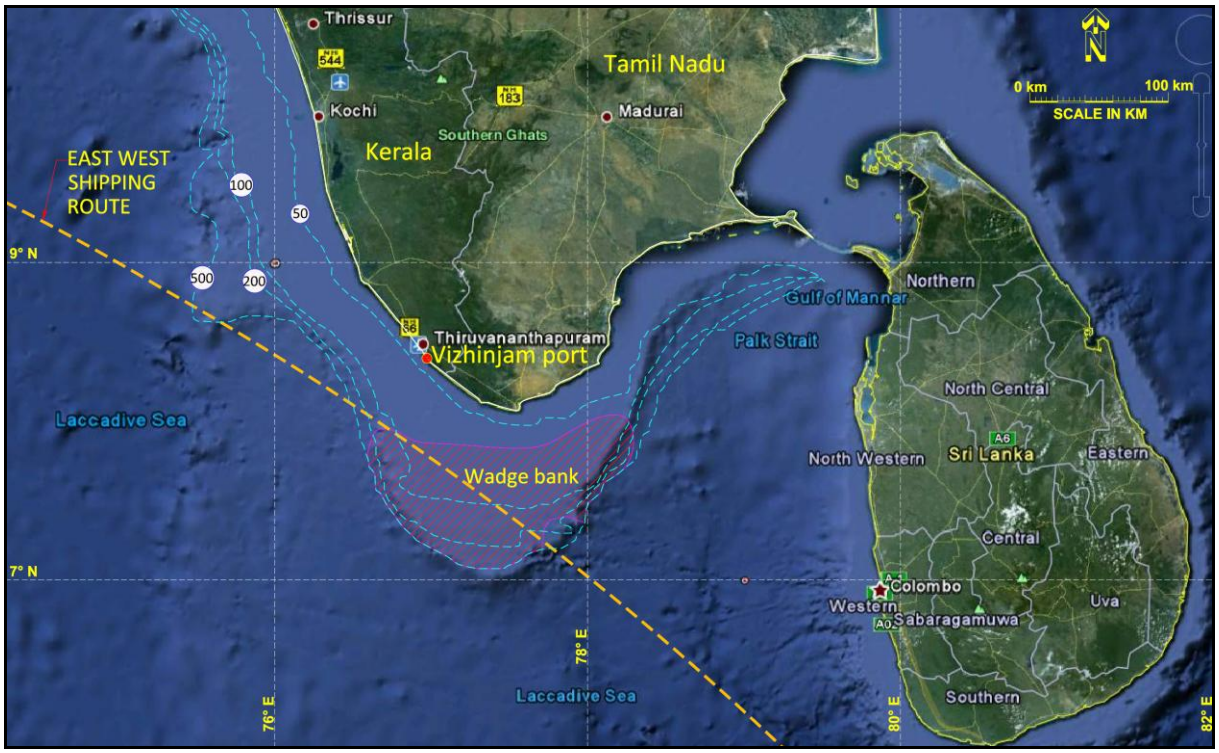


Figure 4-52: Location of Wadge Bank with respect to Project site

[10]Its fish diversity includes: *Lethrinus nebulosus, L. mahsenoides, Lethrinella minlata, Spilotichthys pictus*, *Epinephelus undulosus*, *Pristipomoides typus*, *Lutianus sanguineus*, *L. utjanus*, *Gnathanodon speciosus*, *Caranx chrysophrys*, *C. malabaricus*, *Caranx carangus*, *Tachysurus thalassinus*, *Carcharhlnns sorrah*, *C. macloti*.

[11]Source: Exchange of Letters Constituting an Agreement between the GOI and the Government of Sri Lanka on the Wadge Bank Fisheries, 23rd March1976.

4.5.3.7 Rare Sighting of Endangered and Other Marine Species

In addition to the marine species described above there had been reported rare sightings of other marine species. Leatherback turtles, Olive ridley turtles, Risso dolphins, Devil rays, Green turtles, and Hawksbill turtles were accidentally caught in the nets (usually gill nets/seines) during fishing (Thiagarajan and Pillai 2000, Pillai et al 2003, Kannan and Rajagopalan, 2007). Presence of nesting grounds for olive ridley turtles have been reported in the beach near Mulloor fishing village, which is currently also being used for fishing activity. A collection of 18 hatchlings was made on December 22, 1994 (CMFRI, 1997).

However, during field survey interviews, social surveys and review of other secondary data, no nesting could be confirmed. Only a rare sighting of such marine animals, have been reported. The proposed Project stretch is not a nesting ground for turtles or any protected species. There is also limited data available on these turtles. CMFRI is actively monitoring the Marine environment in this area, and has the largest historical database. They could not confirm nesting of the turtles on these beaches currently or in the past.

4.5.3.8 Vizhinjam Fishing Harbour

Vizhinjam fishing harbour is one of the nine fishing harbours existing in the Coast of Kerala. There are 12 fishing harbours which are under construction. Fishing harbour at Vizhinjam is one of the natural harbours, has a total basin of 16.4 Ha with manmade infrastructure, located at the northern side of the project site (distance of approximately 300 m) falls within the port's influence area (**Figure 4-53**). The harbour consists of a main breakwater of 405 m length, a leeward breakwater of 270 m length and quay walls of 545 m length. The depth of the current fishing harbour entrance is 10 m and the anticipated annual fish production is about 22,000 tonnes. Two general cargo berths are located at the Leeward breakwater where small ships are landing their cargo. The fish catch in Vizhinjam provided in **Table 4-24** include prawns, crabs, lobster, squids, cuttlefish, etc.

Table 4-24: Fish Catch in Tonnes in Vizhinjam Fishing Harbour

S. No.	YEAR	Fish	Mussel
1	2006	21905.68	273.031
2	2007	22233.51	421.892
3	2008	23641.01	489.814
4	2009	25904.89	491.692
5	2010	16236.89	989.155

The northern part of Vizhinjam has a natural deep bay, whereas the southern side is dominated by rocky outcrops. This harbour is connected with NH-47 (almost 8.0 km away from the harbour) through Vizhinjam – Poovar road. Owing to its location which affords facilities for putting the boats out to the sea even in the monsoon season, as well as due to good marketing outlets at nearby places such as Balaramapuram, Thiruvananthapuram and adjacent towns, fishing activity takes place in the Vizhinjam area all throughout the year. Vizhinjam fishing harbour is the brain child of a Swedish fishing harbour expert Mr. Carl. R. Bjuke, and was conceived in the year 1960. The Project was envisaged to be constructed in three phases. The first phase was sanctioned in 1968 by the GoI vide Ltr. No.25/9/67 Fy(H) dated 22/01/68 with a funding of INR 17.3 Million (₹ 173 Lakhs). The first phase was completed in 1974, which included construction of breakwater (305 m), service jetty (60 m length), buildings, quarters, water supply, drainage system, and other ancillary utilities. For the second and third phases,

a fund of the amount of INR 28.0 Millions (₹ 280 lakhs) and INR 25.92 Millions (₹ 259.20 lakhs) was sanctioned respectively, by the GoI in 1977 and 1983. In the second phase, 40 Ha of land were acquired and the main breakwater was extended further by 100 m. A leeward breakwater was also constructed.

In the final phase of the development, dredging, construction of quay wall, auction hall, repair facility, road, administrative office, gate, information centre, toilet, sewage system, drainage system, fencing, radio communication and navigational aids were to be established. In 1985, Vizhinjam fishing harbour underwent a phenomenal change due to the advancement in the fisheries department. To upgrade the existing fishing harbour, an amount of INR 70.4 Million (₹ 704 lakhs) was sanctioned by GoI. The Project proposal was again revised a few times and the budget was finalised in 1995 as INR 158.5 Millions (₹ 1585 lakhs).

Fishing Activities: In general, most of the fisherman from Vizhinjam cross the International shipping route every day to reach out to fishing areas. The fishing ground is mostly beyond 5.0 nautical miles up to 50 nautical miles except for two months during monsoon they fish very close to the shore line mostly within five nautical miles. Vizhinjam fishing harbour is dominated by outboard plywood boats, which are operating in and the near shore areas. There are about 800 plywood boats at Vizhinjam with outboard Yamaha engine operating either with gillnet or hooks and line and this number exceeds 2000 during the monsoon period (peak season). The other major gears operating at Vizhinjam are shore seine and non-mechanised Catamaran with gill nets or hooks and line. The shore seine fishing net is about 150 - 200 feet long and the rope is about 400 feet long. The entire fishing is being carried out within two kilometres from the shore. The mussel /lobster fishing are directly in the foot print zone of the proposed port.

The boats have a varied power capacity like 2.5 HP, 9.9 HP and 40 HP. In the fishing harbour, nearly 20,000 people are involved in the fishing and fishery related activity. The fish landed in nearby beaches like Samudra and Kovalam are also sold in this fishing harbour. The duration of netting varies depending on the availability of catch. Usually fishermen set for fishing around 3.0 pm and gear is operated till they get good catches. However actual fishing takes place between 6.00 pm to 9 pm. When the fishing trip starts in the early morning at 4.30-5.00 am, the fishermen return to the shore between 9 am to 12 am. Except the shore seine fishing, muscle collection most of the fishing from Vizhinjam port is carried out beyond five nautical miles from shore and the fishermen is stated to very often cross the international shipping routes (Middle East-Far East Route and International Suez-Far East Trade Route) located at 18 km. The daily traffic along these two routes is about 90 ships out of which 30 are container ships. The region is densely populated predominantly by fishermen communities. On either side of harbour, are the main fishing communities. The average family size in Vizhinjam north and south villages' ranges from 4.5 to 5.5 and no. of household exist was 4086. The main occupation i.e. 90% of the population in the Vizhinjam village is fishing or fishery related activity. The women participation in fish marketing is a noticeable feature of Vizhinjam. The harbour has generated direct employment for 5,640 persons (Harbour Engineering Department, 2012). The detailed layout plan of the Fishing harbour is given in **Figure 4-53**.

Infrastructural Facilities at Vizhinjam harbour

The activities and infrastructural facilities of the fishing harbour are:

Fish landing centre: The fish landing centre is located at the southern side of the harbour. It is connected with an Auction hall, locker room, gear shed (repair area) and toilets. **I**n the peak season (monsoon), around 590 fishing boats land their fish catch in this centre which includes 536 motorised

boats, 33 mechanised and 21 non-motorised boats. During this season, fishermen from the south (Colachel) also use this harbour for fish landing as other low lying dry areas will be flooded.

Health safety hygiene and Fisheries export: A very poorly maintained fishing harbour is not good for export of fisheries products especially to countries like USA and EU countries. Fish processing from catch to delivery was done on shore, due to absence of proper fish landing centre at the harbour. Though facilities like auction hall, gear shed, toilets, markets and workshops exist, **due to lack of maintenance these facilities** are misused by fishermen's. In addition to the proximity of the polluted Gangayar stream, open defecation and overall dirty picture is a major issue of this fishing harbour. The baseline condition with respect to different environmental components like air, noise, water, land and the biological environment has been discussed earlier in this chapter.

Bathymetry of the Fishing Harbour: The bathymetric data for the year March 1972, May 1984, March 1988, March 1991, April 1992, March 1993, April 1995, April 1997, February 2001, October 2006 and January 2011 were analysed and compiled by LTR (Modelling Report, LTR, 2012). These profiles were analysed considering the seasonal variation in accordance to the seasons from December to April and May to August. It was observed that generally the adjacent beaches became steeper during post-monsoon which indicate cross shore sediment transport. It was observed that there was seasonal variation in the pattern at the entrance. The sea-bed level has deepened towards the west and south breakwaters. In general, the bathymetry of the area remains stable even with the presence of breakwaters and rocky outcrops. The bathymetry inside the fishing harbour changes during the monsoon season, whereas no change is observed during fair-weather season. The bathymetry of the fishing harbour was smoother before the construction of the fishing harbour. The area near the southern breakwater within the fishing harbour appears to have become shallower over the years. **Exhibit 4-13** and **Exhibit 4-14** shows the bathymetric maps of the years 1985 and 2011 of the Vizhinjam fishing harbour.



Exhibit 4-13: Bathymetry of Fishing harbour during 1985

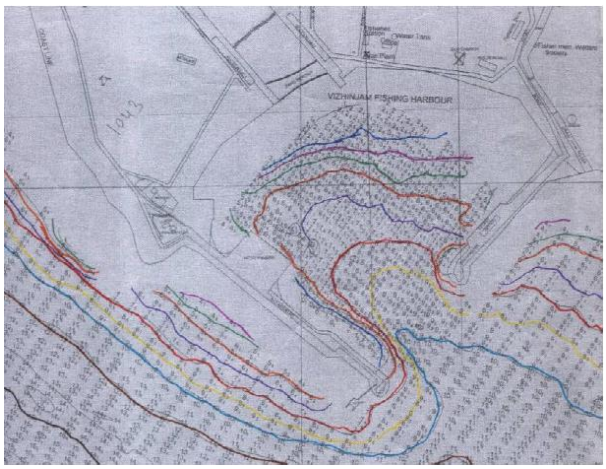


Exhibit 4-14: Bathymetry of fishing harbour during 2011

1. **Dredging and Disposal:** 60,000 – 70,000 m^3 of sand has been excavated manually only on the land portion of the harbour area. Out of which about 20,000 m^3 was dredged about a year ago. The dredged sand is stored in the designated back yard and from there it is auctioned as sand is of high demand in the region. To provide safe berthing for cargo ships dredging was carried out in the basin inside the breakwaters in 2007 to restore its original depth of 5.5 m. The silt and accumulation of the waste dumped by fishing boats has reduced the depth by 1.0 m. The basin was dredged along a channel of 100 m long and 50 m wide near the wharf for ships to berth

safely. A trailer suction dredger (TSD Sindhuraj) belonging to the Kerala State Maritime Development Corporation was used to dredge out 5,000 m^3 of sand (The Hindu, 2007). No other data is available on dredging of the fishing Harbour as there is no regular need of dredging.

2. **Water Supply:** Taps are provided in the fishing harbour area for the supply of water sourced from Vellayani Lake.
3. **Auction Hall:** There are two auction halls of 100 × 10 m dimension, from where the fish catch is sold. The dredged sand, which is stored in the back yard, is also auctioned in this hall. However presently, these auctions halls are misused by fishermen for net mending purpose.
4. **Shore Protection Work:** The shore of the harbour area and the breakwater are protected with bunds, from sea currents. **Exhibit 4-18** shows the bunds mounted to protect the shore in the harbour area.
5. **Ice Plants:** There are privately owned ice plants for the supply of ice to store the fish catch.
6. **Transit Shed:** This shed is under construction and is being built for unloading the cargo from the ships anchoring in the Cargo wharf located at the Leeward breakwater.
7. **Archaeological monument:** The Vizhinjam cave temple a centrally listed archaeological monument is located about 100 m away from the project.



Exhibit 4-15: Aerial View of Existing of Fishing Harbour



Exhibit 4-16: Entry into Fishing Harbour and View of Two Breakwaters



Exhibit 4-17: Roadway along the top of the Breakwater



Exhibit 4-18: Protective Shores with fencing and rock boulders (bunds) of Existing Fishing Harbour

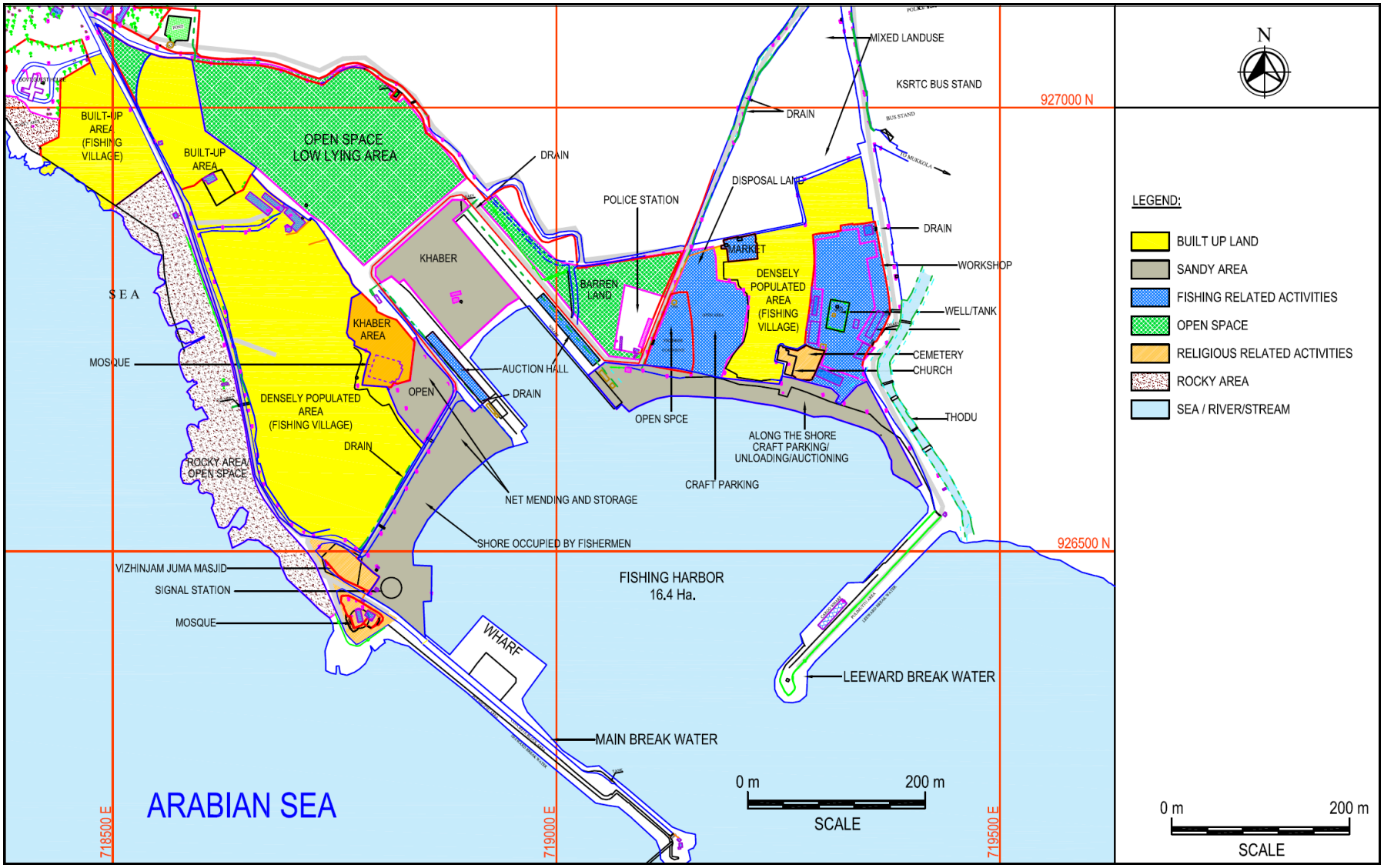


Figure 4-53: Existing Land Use of Fishing Harbour

4.6 Biological Environment

A detailed study on flora and fauna had been carried out at various locations within the study area. Study methodology and status of flora and fauna in the study area have been discussed.

Methodology: Flora and fauna studies were conducted to assess the list of plant and animal species and their habitat in and around the Vizhinjam port project site. Methodology adopted for carrying out flora and fauna study is provided. Flora and fauna studies were carried out to assess the list of terrestrial plant and animal species that occur/presence in the core study area and the general study area.

Flora: A total of *Twenty Seven (27)* sampling locations, out of which, three are from core area and Twenty Four (24) from general study areas were chosen using restricted randomization technique. The sampling locations are shown in **Figure FD0404**. The methodology for study of flora consists:

- Determination of frequency and density of the herbaceous species (Quadrant and line intercept method).
- A nested quadrant of 1.0 m x 1.0 m subdivided in to 0.1 m x 0.1 m was normally used.
- Herbs were sampled along with the shrubs using a quadrant of 10 m x 10 m.
- Similarly, for sampling of trees, a quadrant of 100 m x 10 m was selected.
- Density was calculated as the **number of individuals per square meter** in case of herbaceous plants and as **number per hectare** in case of trees and tree like plants.
- Determination of plant covers in case of both the herbaceous species as well as the trees including shrubs.
- Modified line intercept method was adopted.
- Calculation of Important Value Indices (IVI) of different species
- Based on the IVI values, Shannon – Wiener Indices of Diversity, Simpson Index of dominance and Jaccard index of Evenness were calculated.

Fauna: Methodology for study of fauna consisted of detailing taxonomic accounts based on visual observation, circumstantial evidence based on foot prints, feathers, skin, hair, hooves etc. and the habitat features, reports from locals especially the locals, and published literature including the reports, records and working plans of the forest department.

Modified line intercept method was used for calculation of percent cover of each species. The canopy cover of each species that intercepted or over laid or under laid along a line transect of 100 m was determined based on the total distance intercepted. The average canopy cover was calculated as the percent cover based on five transects of 100 m each. Sampling locations with GPS Co-ordinates are given in **Table 4-25**.

Table 4-25: Sampling Locations with GPS Co-ordinates

S. No.	Latitude	Longitude	S. No.	Latitude	Longitude
1	8°22'28.01"N	77° 0'10.78"E	15	8°25'29.30"N	76°58'51.89"E
2	8°23'34.68"N	77° 0'7.36"E	16	8°25'38.35"N	76°57'31.72"E
3	8°23'55.67"N	77° 0'26.16"E	17	8°25'57.25"N	76°57'12.41"E
4	8°21'53.06"N	77° 0'31.58"E	18	8°26'19.46"N	76°57'18.56"E
5	8°23'35.73"N	77° 0'56.72"E	19	8°26'44.83"N	76°59'12.87"E
6	8°24'34.69"N	77° 0'52.30"E	20	8°27'15.27"N	76°59'58.50"E
7	8°24'22.78"N	77° 1'56.27"E	21	8°20'59.25"N	77° 1'53.40"E
8	8°25'13.49"N	77° 1'22.21"E	22	8°22'5.27"N	77° 2'55.29"E

S. No.	Latitude	Longitude	S. No.	Latitude	Longitude
9	8°25'32.28"N	77° 2'9.84"E	23	8°22'39.19"N	77° 3'29.01"E
10	8°25'12.58"N	77° 2'44.77"E	24	8°24'23.56"N	77° 3'46.18"E
11	8°25'55.28"N	77° 2'40.24"E	25	8°20'28.70"N	77° 3'50.68"E
12	8°26'46.09"N	77° 2'21.50"E	26	8°19'24.26"N	77° 4'13.64"E
13	8°24'27.24"N	76°59'43.90"E	27	8°22'52.90"N	77° 0'40.20"E
14	8°23'43.81"N	76°58'28.33"E			

4.6.1 Status of Flora and Vegetation

Core Study Area: The core study area consists of the stretch from Vizhinjam to Nemom. A comparative list of terrestrial species collected from the core and general study areas is given in **Appendix 4.5**. A list of plants cultivated or grown in the core and general study areas is given in **Appendix 4.5.** Similarly, a list of medicinal plants of the area is given in **Appendix 4.5**. Most of the plants listed in **Appendix 4.5** are common to the core and general study areas. The relative frequency, relative density, relative dominance and the IVI values of the structural species encountered in the quadrats are given in **Appendix 4.5**. Shannon – Wiener Index of diversity of 2.125, Simpson's Index of dominance of 0.829 and Pielou's evenness index of 0.212 (**Appendix 4.5**) reveal that the diversity and evenness were low while dominance was higher. This is mainly because of the fact that the whole area was under the cultivation of Coconut. None of the (species) present in the core area come under any of the threatened categories. It may be noted from **Appendix 4.5** that Coconut alone has accounted for more than 50% of the total IVI of 300 in the core area.

General Study Area: The general study areas are encompassed by different types of ecosystems such as the marine ecosystem of Arabian Sea towards the western side, the coastal narrow sandy beaches, and stagnant ponds of fresh water, back water streams and also the distribution channels of an irrigation canal. Unlike other town and cities in India, houses and shops are scattered all along the road sides. Annual croplands are small in area and they are highly scattered. Only Coconut, Rubber, banana, *Acacia auriculiformis* could be found in large size plots.

The flora of the general study area was more or less similar to that of the core area. A comparative list of terrestrial part species collected from the core and general study areas is given in **Appendix 4.5**. A list of plants cultivated or grown in the core and general study areas is given in **Appendix 4.5**. Similarly, a list of medicinal plants of the area is given in **Appendix 4.5**. The differences between the core and general study areas are very slight and negligible. **There are no Reserve Forests (RF) or Biosphere Reserves or National Parks or wildlife sanctuaries or other protected areas within a radius of 10 km from the boundary of the general study area of Vizhinjam port**.

The relative frequency, relative density, relative dominance and the IVI values of the structural species encountered in the quadrats are given in **Appendix 4.5**. Shannon – Wiener Index of diversity of 2.175, Simpson's Index of dominance of 0.812 and Pielou's evenness index of 0.221 (**Appendix 4.5**) reveal that the diversity and evenness were low while dominance was higher. This is mainly because of the fact that the whole area was under the cultivation of Coconut. None of the structural species present in the core area come under any of the threatened categories. It may be noted from **Appendix 4.5** that Coconut alone has accounted for over 50% of the total IVI of 298.8. Sample Vegetation of the Core and General Study Area are presented in **Exhibit 4-19** to **Exhibit 4-24**.



Exhibit 4-19: Vegetation Near Mulloor Junction Point



Exhibit 4-20: Coastal Vegetation near Panavila



Exhibit 4-21: Water Lilly Pads at Mulloor Pond



Exhibit 4-22: Ipomea Flower at Tiruvallam coast



Exhibit 4-23: Vegetation along Poovar backwaters



Exhibit 4-24: Vegetation at Tanivila

4.6.2 Aquatic/Semi Aquatic Flora

The land use and land cover of the core area reveals the presence of perennial back water bodies, seasonal streams, ponds and the Arabian Sea. As such there are suitable habitats for aquatic flora and fauna. The Puvar East canal is the main source of assured irrigation for the study area as per the information collected from the local people.

The common hydrophytes found in the water bodies of the study area are classified as submerged and emerged types and they are further classified as free-swimming (phytoplanktons) and floating types. Some of the common wetland flowering plants are *Eichhonia crassipes, Pistia stratiotes, Monochoria vaginalis, Monochoria hastata, Limnocharis flava, Lagenandra meeboldii, Lagenandra toxicaria, Colocasia esculenta, Nelumbo nucifera, Nymphaea nauchali, Blyxa allbertii, Blyxa octandra, Hydrilla verticillata, Hygrophila auriculata, Xyris indica, Limnophylla chinensis, Limnophylla indica, Pandanus fascicularis* and *Pandanus thwaitesii.* A list of aquatic and semi aquatic plants found in the general study area is given in **Appendix 4.5**. Most species are common to both the core and general study areas. Some of the species are found along the coast on sandy beaches Beach bean *(Canavalia maritima*) was seen growing in areas which get submerged during high tides. It may however be mentioned that there are no threatened species among the aquatic flora of the area.

Though there are rivers, streams and back waters all along the west coast in the study area, there are no real mangrove forests or mangroves either in the core area or in the general study area. But there are species that grow in swamps and marshy areas as shown in **Appendix 4.5**. *Cerbera odollam,* commonly known as suicide tree or sea mango with mango like but poisonous fruits, *Barringtonia acutangula* with drooping inflorescences, *Clerodendron inerme*, Screw pine (*Pandanus fascicularis)*, jungle rice (*Porteresia coarctata) and climbers like Derris scandens, Dalbergia spinosa, Dalbergia trifoliata* and species of Cyperaceae are quite common in some areas.

4.6.3 Mangrove and other Coastal Flora

None of the known species of mangrove are observed in the entire study area. However, mangrove associates are observed in Poovar region. As described under the environmental setting of the core and general study areas, the area as a whole is uniform with monocultures of coconut plantations is spite of topographic variations. There are different types of ecosystems such stagnant ponds of fresh water, back water streams and also the distribution channels of an irrigation canal. Further the whole area is colonized by scattered human habitations.

4.6.4 Status of Faunal Diversity

Faunal diversity and species inventory of rare and elusive species was based on the following:

- Direct observations during field visits.
- Circumstantial evidence based on dead animal bodies or remains, foot prints, excreta, droppings, feathers, nests and other habitat features.
- Based on the reports from locals engaged in fishing and herbal medicine.
- Published literature including the reports, records and working plans of the forest department.

Except the sedentary animals and small invertebrates such as soil Arthropods, Snails, Annelids etc others may freely move from place to place. As such, the same organism may be present in the core area or general study area during different times. Hence common lists are prepared for the fauna of both the core and general study areas. Special efforts have been made to trace and find whatever wild animals were present in the core area and the general study area. As the chances of migrations

between the core and the surrounding general study area are high, a common list of Mammals, birds & reptiles either noticed or reported from the area up to 10 km radius is given in **Appendix 4.5**. Since the general study area and the core area extend up to the Sea, some the coastal and marine birds could be noticed. As such the avian diversity of the study area is good.

A list of Reptiles either spotted or reported from the study area is given in **Appendix 4.5**. A perusal of the list reveals a very high degree of endemism but the species are not endemic to the area under any IUCN consideration. Seven species of lizards have been recorded from the study area. Lizards include two species of Geckos, two species of Agamids, one species of Skink, a flying lizard and one species of Monitor Lizard. In general, lizards seldom attract the attention of people. No authentic study on the status of lizards in the study area exists.

A list of Amphibians either spotted or reported from the study area is given in **Appendix 4.5**. The list reveals that here are no threatened species in the study area.

A list of Butterflies observed in/reported from the study area is given in **Appendix 4.5**. There are no threatened species among the butterflies.

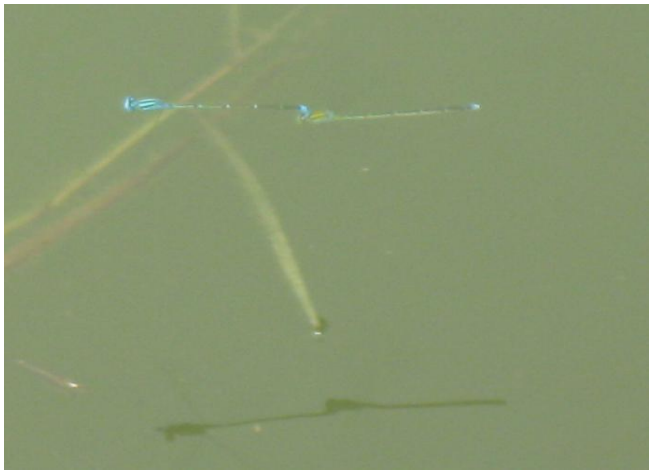


Exhibit 4-25: Damselflies at Vellayani Kayal



Exhibit 4-26: Dragonfly at Vellayani Kayal



Exhibit 4-27: Cormorant Observed at Tiruvallam



Exhibit 4-28: Brahminy Kite near Tiruvallam coast

4.6.5 Eco Sensitive Areas

No eco sensitive zones like a National Park, Wildlife Sanctuary, or Wetlands[12] are present within a 10 km radial area of the proposed Vizhinzam port. The nearest eco sensitive area is the Neyyar Wild Life Sanctuary, which is located at more than 20 km from the project site. The list of other eco-sensitive areas in Kerala and its distance as well as direction from the project site is given in **Table 4-26** and is shown in **Figure 4-54**.

Table 4-26: List of Eco Sensitive Areas in Kerala and their distance to the Project Site

National Park and Wildlife Sanctuary	Distance from Project Location (km)[13]	Direction
Neyyar	25.00	South-East
Peppara	34.83	North-East

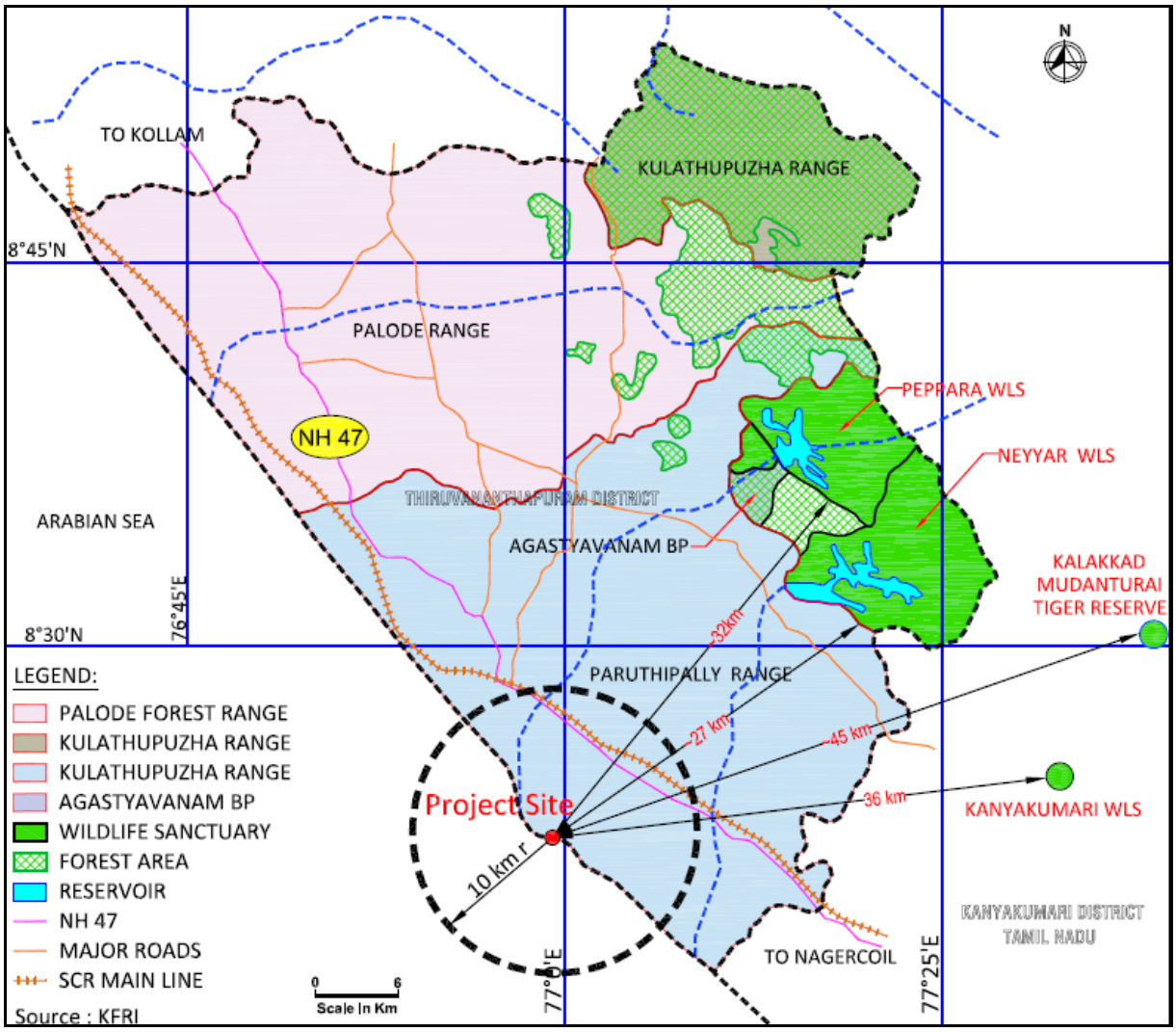


Figure 4-54: Eco-Sensitive Areas in PIA District

[12] Paddy fields are excluded from wetlands in draft MoEF wetland notification
[13] Aerial distance

4.7 Air Environment

4.7.1 Climate and Meteorology

The climate of Kerala is mainly governed by the Arabian Sea and the Western Ghats (range of mountain spread over the Western side of India), which acts as a shield and protects the State from the dry winds blowing North to South. Also, the Ghats play a significant role in the onset of the monsoon. Presence of the sea also plays a significant role in the diurnal variation of climatic condition. The landward sea breeze in the evening keeps the temperature at a pleasant range. The seasons of Kerala are generally divided into Winter, Summer, South-West Monsoon and North-East Monsoon. The meteorological data of Thiruvananthapuram for the year 2011 is given in **Table 4-27**.

Table 4-27: Meteorological Data of Thiruvananthapuram for the Year 2011

Month	Mean Temp. (°C)	Max. Temp. (°C)	Min. Temp. (°C)	Relative Humidity (%)	Mean Wind Speed (km/h)
Jan	27.6	30.0	24.6	72.5	4.8
Feb	28.1	30.7	25.1	66.4	6.3
Mar	28.7	31.2	25.2	69.8	7.4
Apr	28.6	30.9	25.7	74.3	7.2
May	29.4	31.4	26.9	73.7	10
Jun	28.5	30.6	25.9	78.7	10.6
Jul	27.0	29.4	24.9	79.8	11.7
Aug	26.7	29.5	24.7	81.7	10.8
Sep	27.0	29.7	24.6	81.2	10
Oct	27.9	30.8	25.1	77.1	6.3
Nov	27.3	30.8	24.2	76.0	3.5
Dec	27.5	30.7	24.2	71.8	3.6

(Source: IMD, Pune)

The seasonal variation in the meteorological data is discussed below:

Winter (Mid November to mid February): This season has a maximum temperature of 30.8°C and minimum temperature of 24.2°C. Winter season witnesses the lowest rainfall (28 mm). Accordingly, the relative humidity varies in the range of 66.4-76.0%.

Summer (End of February to May): The highest maximum temperature and lowest minimum temperature of this season is 31.4°C and 25.2°C respectively. The temperature is relatively low when compared to the northern states, as the Western Ghats acts as a shield to Kerala and protect it from the hot and dry winds blowing towards the south. Also, the sea breeze originating from the Arabian Sea decreases the temperature. The rainfall during this season is about 110 mm, with a relative humidity in the range of 69.8% to 74.3%.

South-West Monsoon (June to September): The season starts in June locally known as *Edavam*, with the outset of the south-west monsoon, it is referred to as *the Edavappathi* in Malayalam. About 80 - 85% of the total rainfall of Kerala is received in this season. The average rainfall of this season was 2100 mm during the study period (2011). The maximum temperature of this season was recorded 30.6°C and the minimum temperature was 24.6°C. The relative humidity was in the range of 78.7% to 81.7%.

North-East Monsoon (October to November): This monsoon is locally known as the *Thulavarsham*, as it rains during the Malayalam month of *Thulam*. It is also called the Retreating/Reverse monsoon, since the northeast monsoon commences in Kerala during the return of the south-west monsoon wind. The rains in this season usually are accompanied by thunder and lightning. The average rainfall during this season was recorded to be 430 mm. The relative humidity in this season was in the range of 76.0 to 67.7% with maximum and minimum temperatures between 30.8°C and 24.2°C, respectively.

4.7.2 Wind and Cyclone

Wind roses were plotted for the different seasons, are presented in **Figure 4-55** to **Figure 4-57**. During summer, the wind was blowing predominantly from the NE direction. It reached a maximum speed of about 3.6 – 5.7 m/s. The average wind speed for this season was 0.56 m/s. In summer, almost 61.75% of the wind was calm less than 2 m/s.

The Monsoon season has two predominant wind directions, SW and NEnorth-east, which depicts the two different seasons of monsoon (south-west monsoon and north-east monsoon). The average wind speed of this season was recorded at 0.51 m/s and 60.36% of the total wind in that region was calm. Higher wind speeds were recorded in the range of 2.1 – 3.6 m/s. In the winter season, the wind was blowing from NE direction predominately. The wind speed was in the range of 3.6 – 5.7 m/s. The average wind speed was recorded at 0.58 m/s.

The coastal area of Kerala comes under the moderate damage risk zone as per the cyclone hazard map prepared by the Building Materials and Technology Promotion Council (BMTPC). The cyclone hazard map is given in **Figure 4-58**. Only three major cyclones have been reported since 1977 in and near the coast of Kerala, they are listed in **Table 4-28**.

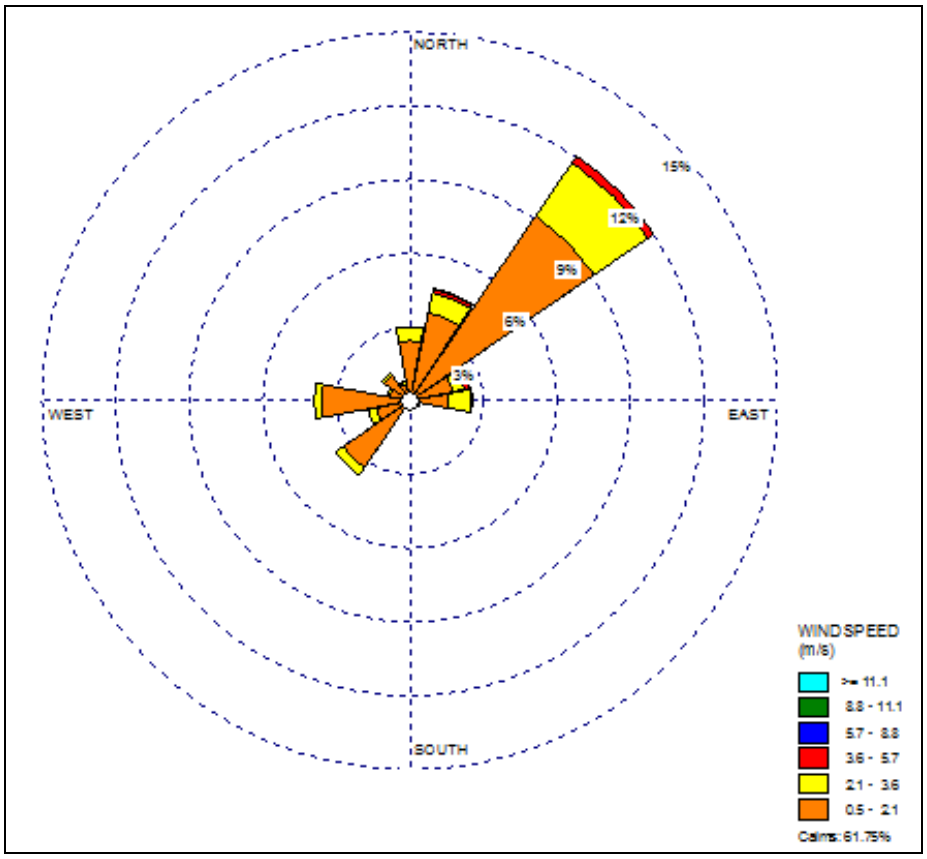


Figure 4-55: Wind Rose for Summer Season (March 2011 – June 2011)

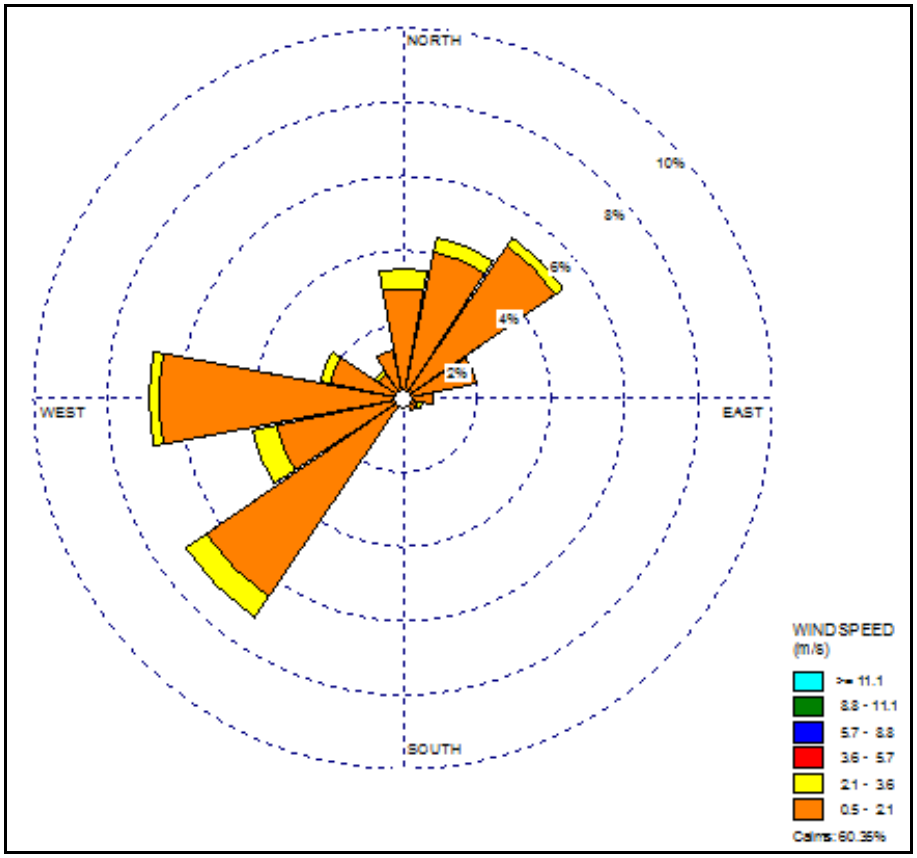


Figure 4-56: Wind Rose for Monsoon Season (July 2011 – October 2011)

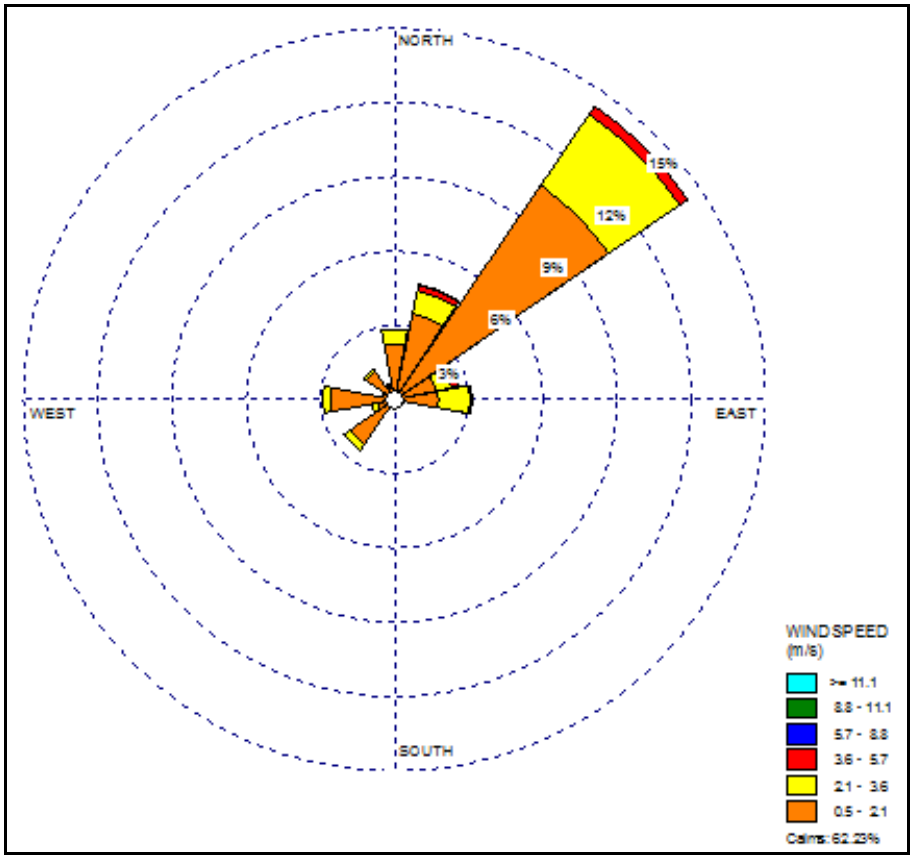
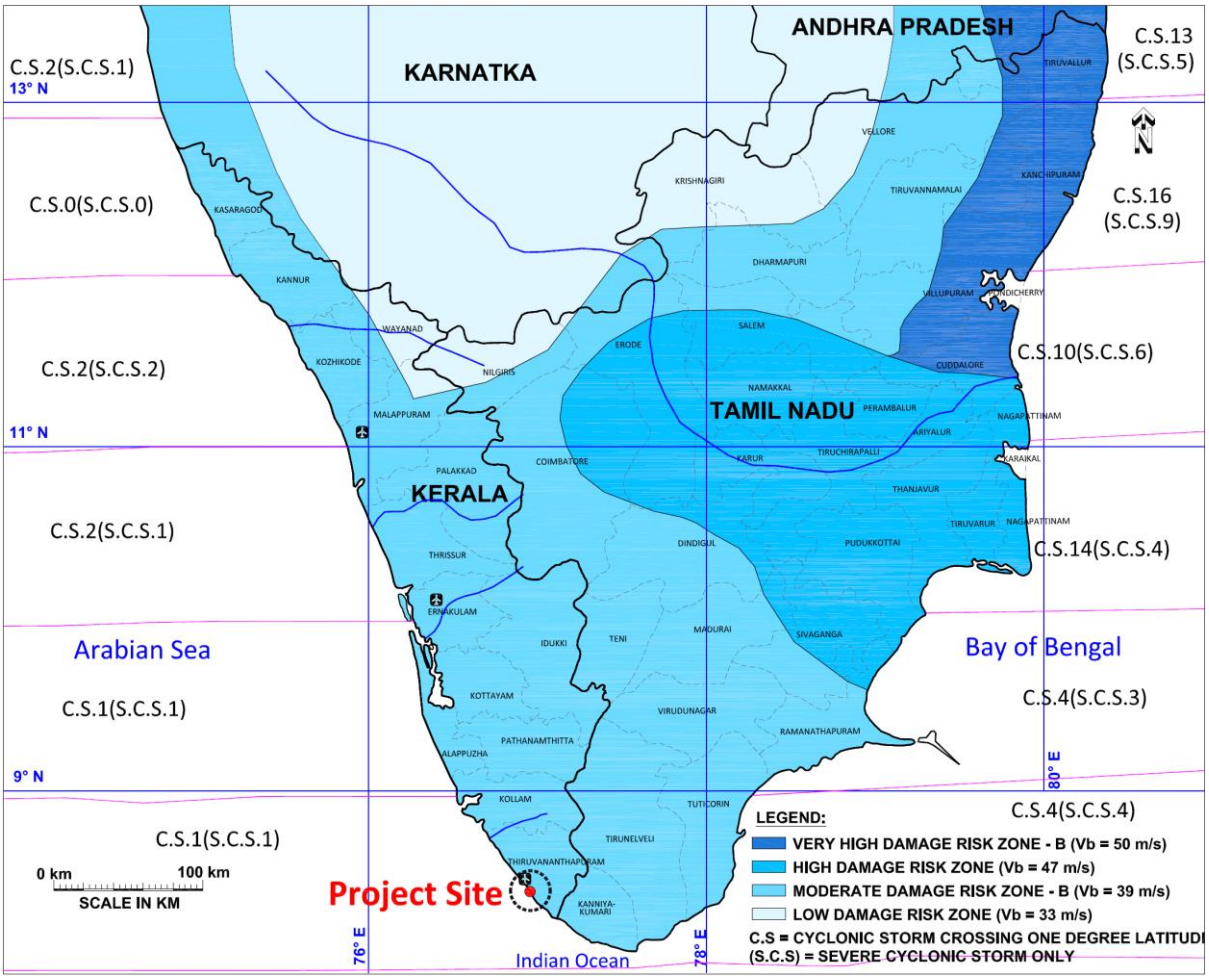


Figure 4-57: Wind Rose for Winter Season (November 2011 – February 2012)



(Source: BMTPC, 2012)

Figure 4-58: Wind and cyclone hazard map of Kerala

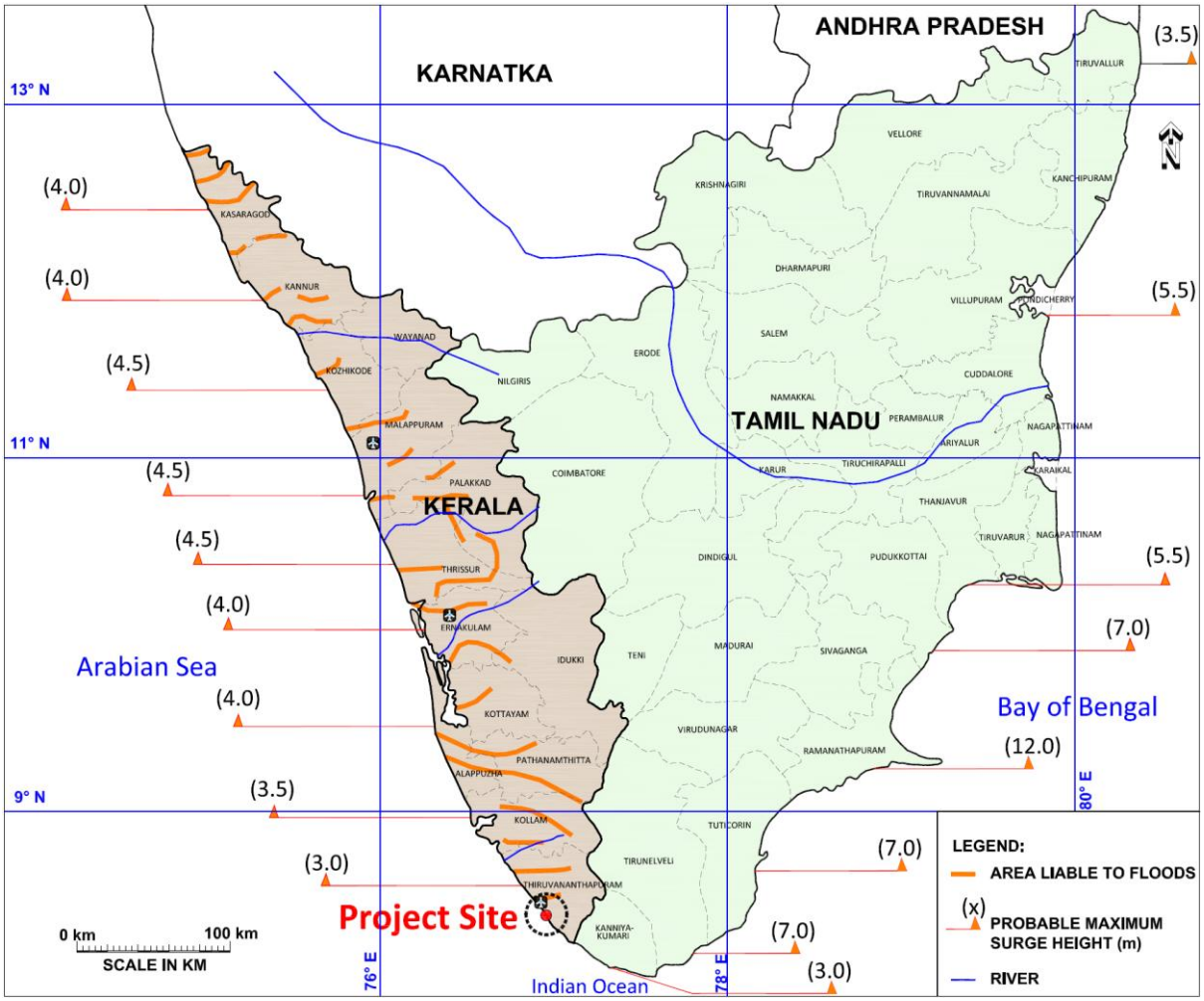
Table 4-28: Cyclonic History of Kerala

Date	Details
November 8-12, 1977	Crossed Tamil Nadu (TN) coast within 10 km to south of Nagapattinam early morning of November 12, 1977. Weakened into a cyclonic storm by that evening over interior parts of TN & emerged into Laccadives off North Kerala coast on the morning of 13th as a deep depression. Maximum wind recorded was about 120 kmph (65 kt) on 12th morning at Thanjavur, Tiruchirapalli and Podukottai.560 people died and one million people were homeless. 23,000 Cattles perished. Total damage to private and public property was estimated to be ₹ 1550 million
November 19-24, 1978	Crossed between Kilakkarai, Rochemary and Ramanatharam District of TN State on 24thevening as a severe storm and emerged into the Arabian Sea off Kerala coast as a deep depression on 25th morning. Batticola of Sri Lanka reported maximum wind speed northerly 145 kmph (78 kt). In India, 5,000 huts were damaged and total damage was estimated to be around ₹ 50 Million.
November 15-23, 1977	Crossed near Honavar, Karnataka and had high impact on Kerala coast. Tidal waves were reported to have damaged 620 fishing vessels.

(Source: IMD, 2012: http://www.imd.gov.in/section/nhac/static/cyclone-history-as.htm)

4.7.3 Flood

The flood hazard map of India is given in **Figure 4-59**. As per the map, the PIA district is flood prone and has a probable maximum surge height of 3.0 m. Flood in Kerala are highly localised due to undulating terrain features except sandy plan coastal areas. Land ward side of the project area is highly unduklating with hills and valleys. Generally, the low lying areas get flooded during the south west monsoon season. The worst flooding ever reported from 1905 to 2005 due to rainstorms was in July 1994, in which 209 human lives were lost and crop worth INR 1445 million (₹ 144.5 cr) was damaged. Also, INR 1050 million (₹ 105 cr) worth public utilities were damaged (De et al 2005)[14].



(Source: BMTPC, 2012)

Figure 4-59: Flood Hazard Map of Kerala

4.7.4 Ambient Air Quality

4.7.4.1 Ambient Air Quality Monitoring Stations

Nine (09) sampling locations were selected in the study area of 10 km radius around the Project for air quality monitoring. Monitoring location details are delineated in **Table 4-29**. The monitoring locations are show in **Figure FD0405**.

[14]Refer to U.S.De, R.K.Dube1 and G.S.Prakasa Rao, Extreme Weather Events over India in the last 100 years, J. Ind. Geophys. Union, July 2005, Vol.9, No.3, pp.173-187.

Table 4-29: Details of Ambient Air Quality Monitoring Stations

S. No.	Location Code	Location Name/ Description	Position with respect to Project Site*	
			Direction	Distance (km)
1.	AQ1	Karimkulam (Silence)	SE	8.56
2.	AQ2	Pullinkudi (Residential)	E	2.42
3.	AQ3	Mulloor (Residential)	E	1.70
4.	AQ4	Avadutura (Commercial)	N	2.21
5.	AQ5	Muttakad (Commercial)	N	4.02
6.	AQ6	Madhupalam (Residential)	N	9.42
7.	AQ7	Punnamoodu (Residential)	NE	7.43
8.	AQ8	Balaramapuram (Residential)	NE	9.04
9.	AQ9	Nellimudu (Residential)	E	5.74

**Direction and distance are given with respect to the project site*

4.7.4.2 Parameters, Frequency and Monitoring Methodology

Sampling was carried out twice a week for at each location for all seasons. Gaseous samples were collected for the duration of eight hour and PM_{10}/$PM_{2.5}$ samples were collected for 24 hour duration as per the guidelines of the National Ambient Air Quality Standards, 2009. High Volume Air Samplers, Respirable Dust Samplers and impingers with trapping solutions were used to collect samples (**Exhibit 4-29** to **Exhibit 4-32**). The method of analysis for different air quality parameters are given in **Table 4-30**.

Table 4-30: Methodology for Ambient Air quality monitoring

Parameters	Measurement Methods
PM_{10}	IS:5182(Part 23):Gravimetric
$PM_{2.5}$	Gravimetric
Sulphur dioxide (SO_2)	IS:5182(Part II):Improved West and Gaeke
Nitrogen dioxide (NO_2)	IS:5182(Part VI):Modified Jacob &Hochheiser (Na-Arsenite)
Carbon monoxide (CO)	Digital Gas Analyser

4.7.4.3 Results and Discussions

The analytical results of ambient air quality at all the monitoring locations are given in **Appendix 4.5**.

Particulate Matter 10 (PM_{10}): The level of PM_{10} recorded during the campaign in various sampling stations varied between 45.20 and 81.30 µg/m^3, which is well below the prescribed NAAQS[15] standard of100 µg/m^3. Comparative result of the various sampling sites shows that Muttakad and Balarampuram present the highest values and Pulinkudy and Karimkulum had the lowest values (45.20 to 69.91µg/m^3). Muttakad is a commercial area, while Balaramapuram sampling station is adjacent to a National Highway where the movement of vehicles is higher compared to the other more residential areas.

PM_{10} concentration in Nellimudu during the winter and summer season was found to be almost equivalent to that of Muttakad and Balrampuram. This might be attributed to suspension of particulate matter during the dry weather conditions. The values of other stations were in the range of 50 to 75 µg/m^3 in all the seasons. **Figure 4-60** shows the concentration of PM_{10} at different sampling locations.

[15]National Ambient Air Quality Standards



Exhibit 4-29: Air Quality at Pulinkudi (January 2011)



Exhibit 4-30: Air Quality Monitoring at Madhupalam (December 2011)



Exhibit 4-31: Air Quality Monitoring near Mulloor Petrol Pump (May 2012)



Exhibit 4-32: Air Quality Monitoring at Balaramapuram (January 2012)

The annual mean concentration for PM_{10} for different sampling stations varied between 52.94 and 72.4 µg/m^3 which is slightly higher than the IFC EHS Guidelines of 70 µg/m^3 Muttakad and Balarampuram had little higher values and Pulinkudy and Karimkulum had lower concentration.

Particulate Matter 2.5 ($PM_{2.5}$): The $PM_{2.5}$ values at Muttakad, Nellimudu, Mulloor, Balrampuram and Advadatura areas were comparatively higher during post-monsoon seasons, but were well below the NAAQ Standard (2009) of 60µg/m^3.

The value of $PM_{2.5}$ at Muttakad, Balarampuram, Nellimudu and Avadatura stations were higher during winter and summer season, which might be due to suspension of particle matter in dry weather conditions. The highest value was recorded at 39.76 µg/m^3 in Muttakad and lowest annual mean value of 24.12 µg/m^3 was recorded in Karimkulum. **Figure 4-61** shows the concentration of $PM_{2.5}$ at different sampling locations for different seasons.

The annual mean concentration for $PM_{2.5}$ for the observed sampling stations varied between 24.12 and 35.71 µg/m^3 Muttakad and Balarampuramhad recorded little higher values and Pulinkudi and Karimkulum had lower concentration.

Sulphur Dioxide (SO_2): The Sulphur dioxide concentrations at the observed monitoring stations were well below the NAAQ standard (2009) of 80µg/m^3. The results ranged between 6.33 and 11.47 µg/m^3 all through the study period.

The highest annual mean value of SO_2 recorded was10.33 µg/m^3 during the winter of 2011 at Balarampuram, which is a commercial area. The lowest annual mean concentration of 6.73 µg/m^3 was observed at Karimkulum. **Figure 4-62** shows the concentration of SO_2 at different sampling locations for different seasons.

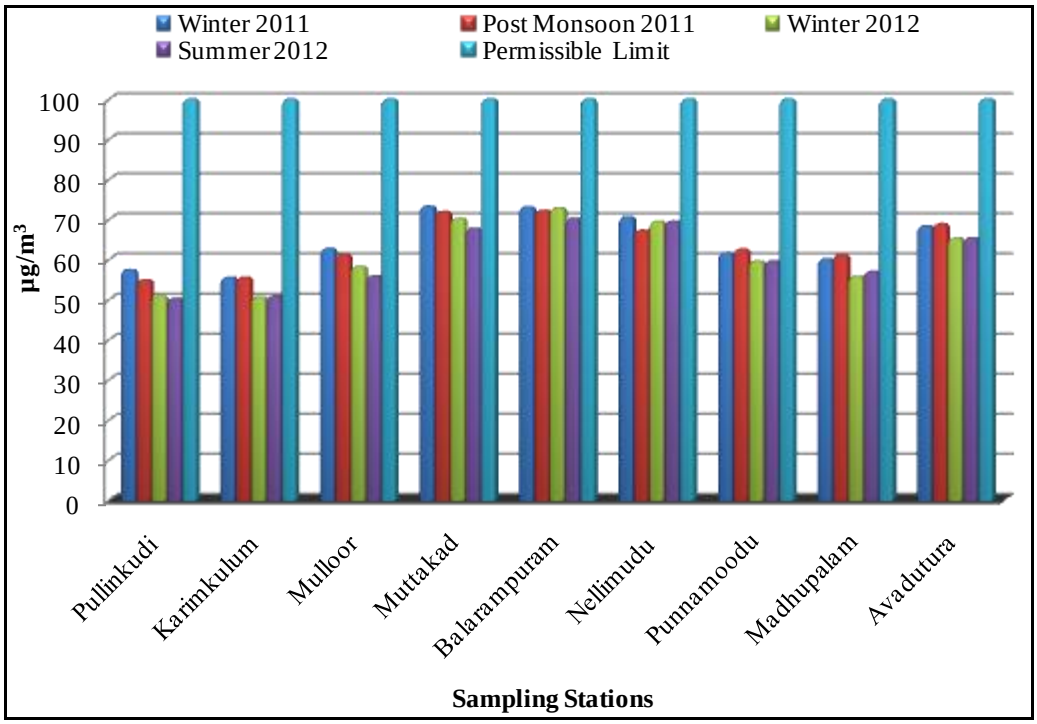


Figure 4-60: Concentration of PM_{10} in the Project Area

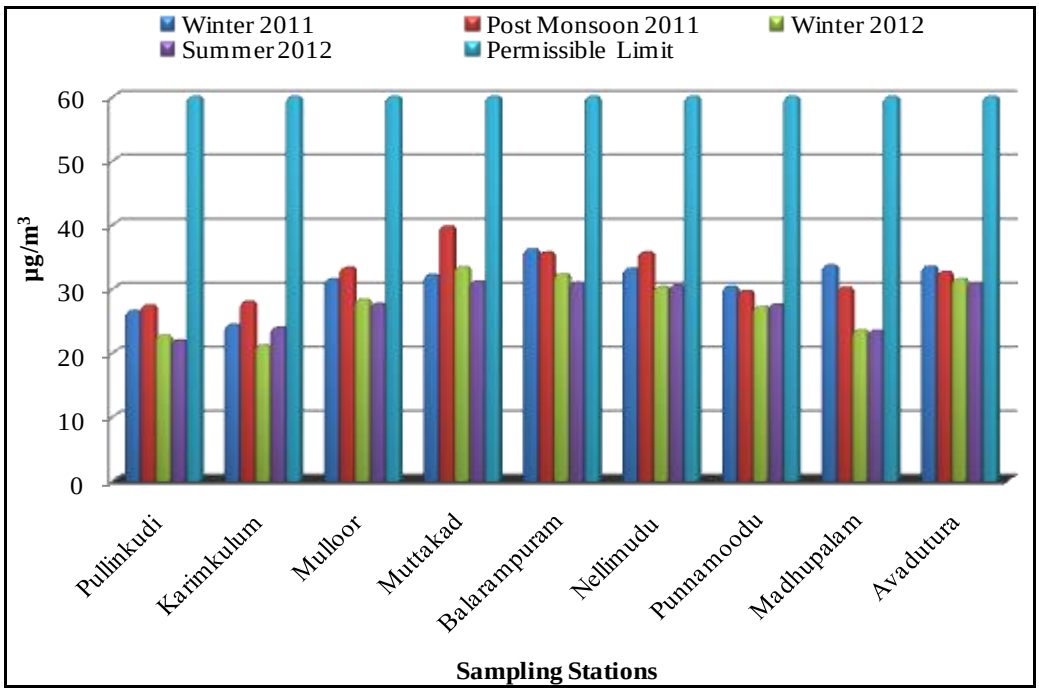


Figure 4-61: Concentration of $PM_{2.5}$ in the Project Area

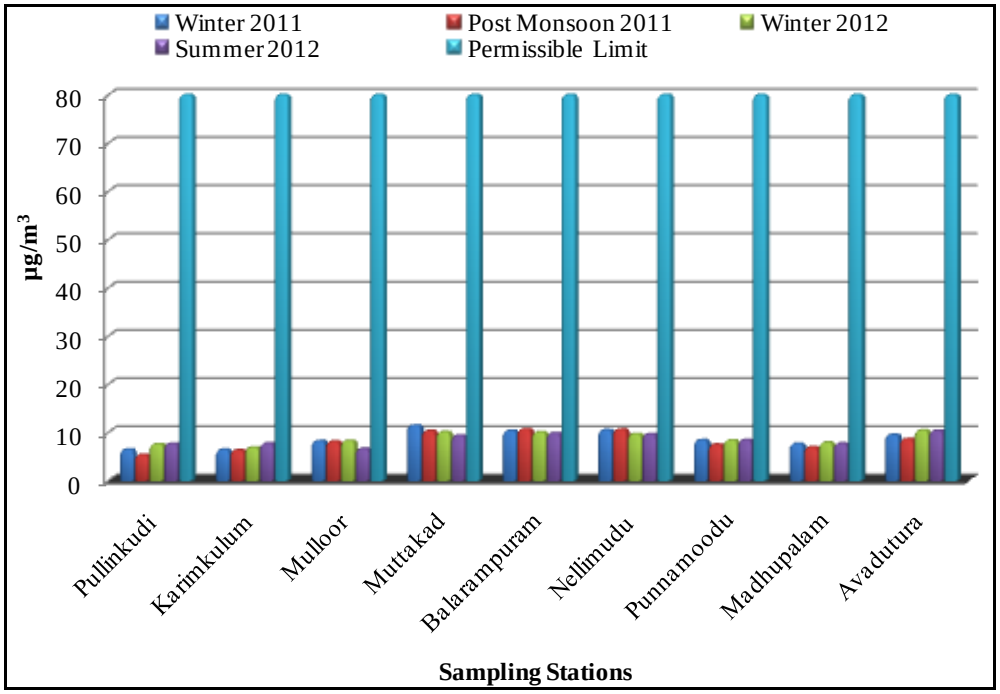


Figure 4-62: Concentration of SO_2 in the Project Area

Nitrogen Dioxide (NO_2): During the study period the observed concentration for NO_2 ranged between 9.7 and 24.9 µg/m^3, which is within the NAAQ Standard, 2009 of 80 µg/m3. The concentration of NO_2 at different stations and seasons is shown in **Figure 4-63**. During the study period the annual mean concentration of NO_2 as observed in the study area ranged between 10.82 µg/$m^3$and 17.54 µg/m^3.

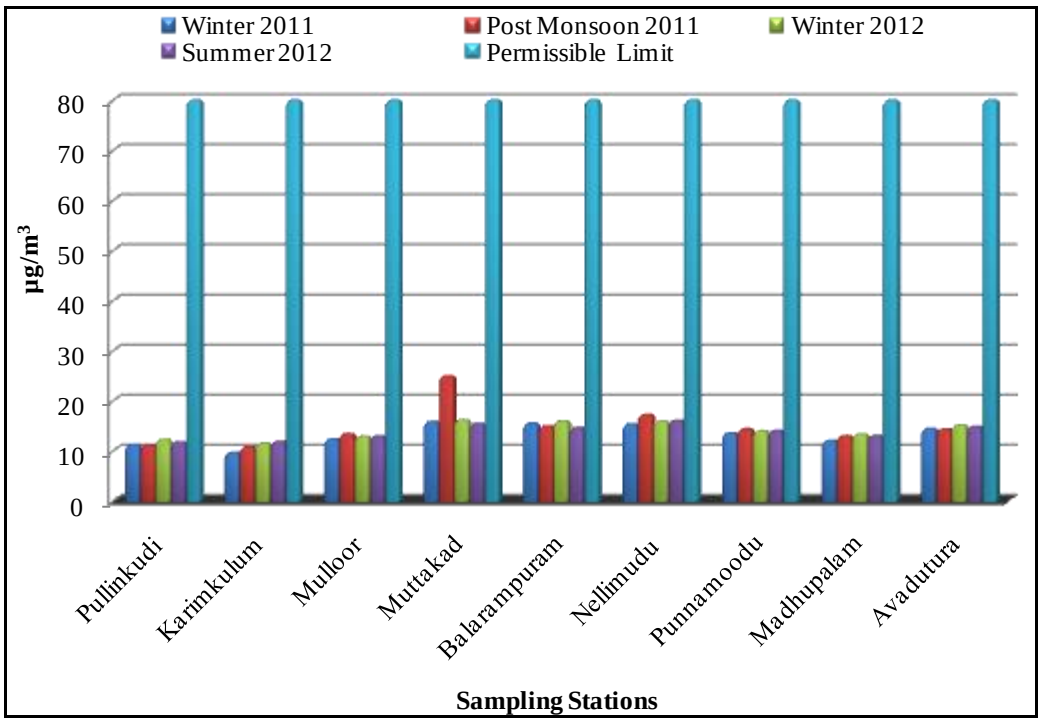


Figure 4-63: Concentration of NO_2 in the Project Area

Carbon Monoxide (CO): Figure 4-64 shows that the CO concentration was decreasing season wise from 2011 to 2012 in Punnamad, Nellimudu, Pullinkudi and Balarampuramareas. Comparatively in

Karimkulum, Mulloor and Muttakad it remained almost the same in all the seasons. In Madhuppalam and Avadutura the CO level was recorded high in winter season and low in post-monsoon and summer. In the winter season as the wind velocity reduces and circulation and upward movements become less, the possibility of presence of higher concentration of CO in the ambient air increases. In summer on the other hand the level of CO decreases due to rapid wind circulation and higher upward mobility. The overall reason for high CO levels during the monitoring period might be due to the increase of flow of vehicular traffic in the area and because of low wind velocity. The observed mean annual concentration of CO was very low and ranging between 0.18 to 0.46 µg/m^3.

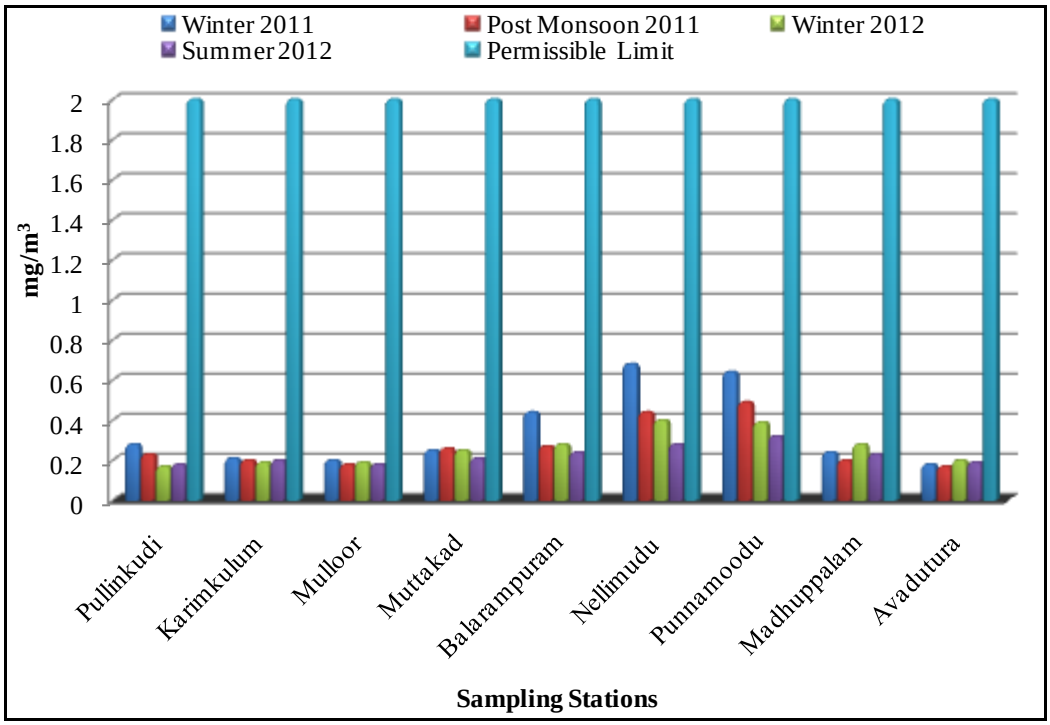


Figure 4-64: Concentration of CO in the Project Area

Ozone (O_3): The concentration of Ozone is collected from secondary information, in the atmosphere at Thumba, which is about 20 km aerial distance from the Project site towards NW direction was analysed and is presented in this section. The observation site was reported to be a flat sandy terrain on the southwest coast of India some 0.5 km away from the Arabian Sea coast. The city of Thiruvananthapuram lies 10km in East/South-East direction and there were no major industries in the vicinity of the monitoring site. The level of daytime average O_3 measured at Thumba was reported to be in the range of 72 µg/m^3 and 80 µg/m^3, which is below the prescribed IFC EHS General Guidelines of 100µg/m^3. The surface O_3 concentration during summer and post-monsoon season was found to be almost equal (80 µg/m^3). During summer, convective activity and turbulent mixing were stronger, which enabled mixing of O_3 to higher levels causing dilution at the surface level (David and Nair, 2011).

4.8 Noise

4.8.1 Noise Monitoring Stations

To establish the ambient noise in the study area, monitoring of ambient noise level was carried out at nine representative locations in the study area using a suitable Portable sound level meter over a

period of twenty-four hours, with uniform interval of one hour, in each season. The sampling locations varied in nature from Silence zone to residential areas. The details of the noise monitoring locations are given in **Table 4-31** and shown in **Figure FD0406**.

Table 4-31: Details of Noise Monitoring Stations

S. No.	Location Code	Location Name (Description)	Position with respect to Project Site	
			Direction	Distance (km)
1	N1	Karimkulam (Silence)	SE	8.56
2	N2	Pullinkudi (Residential)	E	2.42
3	N3	Mulloor (Residential)	E	1.70
4	N4	Avadutura (Commercial)	N	2.21
5	N5	Muttakad (Commercial)	N	4.02
6	N6	Madhupalam (Residential)	N	9.42
7	N7	Punnamoodu (Residential)	NE	7.43
8	N8	Balaramapuram (Residential)	NE	9.04
9	N9	Nellimudu (Residential)	E	5.74

4.8.2 Noise Monitoring Methodology

Ambient noise level or sound pressure levels (SPL) were measured by a Portable sound level meter. A-weighted equivalent continuous sound pressure level (L_{eq}) value was computed from the values of A-weighted SPL. Noise Measurements were carried out as per IS: 4954 standards as given by the Central Pollution Control Board (CPCB). At each location, noise monitoring was conducted continuously over a period of 24 Hourss to obtain L_{eq} values at uniform time intervals of one hour. Day time Leq has been computed from the hourly Leq values between 6.00 a.m. and 10.00 p.m. and night time L_{eq} from the hourly L_{eq} values between 10.00 p.m. and 6.00 a.m. using the following formula:

$$L_{eq_{night}} = 10\log\frac{1}{8}\sum_{i=1}^{8}10^{\frac{L_i}{10}} \qquad L_{eq_{day}} = 10\log\frac{1}{16}\sum_{i=1}^{16}10^{\frac{L_i}{10}}$$

Where, Li = L_{eq} value of the hourly time interval.

4.8.3 Analysis of the Results

The results of the noise monitoring in different seasons are depicted in **Figure 4-65** to **Figure 4-68**. The Noise Sampling results are given in **Appendix 4.6**. The level of noise at Karimkulam, (a silence zone adjacent to school building), was found to be high in all the seasons. This was due of continuous vehicular movements in the adjacent road. The noise value of Balaramapuram was also found to be higher as a result of the presence of a local vehicular air pollution testing centre nearby, where the vehicular movement was continuous.

In the winter of 2011, the L_{eq} (day time) and L_{eq} (night time) values were in the range of 47.6 – 55.0 dB and 39.3 – 43.2 dB, respectively. While it was recorded as 48.8 – 55.6 dB and 39.5 – 43.4 dB, respectively for the day and night time L_{eq} values in the winter 2012. This indicates there was not much change in the ambient noise level of the area over the period of one year. During the post-monsoon period of 2011 the day time and night time L_{eq} values were also in the same range of 44.3 – 56.6 dB and 39.1 – 44.1 dB, respectively. Comparatively steady noise level of the study area indicates that there was not much new activity in the area over the last one year. The ambient noise level for Mulloor and Pulinkudi all through the study period were in L_{eq} day time and 45 dB(A) for L_{eq} night time.

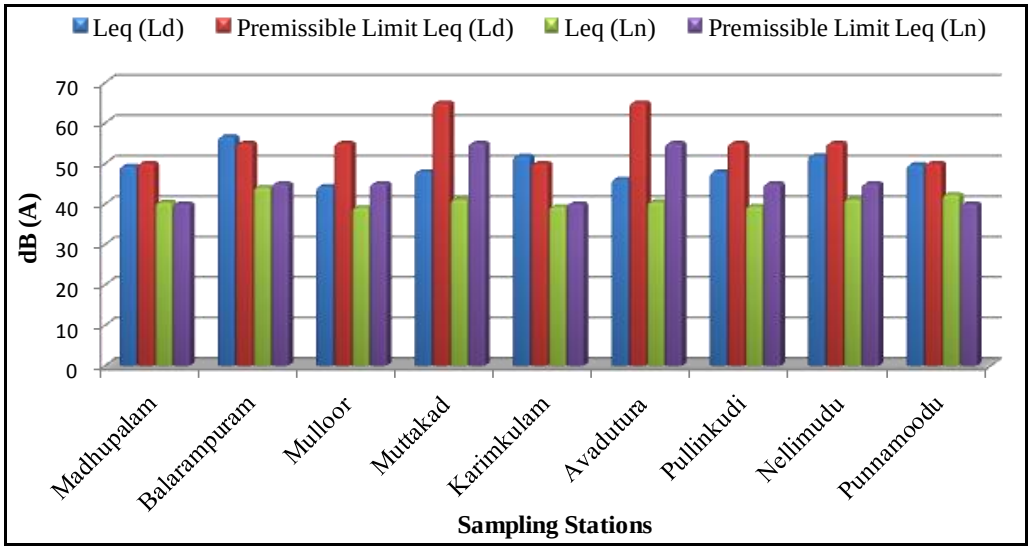


Figure 4-65: Noise Levels in Post-Monsoon Season, 2011

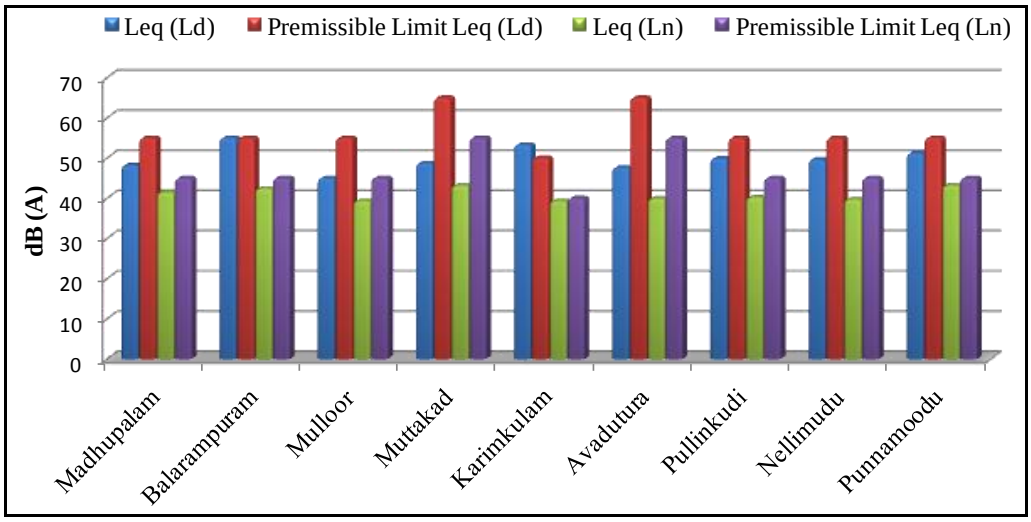


Figure 4-66: Noise Levels in Winter Season, 2011

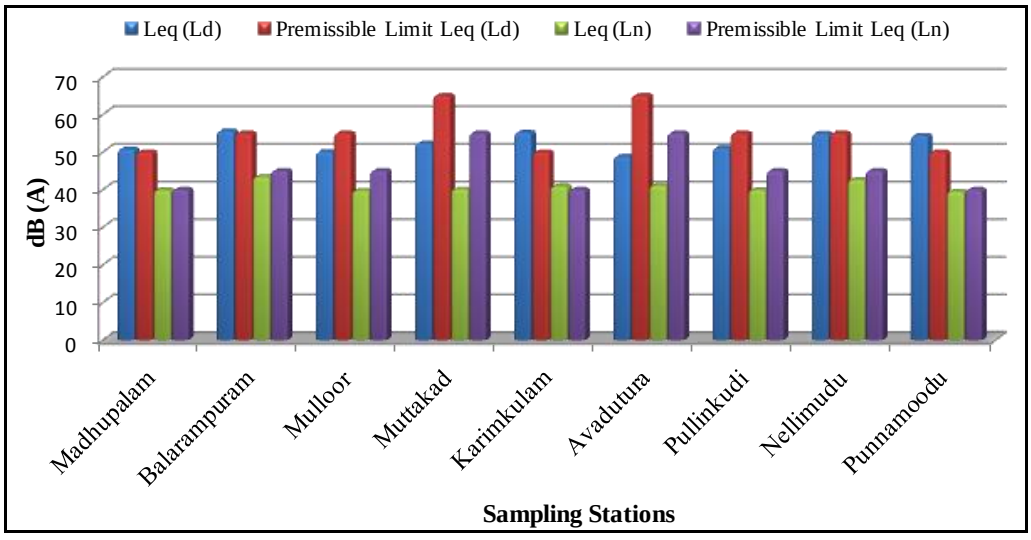


Figure 4-67: Noise levels in Winter Season 2012

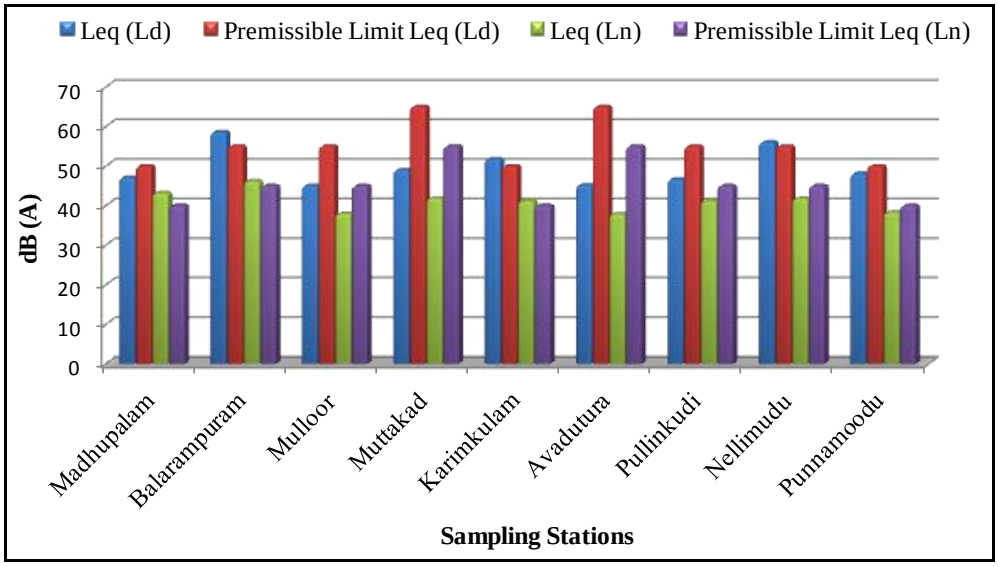


Figure 4-68: Noise Levels in Summer Season 2012

4.9 Socio-economic and Occupational Health Environment

The Project stretch, which is the footprint of the Project layout, falls under the Thiruvanathapuram Municipal Corporation and Neyyattinkara Taluk, in PIA District of Kerala. The study area for the socio-economic baseline description consists of 10 km radius around the Project stretch and also coastal villages present 15 km both sides towards north and south.

4.9.1 Brief Socio-Economic Profile of the PIA District

Based on the PIA District official website[16], agriculture represents one of the main occupations in the district. More than 42% of the total district population depend on agriculture. Cultivable land may be classified as wet, dry, garden and plantations. Paddy is the most important crop cultivated in the low lying lands. It is cultivated in 1,493 Ha in 2010-11 and the production was 6,923 metric tonnes with productivity of 3,272 kg/Ha.

In PIA district there are over 60 private sector medium and large scale industries. There are 26,821 Small Scale Industries units in the district providing employment for 98,193 people (as on March 31, 2011). Of these SSI units, 1100 are Scheduled Caste/Scheduled Tribe units and 6621 are women units. Such units include oil mills, cashew factories, textile enterprises, saw mills, printing units, rubber industrial units, chemical units, match factories, general engineering units and automobile workshops.

PIA district offers significant opportunities for fisheries. Varkala, Anchuthengu, Marianad, Poonthura, Vizhinjam and Poovar are some of the major fishing centres. The fishing population in Vizhinjam in 2009-10 was around 188,000, and the total catch in that period was close to 32,000 tonnes. Anchovies, sardine, catfish, perch, mackerel and tuna are major fish types in this area. However, the introduction of mechanised fishing and modern fishing gear has recently changed the content of the catch. There are 42 fishing villages and the total number of households engaged in fishing is estimated to be about 40,000. The coastal fisheries belt is divided into 42 fishery villages most of which have fishing welfare societies formed under the Kerala Fisheries Welfare Society Act of 1980.

[16]http://www.tvm.kerala.gov.in

Several social welfare schemes exist in the district and can be broadly classified into; welfare of the handicapped, welfare of women and children, correctional services and social security. In PIA district there are five welfare institutions; one after-care hostel, one after-care home, one home for physically handicapped women, one home for sick children and one vocational care centre for those who are physically handicapped. There are also 30 crèches to look after children under three years of age and three Day-Care Centres located at Ottoor, Poomkulam and Poovar, and help to look after children of fishermen and coir workers. The approach and methodology, and the findings of the socio-economic study are described in the sections below.

4.9.2 Scope and Methodology

To assess the existing socio-economic condition of the study area, information was collected both from secondary sources and primary data collection through a household survey, Focus Group Discussions (FGD) and public consultation.

4.9.3 Secondary Information and Data Collection

Secondary socio-economic sources included various published documents like the Economic Review (2011) of Kerala State Planning Board, City Development Plan of Thiruvanathapuram (2006), Marine Fisheries Census Data Kerala (2010), the official website of Thiruvanathapuram District (http://trivandrum.gov.in/) and so forth.

4.9.4 Primary Data Collection

Primary data was collected through household survey, Focus Group Discussions (FGD) with key stakeholders and public consultations. The primary data collection and consultations were carried out with the objectives of:

- Assessing the socio-economic situation of the local people
- Creating public awareness about the project
- Assessing the views of local people about the project and
- Understanding the needs of the community for possible incorporation into community development plans.

For the primary survey, the study area was divided into three zones depending upon the distance from the Project site: the study area of three impact zones is given as **Figure 4-69**.

- **Zone 1 (the Core Zone)**: 0-2 km from the proposed project site and all the villages along the coast up to 10 km;
- **Zone 2 (the Moderately Impacted Zone)**: 2-5 km from the proposed project site; and
- **Zone 3 (the Low Impact Zone)**: 5-10 km from the proposed project site.

The approach and methodology adopted for primary data collection is described below:

- First, a detailed desk review of reports and secondary data related to the socio-economic context of the project was undertaken.
- Reconnaissance visits to the project site were made and screening of potential social impacts in the study area was carried out. During these visits, public consultations were conducted to gather feedback from the local people on the proposed development and its perceived socio-economic impacts.
- Various meetings and consultations with relevant Government departments were conducted.

- Stakeholder consultation workshops were also conducted to inform the public about the project and to seek their suggestions. This helped in identifying the various stakeholders of the project.
- Sample size was finalised by using population data of the area from the 2001 census and also by visiting all the Panchayats, collecting relevant information related to census of the villages which may be affected by the proposed project.



Figure 4-69: Study Area and its three Impact Zones

4.9.4.1 Household Survey

Household survey on sample basis was conducted from April, 26 – June, 6 2012 to collect study area specific information and to understand the baseline socio-economic conditions. The following socio-economic issues were covered as part of the household survey:

- Demographic characteristics: Includes population, gender division, age division, literacy
- Social characteristics: Includes caste and religion of the local inhabitants
- Economic profile: Includes occupation, income, expenditure and assets of the local inhabitants

- Service infrastructure: Includes educational institutions, health care, water supply, sewerage/drainage facilities and solid waste management facilities. Other Infrastructural facilities, including the fishing harbour and local small scale industries
- Cultural heritage and practices: Includes archaeological monuments and cultural/ traditional practices, Government economic support schemes for locals, including various national and state government schemes for local welfare
- Major socio-economic issues in the study area

Using statistical sampling method, 15%, 5% and 1% of the total households in Zone 1, Zone 2 and Zone 3, respectively, were taken as sample size for the social survey. The households for the survey were identified randomly. Accordingly, 5,871 households were covered in the social survey. The zone-wise number of households covered as part of the survey is provided in **Table 4-32**.

Table 4-32: Number of Villages, Ward and Households Surveyed

Zones	No. of Villages/Wards	Number of Households	
		Total	Fisher Households
Zone 1	15 villages	3167	2112
Zone 2	10 villages and 1 ward	2023	262
Zone 3	7 villages and 6 wards	681	12
Total		**5871**	**2380**

4.9.4.2 Focus Group Discussion (FGD)

Apart from the above mentioned door to door household survey, Focus Group Discussions (FGDs) were conducted. The FGDs were conducted specifically to understand the impact on fishery and tourism in the study area. Altogether, Forty Three (43) FGDs were conducted and these were attended by 425 informed people. Twenty Eight (28) FGDs were conducted with the fishing community in 22 villages along the coastline up to 25 km North and 15 km south of the breakwater. In addition to this, two (02) more FGDs were conducted in and around the Kadavila and Theviyodu Quarry locations. Remaining Fifteen (15) FGDs were conducted related to tourism and allied activities.

FGDs were held in resorts/ hotels located in the Project stretch and in the adjacent tourist location, Kovalam, which is located about 2.0 km from the Project stretch in the Northern direction. Out of the Thirty One (31) resorts identified in the Project stretch, FGDs were conducted in nine (09) resorts with the owners, employees, visitors and travel agents. Six (06) more FGDs were conducted in Kovalam and Mulloor to understand the apprehensions of the tourists and people involved in tourism related activities. In addition to FGD, all the 31 resort owners attended an official meeting conducted at Government guest house, Thycaud to understand their grievances.

4.9.5 Survey Team

The survey was conducted by trained and educated (minimum graduate level) surveyors, who were from the project area and were fluent in the local vernacular language ‘Malayalam’. The surveyors were fluent in English as well.

An internal orientation programme was conducted for the surveyors, using mock survey to understand the difficulties and short comings of the format. The survey format was further fine-tuned based on the local needs. The structre of the survey team is given as **Figure 4-70**.

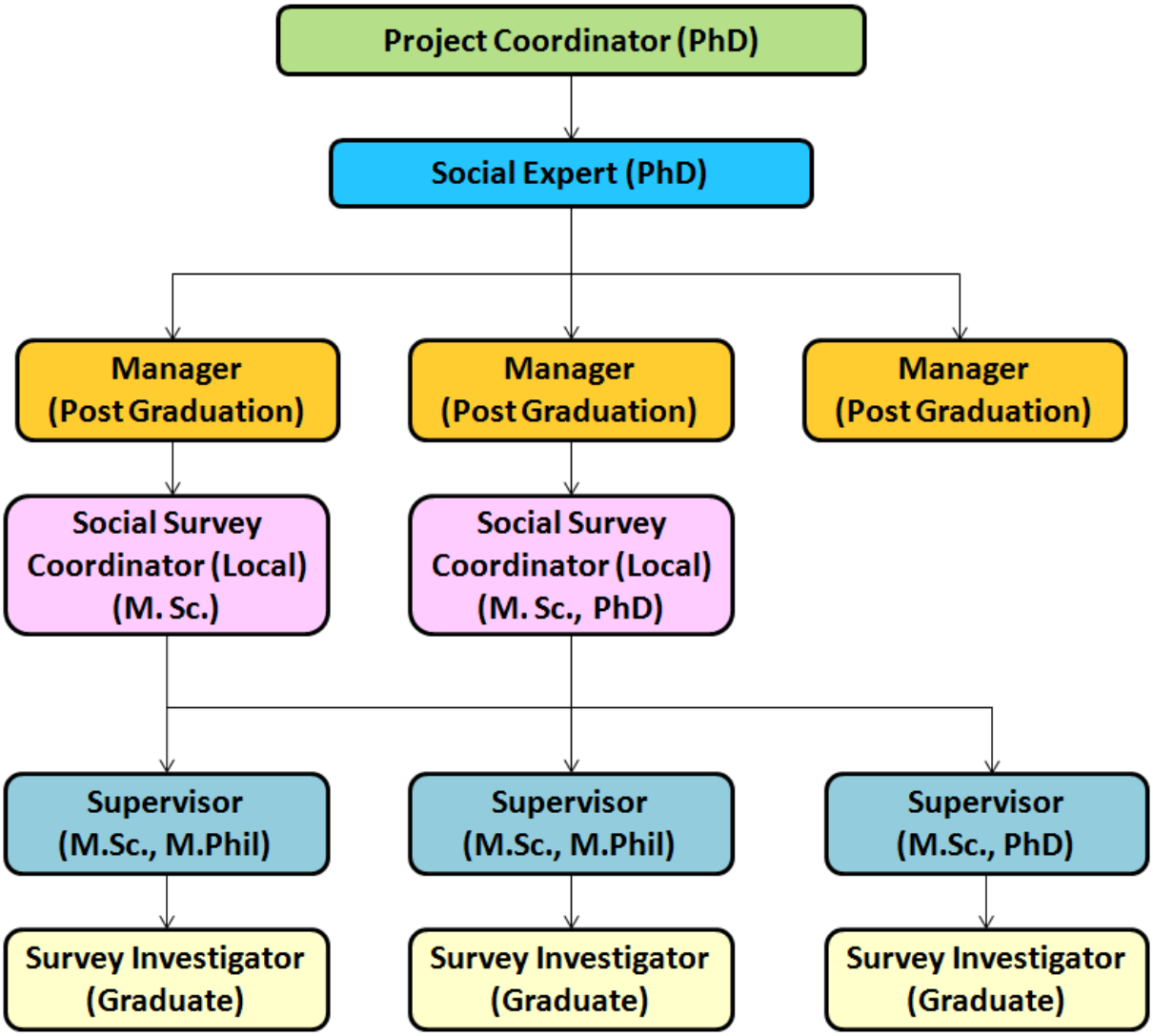


Figure 4-70: Structure of Survey Team

4.9.5.1 Limitations of the Survey

The limitations of the social survey are the following:

- As the survey and FGDs were conducted on a random sampling basis, the possibility of statistical errors cannot be neglected. However, due consideration has been taken during data analysis.
- Outcome of the survey is based on the information collected from the respondents; therefore, there are chances that the information might change over a period of time and be affected by socio-economic, political and other influencing factors.
- Study did their best to understand the perception of people towards the project at that time. As perception is a dynamic process it is likely to get changed due to new information being available.
- Study was limited by scope and coverage. Therefore, results are specific to the study area and these results and findings of the study cannot be generalised for other Projects of similar nature in the region.
- Information provided by individual perception has limitations of accuracy, exaggeration, wrong perception, etc.

4.10 Socio-Economic Profile of the Study Area

4.10.1 Demographic Profile

Population: At time of the household survey (May 2012) and finalization of the report, village-wise census data of 2011 was not available. The 2001 Census data could not be used for all villages on account of reorganization of Thiruvananthapuram district in 2010. As a result of this reorganization, certain areas which were identified as villages in the 2001 census were included in existing wards and boundaries of some of the existing wards were redefined. Reconciliation of village- and ward- wise population thus became difficult.

The population for villages and wards for which population figure could not be extracted from the census data (2001) was collected from local administrative department, i.e., Panchayat or Ward office and Municipal Corporate office and verified during interaction with Ward/ Panchayat members and villagers. Therefore, there is possibility of little deviation of the population figure mentioned in this report with the official record (2011 census data).

Total population count in the study area was 440,180 (source: Census of India, 2001, primary data collected from administrative offices like Panchayat, Municipality, etc.), out of which 25,850 people (5871 households) were covered by the household survey. The zone wise coverage of total households and fishing households is included in **Table 4-33**.

The table shows the demographic profile of the surveyed villages/wards and the number of fishing households in the surveyed population. The surveyed households had an average size of 4.2 members. In the surveyed settlements, about 53% of respondents were from rural areas, 29% were from semi-urban and the rest were from urban areas. The study area has medium[17] (42.3%) to high[18] (53.4%) density.

Table 4-33: Zone Wise Distribution of Population and Households in the Study Area

Villages	Population (Nos.)		Households (Nos.)		
	Total Population	Surveyed Population	Total Households	Covered by Surveyed	
				Total Households	Fishermen Households
Population Covered under Zone 1 (Core Zone)					
Vizhinjam North	7,893*	1,889	1,471	218	214
Vizhinjam South	9,384	1,057	2,476	371	273
Adimalathura	3,747*	706	1,002	152	81
Mulloor	5,654	874	1,414	211	12
Harbour	5,483	927	1,371	206	112
Chowara	443	81	121	18	0
Pulluvilla	11,632	1,851	3,102	466	421
Pallom	1,706	278	499	75	72
Pattiyatura	7,898	1,242	1,917	289	240
Kochuthura	1,369	208	345	57	30
Karumkulam	3,330*	553	938	141	74
Poovar	7,666#	1,253	1,986	298	229

[17] Medium density refers to 500-1000 persons/km^2
[18] High density refers to 1000-1500persons/km^2

Villages	Population (Nos.)		Households (Nos.)		
	Total Population	Surveyed Population	Total Households	Covered by Surveyed	
				Total Households	Fishermen Households
Panathura	2,017	268	327	49	25
Poonthura	26,474	2,662	3,848	573	329
Kovalam	1,747*	180	287	43	0
Total		**14,029**	**21,104**	**3,167**	**2,112**
Population Covered under Zone 2 (Moderate Impact Zone)					
Kottukal	45,836**	1,314	10,792	321	48
Venganoor	33,372	1,672	8,205	410	1
Kanjiramkulam	18,820	842	4,566	228	0
Vellar	21,369	937	4,728	236	124
Venganoor 59	6,525	993	1,631	245	1
Vizhinjam North	7,893*	179	2,476	35	25
Balarampuram	6,564	359	1,641	82	1
Kovalam	28,746*	910	4,970	237	5
Adimalathura	3,747*	247	1,002	48	38
Karimkulam	3,330*	220	1,079	54	19
Ward no. 72 for Thiruvananthapuram corporation	11,061	486	2,544	127	0
Total		**8,159**	**43,634**	**2,023**	**262**
Population Covered under Zone 3 (Low Impact Zone)					
Athiyanoor	39,556	402	9,571	96	0
Thirupuram	38,373	340	9,167	92	0
Poovar	7,666[#]	94	1,986	23	12
Kalliyoor	36,836	360	9,007	90	0
Pallichal	52,562	464	12,355	124	0
Peringamala	21,477	215	5,302	53	0
Kottukal	45,836**	321	10,792	79	0
Thiruvananthapuram Ward No. 73, 71, 70, 69, 68, 67	81,605	473	12478	124	0
Total		**2,669**	**70,658**	**681**	**12**
Grand Total		**25,850**	**1,35,396**	**5,871**	**2,386**

(Source: Social Surveys, May 2012)

Note:

** Vizhinjam North, Kovalam, Karumkulum, Adimalathura is spread over Zone 1 and Zone 2. Since the proportion of total population residing in zone 1 and 2 was not available, the sample size for zone 1 and 2 for the aforementioned villages were calculated on the basis of 15% and 5% of the respective total households in the Villages.*

*** Kottukal is spread over Zone 2 and zone 3. Since the proportion of total population residing in zone 1and 3 was not available, the sample size for zone II and III for the aforementioned village was calculated on the basis of 5% and 1% of the respective total households in the Village.*

[#]Poovar Village is spread over Zone 1 and zone 3. Since the proportion of total population residing in zone 1 and 3 was not available, the sample size for zone 1 and 3 for the aforementioned village was calculated on the basis of 15% and 1% of the respective total households in the Village.

Some photographs of the household survey process are presented in **Exhibit 4-33** to **Exhibit 4-38**.



Exhibit 4-33: Survey at Poovar

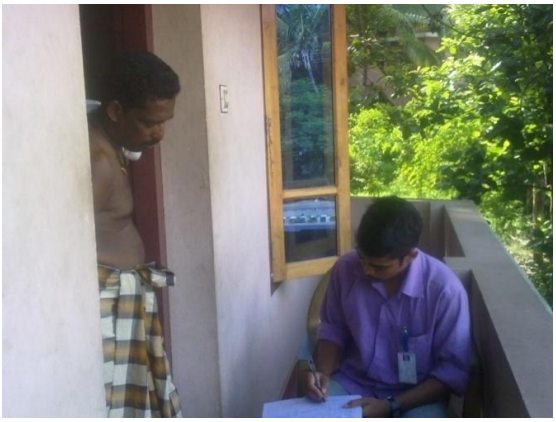


Exhibit 4-34: Survey at Vellar



Exhibit 4-35: Survey at Venganoor



Exhibit 4-36: Survey at Balarampuram



Exhibit 4-37: Survey at Manacaud

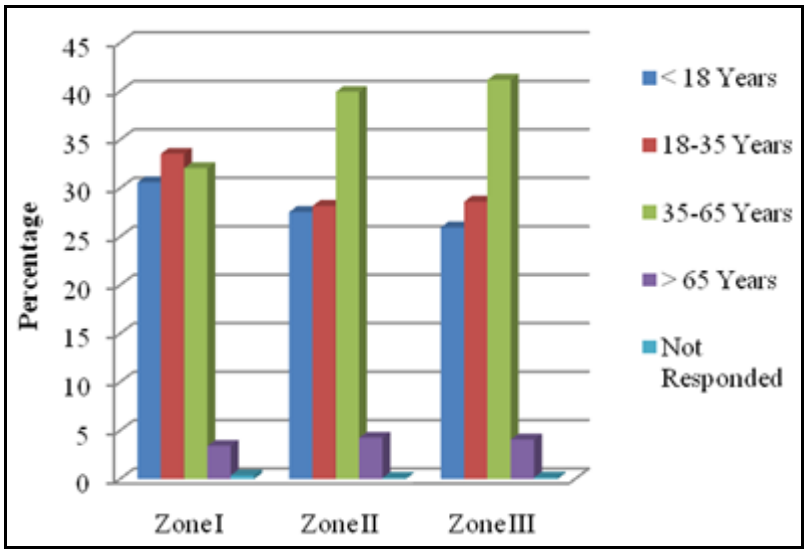


Exhibit 4-38: Survey at Thirupuram

Gender Profile: Gender profile of the surveyed population is presented in **Table 4-34**. The survey reveals that the population of male and female in the study area is almost equally distributed with men constituting 52% of the total surveyed population. The average sex ratio (number of women per 1000 men) of the surveyed population was 935. The sex ratio amongst the fishing households was 913 females for every 1000 men. This is significantly less than the State sex ratio of 1084 for the year 2011 (Census of India). Kerala is one of the two states in India where the number of women is more than the number of men. Zone wise male population constitutes 52%, 51% and 51% in Zone 1, Zone 2 and Zone 3 respectively of the total surveyed population. The percentage of male population in fishing

households in Zone 1 and Zone 2 mirrored the overall percentage of surveyed male population. In Zone 3, however, the male population in fishing households was around 61%.

Detail of the age breakdown of the surveyed population is depicted in **Figure 4-71**.



(Source: Social Surveys, May 2012)

Figure 4-71: Zone Wise Age Division of the Surveyed Population

From the figure above, it is clear that among the three zones, Zone 1 has the highest percentage of people below the age of 18 years (31%), whereas in Zone 2 and Zone 3, it is 28% and 26% respectively. Zone 1 also had the highest percentage (36%) of people aged between 18-35 years, whereas it was almost equal in Zone 2 (28%) and Zone 3 (29%). For the age group 35-65 years nearly equal percentages were observed in zone 3 (41%) and zone 2 (40%) and the lowest percentage was in zone 1 (32%). The percentage of population for the age group >65 years for the three zones was 3.4% (Zone 1), 4.3% (Zone 2) and 4.1% (Zone 3).

Education Level: The survey results show that about 77% of people were literate in the study area, with educational qualifications up to post graduate level. This was lower than the literacy rate of Kerala State (94%) and PIA District (93%) for the year 2011 (GoK, Official Web Portal). Out of the total literates from the surveyed population, 51% of people were from Zone 1, 36% from Zone 2 and 13% from Zone 3. Details are presented in **Table 4-35**.

Age Group: Age of the members in the surveyed population ranged from a few months to 98 years.

Table 4-34: Gender Profile of the Surveyed Population

Village	Surveyed HHs (Nos.)				Fisherman HHs (Nos.)			
	Total HHs	Male Population	Female Population	Surveyed Population	Fishermen HHs	Male population	Female population	Surveyed Population
Core Zone								
Vizhinjam North	371	1,004	885	1,889	273	714	617	1,331
Vizhinjam South	218	548	509	1,057	214	533	498	1,031
Adimalathura	152	371	335	706	81	195	194	389
Mulloor	211	443	431	874	12	34	27	61
Harbour	206	500	427	927	112	284	251	535
Chowara	18	44	37	81	0	0	0	0
Pulluvilla	466	988	863	1,851	421	859	789	1,648
Pallom	75	143	135	278	72	139	128	267
Pathiyathura	289	634	608	1,242	240	485	468	953
Kochuthura	57	113	95	208	30	58	53	111
Karimkulam	141	282	271	553	74	153	143	296
Poovar	298	663	590	1,253	229	490	420	910
Panathura	49	128	140	268	25	76	77	153
Poonthura	573	1,381	1,281	2,662	329	867	782	1,649
Kovalam	43	79	101	180	0	0	0	0
Total	**3,167**	**7,321**	**6,708**	**14,029**	**2112**	**4887**	**4447**	**9334**
Moderate Zone								
Kottukal	321	644	670	1,314	48	93	117	210
Venganoor	410	836	836	1,672	1	3	4	7
Kanjiramkulam	228	429	413	842	0	0	0	0

Village	Surveyed HHs (Nos.)				Fisherman HHs (Nos.)			
	Total HHs	Male Population	Female Population	Surveyed Population	Fishermen HHs	Male population	Female population	Surveyed Population
Vellar	236	518	419	937	124	272	236	508
Venganoor 59	245	494	499	993	1	2	2	4
Vizhinjam North	35	98	81	179	25	85	74	159
Balarampuram	82	190	169	359	1	2	4	6
Kovalam	237	475	435	910	5	9	10	19
Adimalathura	48	133	114	247	38	102	92	194
Karimkulam	54	111	109	220	19	42	41	83
Ward no. 72	127	246	240	486	0	0	0	0
Total	**2,023**	**4,174**	**3,985**	**8,159**	**262**	**610**	**580**	**1,190**
Low Impact Zone								
Athiyanoor	96	204	198	402	0	0	0	0
Thirupuram	92	179	161	340	0	0	0	0
Poovar	23	50	44	94	12	31	20	51
Kaliyoor	90	181	179	360	0	0	0	0
Pallichal	124	232	232	464	0	0	0	0
Peringamala	53	99	116	215	0	0	0	0
Kottukal	79	156	165	321	0	0	0	0
Corporation Area	124	249	224	473	0	0	0	0
Total	**681**	**1,350**	**1,319**	**2,669**	**12**	**31**	**20**	**51**
Grand Total	**5,871**	**12,845**	**12,012**	**24,857**	**2,386**	**5528**	**5,047**	**10,575**

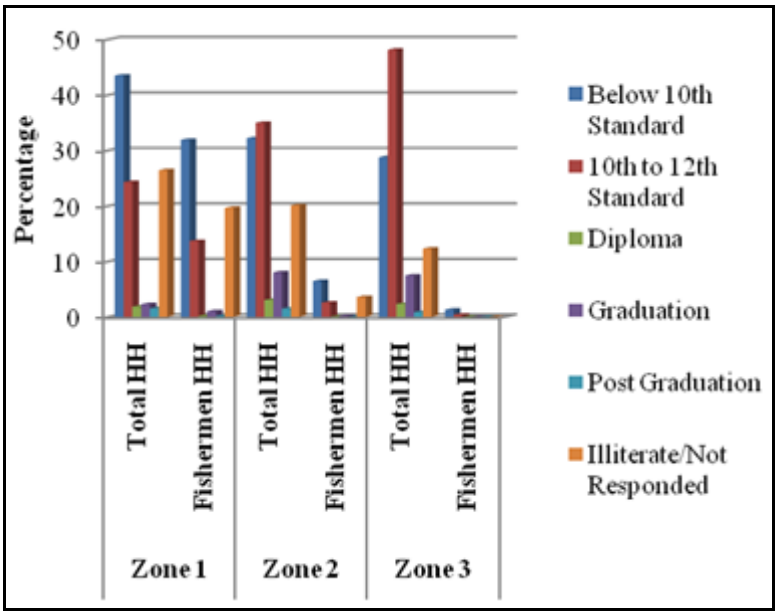
(Source: Social Surveys, May 2012)

Table 4-35: Education Profile of the Surveyed Households

Education Level	Number of Respondents					
	Zone 1		Zone 2		Zone 3	
	Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)
Below 10th Standard	1,378	43.25	652	32.23	196	28.78
10th to 12th Standard	770	24.31	708	34.99	328	48.16
Diploma	59	1.86	62	3.06	16	2.35
Graduation	73	2.3	163	8.06	51	7.49
Post-Graduation	49	1.55	31	1.53	6	0.89
Illiterate/Not Responded	838	26.46	407	20.12	84	12.33
Total	**3,167**	**100**	**2,023**	**100**	**681**	**100**

(Source: Social Surveys, May 2012)

The survey findings presented in the table above reveal that 38% of the total surveyed households have education below Standard 10, whilst 31% of respondents were educated up to Standard 12, 2.3% were diploma holders, 4.8% were graduates, 1.5% was educated up to post-graduate level and 22.6% were uneducated. Zone wise education levels in total surveyed households and fisher households are depicted in **Figure 4-72.**



(Source: Social Surveys, May 2012)

Figure 4-72: Zone Wise Percentage of Education Level of Surveyed Households

The figure above shows that in Zone 1 the average education level of fishing households was around 10% lower in all categories than that of the general population. This education level gap was found to be even wider in Zones 2 and 3. The overall education level was found to be highest in Zone 3, followed by Zone 2 and then Zone 1, which had the highest percentage of uneducated people.

4.10.2 Social Stratification

Caste: The majority (70%) of the total surveyed population are classified as Other Backward Caste (OBC). Scheduled Caste (SC) and Scheduled Tribe (ST) constituted about 9% and 2.5%, respectively, of the surveyed population. The remaining percentage of people belong from general castes (upper

caste, 10%), and Other Eligible Communities (OEC, e.g. Malayan, Chemman). Zone wise social stratification as captured during the household survey is presented in **Table 4-36**.

Table 4-36: Zone Wise Social Stratification of Surveyed Households

Caste Category	Number of Respondents					
	Zone 1		Zone 2		Zone 3	
	Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)
Scheduled Caste (SC)	120	3.79	327	16.16	87	12.78
Schedule Tribe (ST)	89	2.81	43	2.13	16	2.35
Other Backward Castes (OBC)	2,561	80.87	1,078	53.29	474	69.60
General	127	4.01	362	17.89	90	13.22
Others	218	6.88	67	3.31	14	2.06
Not Responded	52	1.64	146	7.22	0	0.00
Total	**3,167**	**100**	**2,023**	**100**	**681**	**100**

(Source: Social Surveys, May 2012)

The highest percentage of the OBC category is found in Zone 1: 81% for total surveyed households and 60% of fisher households. This is followed by Zone 3 where the percentage of OBC amongst total households is 70% and among fishers 1.6%; whilst in Zone 2 the relative percentage of OBC category in these types of households is 53% and 13% respectively.

There are Scheduled Tribes in the study area. Maximum proportion of ST population is in Zone 1 followed by Zone 3 and Zone 2. Information on the specific tribe was not collected as part of the household survey. 2.05% and 0.10% of the fisher households in Zones 1 and 2 respectively are STs. Around 0.19% and 0.20% in Zone 1 and 2 respectively of the fishing households are SCs.

Religion: The surveyed households in the study follow three main religions, namely, Christianity, Islam and Hinduism. The study area is dotted with mosques, churches and temples. The northern side of the Vizhinjam fishing harbour is dominated by Muslims whereas the southern side was dominated by Christians. Hindu population is also present in pockets throughout the study area.

Almost 46.6% of surveyed households are Christians, 42.4% are Hindus and 10.89% were Muslims. The remaining 0.1% of people follows other religion. **Table 4-37** shows the zone-wise breakdown of followers of different religions.

Table 4-37: Zone wise Religious Stratification of the Surveyed Households

Zone	Hindu		Christian		Muslim		Others		Total
	Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)	
Zone 1	596	18.82	2020	63.78	550	17.37	1	0.03	**3,167**
Zone 2	1426	70.49	521	25.75	74	3.66	2	0.10	**2,023**
Zone 3	469	68.87	194	28.49	16	2.35	2	0.30	**681**
Total									**5,871**

(Source: Social Surveys, May 2012)

4.10.3 Occupation

The occupation of the surveyed respondents could be classified as fishing, fishing allied activities, agriculture, tourism and others (jobs in private/public sectors, job in Gulf Countries, business etc.). A

number of respondents were also involved in mussel and lobster collection. The zone-wise details of occupations is summarised in **Table 4-38**.

Table 4-38: Categorisation of Occupation in Zones of the Project

Zone		Zone 1		Zone 2		Zone 3	
		Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)
Fishing and Allied Activities	MC + DF	150	4.74	1	0.05	0	0.00
	LC + DF	582	18.38	53	2.62	0	0.00
	SS +DF	708	22.35	2	0.10	0	0.00
	IF +DF	501	15.82	55	2.72	0	0.00
	IF, MC, LC, SS & other kinds of fishing	170	5.37	151	7.46	12	1.76
Agri		438	13.83	573	28.32	17	2.50
Tourism		99	3.13	32	1.58	1	0.15
Others*		519	16.38	1156	57.14	651	95.59
Total		**3,167**	**100**	**2,023**	**100**	**681**	**100**

Note: MC+DF = Mussel Collection and Direct Fishing**;** LC+DF = Lobster Collection and Direct Fishing**;** SS+DF = Shore Seine and Direct Fishing**;** IF+DF = Indirect Fishing (Boat maintenance, Net weaving, Fish sale etc.) and Direct Fishing**;** IF, MC, LC, SS and other kind of fishing = Summation of Respondents exclusively involved in Indirect Fishing/ Mussel Collection/ Lobster Collection/ Shore Seine/ Other kind of fishing like deep sea fishing, etc.

*****Service in Govt., Private sector, Job in Gulf Countries, Business, Labour, etc.

It can be seen from the information above that occupations in Zone 1 are mainly in fishing and allied activities (about 67%, including sea fishing, mussel collection, lobster collection, shore seine fishing and allied activities) followed by agriculture (14%), tourism (3%) and others (about 16%, including service in Government & Private sectors, overseas jobs, especially in Gulf countries, jobs in Business, etc.).

In Zone 2, agriculture (28%) and 'other' categories (57%) were observed to be the predominant occupations, whilst in Zone 3 more than 95% of the surveyed respondents were employed with government/private sectors/in overseas/self-employed etc. and only 1.76% were involved in fishing. Very few were involved in agriculture (2.5%) and tourism (0.15%).

The trend in occupation is depicted in **Figure 4-74**. From this figure, it can be visualised that surveyed people were employed in all occupations, namely direct fishing, agriculture, tourism and in other profession, i.e., services/business/coolie etc. in all three zones. No respondents from Zone 2 and 3 were involved exclusively in indirect fishing activities. As might have been expected, the percentage of people involved in direct and indirect fishing and tourism-related activities decreased as the distance from the coast increased.

4.10.4 Household Income, Expenditure and Asset Ownership

Household Expenditure: The zone wise expenditure pattern of the surveyed households is tabulated below. In Zone 1, the highest average monthly expenditure (42.57% of total expenditure) was on food (₹ 4,086), followed by other category (₹ 1853) consisting of money spent on fuel, festival, marriage related, loan repayment etc., which constitutes to 19.31% of the total expenditure. 14.01% of the total expenditure was spent on health care.

Similarly in Zone 2, majority of the total expenditure (43.09%) was spent on food and it was followed by expenditure on fuel, festival, loan repayment etc. (other category), which constituted 15.46% of the total expenditure. 13.05% of the total expenditure was spent on health care.

In Zone 3 the highest percentage of expenditure was contributed by food (46.34%) followed by other category (16.33%) and health (10.8%).

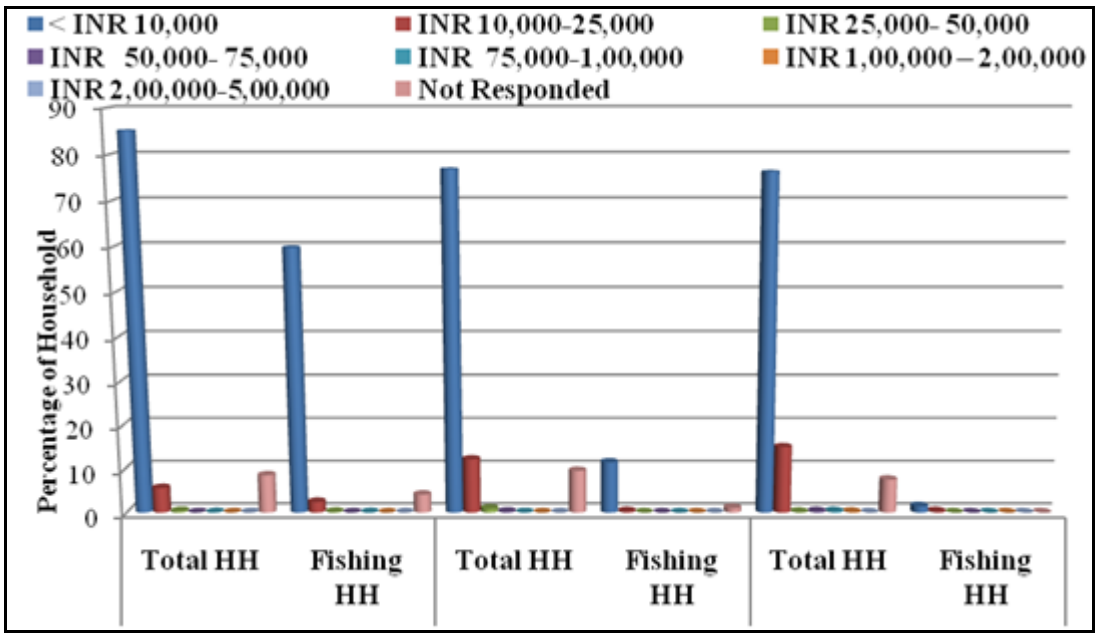


Figure 4-73: Zone wise Income of Surveyed Households

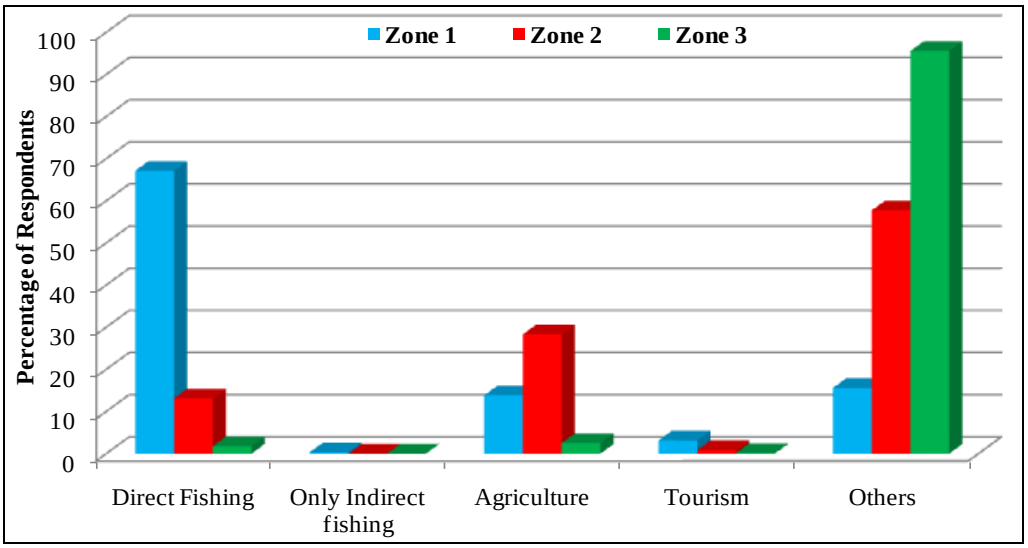


Figure 4-74: Trends in Occupation

Table 4-39: Zone Wise Average Monthly Expenditure

Expenditure	Average Monthly Expenditure (₹/Month)					
	Zone 1		Zone 2		Zone 3	
	Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)
Food	4,086	42.57	3,886	43.09	3,309	46.34
Health	1,345	14.01	1,177	13.05	772	10.81

Expenditure	Average Monthly Expenditure (₹/Month)					
	Zone 1		Zone 2		Zone 3	
	Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)
Rent	144	1.50	138	1.53	146	2.04
Electricity	457	4.76	381	4.22	310	4.34
Education	811	8.45	917	10.17	691	9.68
Water	181	1.89	99	1.10	85	1.19
Travel	610	6.36	671	7.44	519	7.27
Tax	37	0.39	49	0.54	54	0.76
Agriculture	30	0.31	275	3.05	43	0.60
Commercial	44	0.46	31	0.34	45	0.63
Others	1,853	19.31	1,394	15.46	1,166	16.33
Total	**9,598**	**100**	**9,018**	**100**	**7,140**	**100**

Assets Ownership: In Zone 1, a large number of the surveyed population owned a house (80.74%), a TV (79.63%), a cell phone (77.52%), a LPG Cylinder (62.71%) and a refrigerator (29.21%). In Zone 2, 92.14% possessed a house, 92.39% possessed a TV, 89.97% possessed a cell phone, 25.11% had a LPG cylinder and 46.37% had refrigerators in their houses. In Zone 3 the numbers were as follows: 94.13% owned houses, 92.07% televisions, 90.75% owned mobile telephones, 70.63% had LPG cylinders in their houses and 52.72% had refrigerators. The assets ownership by the surveyed population is given in **Table 4-40**.

Table 4-40: Asset Classification and Possession for the Surveyed Households

S. No.	Assets	Zone I		Zone II		Zone III	
		Nos.	Percentage (%)	Nos.	Percentage (%)	Nos.	Percentage (%)
1.	Own House	2,557	80.74	1,864	92.14	641	94.13
2.	TV	2,522	79.63	1,869	92.39	627	92.07
3.	Cell Phone	2,455	77.52	1,820	89.97	618	90.75
4.	LPG	1,986	62.71	508	25.11	481	70.63
5.	Refrigerator	925	29.21	938	46.37	359	52.72
6.	Cycle	700	22.10	716	35.39	268	39.35
7.	2 Wheeler	472	14.90	904	44.69	305	44.79
8.	Telephone	461	14.56	717	35.44	245	35.98
9.	Radio	650	20.52	506	25.01	166	24.38
10.	Computer	331	10.45	311	15.37	83	12.19
11.	Washing Machine	240	7.58	250	12.36	72	10.57
12.	Car	150	4.74	195	9.64	71	10.43
13.	Oven	241	7.61	100	4.94	66	9.69
14.	Fax	121	3.82	46	2.27	6	0.88
15.	AC	74	2.34	34	1.68	16	2.35
16.	Cooler	73	2.31	29	1.43	11	1.62
17.	Tractor	105	3.32	35	1.73	13	1.91
18.	Other	25	0.79	21	1.04	1	0.15

(Source: Social Surveys, May 2012)

Livestock Ownership: About 255 (0.08%), 338 (0.17%) and 23 (0.03%) no. of households in Zone 1, 2 and 3 had domestic animals in their houses. Cow, goat and poultry were the preferred animals for

rearing in all the three Zones; Poultry was reared in 459 households, whereas goat and cow were reared in 248 and 224 households only.

The total no. of poultry was higher (69% to 82%) in all the three zones compared to other domestic animals. Goats were the next significant domestic animal, with their contribution to total livestock ranging from 7% to 17%. The percentage of cow in the total livestock varied from 6 to 14%.

Zone 2 had the highest number of domestic animals (3,692), it was followed by Zone 1 (1140) and Zone 3 (107). From this, it can be concluded that animal husbandry is higher in Zone 2.

4.10.5 Economic Activities

The two main economic activities in the study area are (i) fishing including fish -related activities; and (ii) agriculture. These are described in the following sections.

Fishery: Being a coastal area, fishing is an important occupation. The coastal villages (Zone 1) are primarily inhabited by fishing communities. Details about the fishing villages in the study area in general and in the Project shadow area specifically are given here. The information presented in this section is based on both primary and secondary sources.

Fishing Villages: A significant proportion (42.54%) of the population surveyed in the study area is found to be directly or indirectly dependent on fishing or fishing allied activities. Thirteen villages in the coastal stretch of the study area (10 km radial area) are registered as fishing villages, (Marine Fisheries Census, Kerala Part 2, 2010) namely, Poonthura, Panathura, Kovalam, Vizhinjam North, Vizhinjam South, Chowara, Adimalathura, Pulluvila, Pallom, Puthiyathura, Kochuthura, Karimkulam and Poovar.

Around 54,000 fishermen (including children in fishermen households) reside in these 13 designated fishing villages (Ref. Marine Fisheries Census 2010). **There are no fishing villages in the shadow area of the breakwater**. Adimalathura and Chowara, however, fall in the shadow area of the approach channel. The fishermen men population of the 13 designated fishing villages as per the Marine Fisheries Census 2010 is shown in **Table 4-41**.

Table 4-41: CMFRI – Census of the Fishermen Population in Fishing Villages

Designated Fishing Villages	Fishermen Families	Traditional Fishermen Families	BPL Families	Percentage of BPL Families	Fishermen Population	Average Family Size
Poonthura	1,290	1,290	968	75%	8,871	6.88
Panathura	30	30	9	30%	185	6.17
Kovalam	60	60	25	42%	365	6.08
Vizhinjam North	1,050	1,050	403	38%	5,849	5.57
Vizhinjam South	3,036	3,058	1,724	56%	11,606	3.79
Chowara	238	238	236	99%	871	3.66
Adimalathura	1,307	1,307	1,304	100%	4,885	3.74
Pulluvila	2,078	2,027	683	33%	7,800	3.75
Pallom	353	353	71	20%	1,206	3.42
Puthiyathura	1,587	1,587	1,169	74%	6,544	4.12
Kochuthura	262	259	248	95%	1,040	3.97
Karumkulam	375	375	193	52%	1,330	3.55

Designated Fishing Villages	Fishermen Families	Traditional Fishermen Families	BPL Families	Percentage of BPL Families	Fishermen Population	Average Family Size
Poovar	963	963	961	100%	3,721	3.86
Total	**12,629**	**12,597**	**7,994**	**-**	**54,273**	**-**

It is important to note that nearly **60% of the fishing households are below the official poverty line**[19] indicating poor socio-economic conditions in the fishing villages.

Beside these designated fishing villages, there are scattered fishermen living in Nellikunnu, Pulinkudy, Azhimala and Chapathu, which are located in the Project shadow area. Since the coastline of Nellikunnu, Mulloor, Pulinkudy, Azhimala and Chapathu (**Figure 4-75**) is lined with resorts/ hotels, the fishing population of these villages are scatterly settled about two to three kilometres inland, away from the coastline. The details of beaches present in the shadow area of project stretch are provided in (**Figure 4-76**). Besides these beaches there are small beaches which are seasonal, they only appear over a very short time during the pre-monsoon months (March- April).

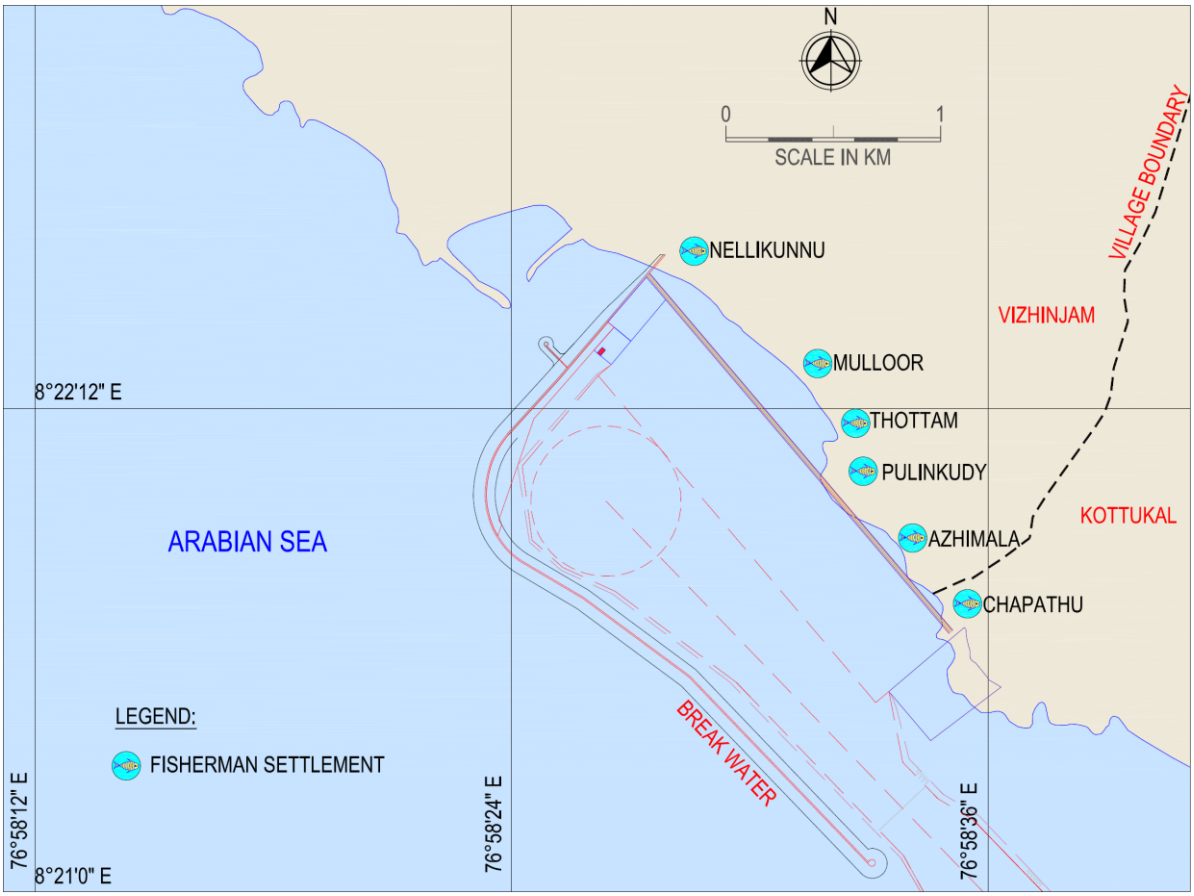


Figure 4-75: Isolated houses of Fishing Community in the Project Shadow Area

[19] In Kerala state, the below poverty line is decided by the nine parameters like no land or less than five cent of land, no house or dilapidated house, no sanitation latrine, family without colour television (in case of rural areas, this criteria is replaced by family with an illiterate adult member), no regular employed person in the family, no access to safe drinking water, women-headed household or presence of widows or divorcee, scheduled castes and scheduled tribes (SC/ST), mentally retarded or disabled member in the family.

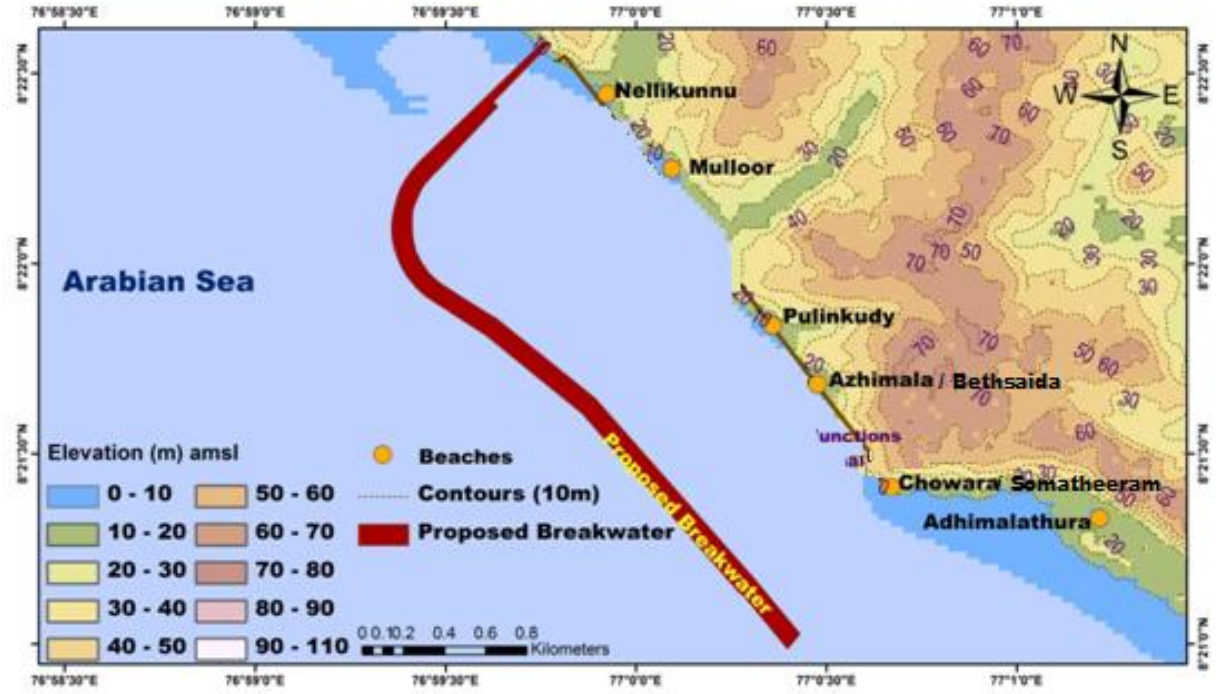


Figure 4-76: Different Beaches in the Project Shadow Area

Participation in Fishing: The survey findings reveal that mussel collection, lobster fishing, shore seine fishing, other fishing in sea including deep sea fishing and miscellaneous fishing-related activities are the major occupation in the surveyed population (**Figure 4-77**).

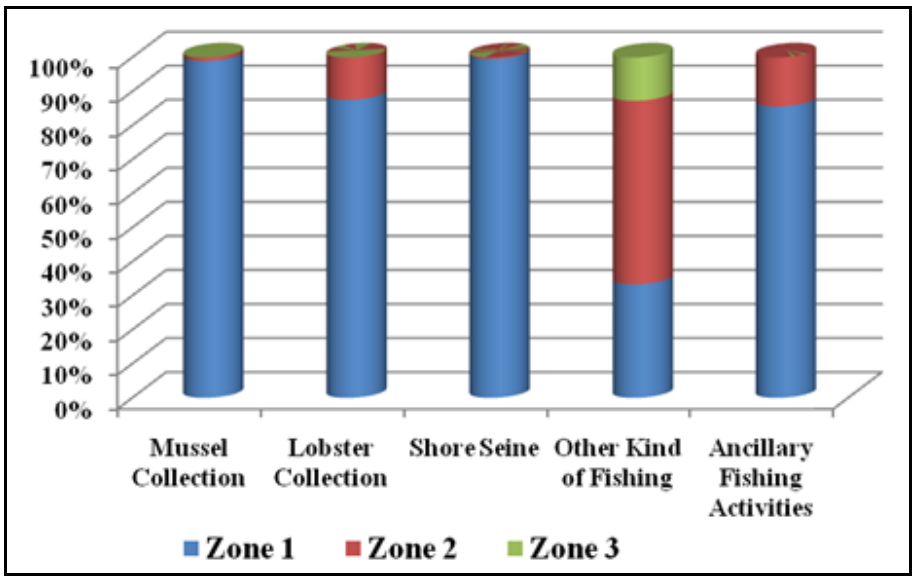


Figure 4-77: Zone Wise Percentage of Households involved In Direct Fishing

More than 65% of the surveyed population in the Zone-1 depend on sea for their livelihood through fishing and fishing-related activities like boat/catamaran repair, net weaving, fish transaction (retail and whole sale both)/ work as coolie for fish handling etc. and rest of the people from Zone 1 are involved in other non-fishing professions**.**

The involvement in fishing as an economic activity goes down as one moves away from the coast. For instance in Zone 2, only about 10% are found to be engaged in fishing and related occupation. In Zone 3, only 1.76% from the surveyed household was engaged in fishing in the sea.

The Marine Fisheries Census 2010 report presents useful information to understand the participation rate in fishing. As per the report, there are 13,630 active fishermen in the 13 fishing villages. Active fishermen include fishermen engaged in actual fishing as well as those engaged in fish seed collection. The proportion of active fishermen constitutes 37% of the total adult population and 70% of the total adult male population in the fishing villages. The village wise proportion of active fishermen in the 13 fishing villages is presented in the **Table 4-42**.

Table 4-42: Population of Active Fishermen

S. No.	Designated Fishing Villages	No. of active fishermen	% of total adult population	% of total adult male population
1.	Poonthura	1,584	30	59
2.	Panathura	43	31	69
3.	Kovalam	103	36	73
4.	Vizhinjam North	1,308	32	60
5.	Vizhinjam South	3,137	41	78
6.	Chowara	234	39	76
7.	Adimalathura	1,390	41	76
8.	Pulluvila	1,938	36	68
9.	Pallom	352	40	77
10.	Puthiyathura	1,800	38	72
11.	Kochuthura	297	42	77
12.	Karumkulam	350	37	68
13.	Poovar	1,094	41	79
Total		**13,630**	**37**	**70**

The data indicates that around 98% of the active fishermen men are involved in actual fishing and the remaining 2% is involved in fish seed collection. Majority (92%) of those involved in actual fishing are full time fishermen (**Table 4-43**).

Table 4-43: Full Time and Part Time Fishermen

S. No.	Designated Fishing Villages	Actual Fishing			
		Full Time	Part Time	Total	Full Time Fishermen % of Total Population Involved in Actual Fishing
1.	Adimalathura	1,245	136	1,381	90
2.	Chowara	212	22	234	91
3.	Karumkulam	328	22	350	94
4.	Kochuthura	265	32	297	89
5.	Kovalam	103	0	103	100
6.	Pallom	326	26	352	93
7.	Poovar	1,082	11	1,093	99
8.	Pulluvila	1,722	214	1,936	89
9.	Puthiyathura	1,472	325	1,797	82
10.	Vizhinjam North	1,292	16	1,308	99
11.	Vizhinjam South	2,816	319	3,135	90

S. No.	Designated Fishing Villages	Actual Fishing			
		Full Time	Part Time	Total	Full Time Fishermen % of Total Population Involved in Actual Fishing
12.	Panathura	43	0	43	100
13.	Poonthura	1,378	18	1,396	99
Total		**12,284**	**1,141**	**13,425**	**92**

As per the Marine Census 2010, nearly 37% of the total adult population is engaged in actual fishing and around 14% are involved in fishing-related activities in the 13 designated fishing villages. Proportion of adult population in fishing villages involved in activities other than fishing is insignificant at 2%. Information on what other fishermen do is not provided in the Marine Fisheries Census report.

Chowara has the highest percentage of adult fishermen men (40%) involved in fishing allied activities followed by Adimalathula (29%). **Table 4-44** shows the village-wise involvement in fishing-related activities as per the Marine Census 2010.

Table 4-44: Adult population engaged in fishing-related activities

S. No.	Villages	Marketing of Fish	Marketing/ Repairing Net	Curing/ Processing	Peeling	Labourer	Others	Total allied	% of total adult population
1.	Poonthura	752	3	21	0	105	1	882	17
2.	Panathura	0	0	0	0	0	0	0	0
3.	Kovalam	0	0	0	0	0	0	0	0
4.	Vizhinjam North	4	0	0	0	144	0	148	4
5.	Vizhinjam South	465	3	0	0	16	15	499	7
6.	Chowara	116	121	0	0	0	3	240	40
7.	Adimalathura	541	270	155	0	1	38	1,005	29
8.	Pulluvila	565	3	253	8	38	9	876	16
9.	Pallom	156	3	35	1	3	4	202	23
10.	Puthiyathura	386	29	65	8	22	17	527	11
11.	Kochuthura	84	1	12	0	1	3	101	14
12.	Karumkulam	112	2	41	0	6	0	161	17
13.	Poovar	501	27	2	0	3	9	542	20
	Total	**3,682**	**462**	**584**	**17**	**339**	**99**	**5,183**	**14**

(Source: Marine Census, 2010)

Amongst allied activities, a large proportion (71%) of the total population involved in allied activities is involved in marketing followed by curing/ processing (11%) and labourer (7%).

Participation of Women in Fishery: The Marine Fisheries Census reveals that less than 1% of the total adult female population in the 13 designated fishing villages constitutes active fishermen population. Women are not involved in actual fishing. They are involved in fish seed collection with only 15% involved in full time in seed collection and the rest undertaking fish seed (fish eggs) collection as part time occupation. The Census indicates very limited involvement of women in actual fishing. However, approximately 22% of the total adult female population in fishing villages is involved in fishing allied activities. This means that 75% of those involved in fishing allied activities are women (**Table 4-45**).

Table 4-45: Involvement of Women in Fishing Allied Activities

S.No.	Allied activity	% of total women involved in allied activities
1.	Marketing of fish	77
2.	Marketing/ repairing net	3
3.	Curing/ processing	13
4.	Peeling	0.30
5.	Labourer	6
6.	Others	1

The above indicates that women participate actively in selling fish in the local markets. Women also get involved in the shore-based household processing and net making activities.

Catch Composition and Seasonality: The fish catch composition data of the Vizhinjam and Adimalathura fish landing centre was collected by Central Marine Fisheries Research Institute, Vizhinjam Regional Centre as part of marine monitoring for the proposed Project from October 2011 to September 2012. The study area for the marine monitoring was divided into three zones, as indicated in **Table 4-46**. These are not the same zones as used in the socio-economic survey, but based on the CMFRI zonation. This section presents information for the direct foot print zone of this project in which two sampling stations, namely, Mulloor and Karimpallikkara.

Table 4-46: Zoning of the Marine Impact According to the CMFRI Census

	Zone	Station	Latitude	Longitude
Direct foot print zone	**Zone-1**	Karimpallikkara	8°22'18.03"N	76°59'22.14"E
		Mulloor	8°22'3.39"N	76°59'59.43"E
Potential impact zone	**Zone-2**	Kovalam	8°22'15.08"N	76°57'58.68"E
		Karichal	8°20'34.67"N	76°59'18.75"E
Control zone	**Zone-3**	Panathura	8°24'21.17"N	76°57'20.23"E
		Puthiyathura	8°19'16.48"N	77°2'28.71"E

The seasonal catch composition is given in **Table 4-47**. It can be inferred from the data that Indian mackerel, bullet tuna, kawakawa, Indian oil sardine are the dominant fish species in the study area. Mussels and crabs are also landed in this area. The quantity of catch in pre monsoon season is the highest, when compared to post monsoon and monsoon seasons.

Table 4-47: Seasonal Catch Composition at Vizhinjam and Adimalathura

Season	Fish Landing Centre	Type	Common Name	Catch (T/season)
Post Monsoon	Vizhinjam	Fish	Indian mackerel	488.37
			Bullet tuna	307.5
			Indian scad	86.0
		Cephalopods	Bigeye scad	88.5
			Kawakawa	69.3
			Cuttle fish	54.4
			Loligo squid	33.2
		Crustaceans	Spotted crab	1.5
		Bivalve	Rock lobster	1.0
	Adimalathura	Fish	Sardine	33.7
			Indian mackerel	31.4
Pre Monsoon	Vizhinjam	Fish	Indian mackerel	655.1

Season	Fish Landing Centre	Type	Common Name	Catch (T/season)
			Bullet tuna	594.9
			Kawakawa	238.7
			Indian scad	182.2
			Indian oil sardine	157.5
		Bivalve	Brown mussel	177.6
	Adimalathura	Fish	Sardine	30.8
			Indian mackerel	26.9
			Indian oil sardine	16.6
			Bigeye scad	15.5
			Kawakawa	13.5
			Indian scad	11.6
Monsoon	Vizhinjam	*Fish*	Indian mackerel	917.0
			Indian scad	475.8
			Bullet tuna	460.0
			Largehead hairtail	480.5
			Unicorn leatherjacket filefish	458.7
			Kawakawa	244.2
		Cephalopods	Indian Squid	227.2
			Cuttle fish	66.9
			Loligo squid	15.6
		Shrimps	Indian white prawn	17.2
			Giant tiger prawn	0.5
		Crab	Spotted crab	10.5
			Flower crab	1.0
		Bivalve	Brown mussel	346.8
	Adimalathura	Fish	Indian oil sardine	15.0
			Malabar thryssa	6.0

Figure 4-78 shows the fishing months identified as a result of the survey in Zone 1 and 2. The findings show that fishing activity was carried out almost throughout the year, but December was the busiest for the fishermen residing in Zone 1 (about 62%). As per the fishermen respondents in Zone 2, apart from December (38%), about 42% of the fishermen are also involved in fishing activity in the month of April.

Seasonality in use of fish landing: The seasonal variation in the fish landing locations in Zone 1 and 2 is depicted in **Figure 4-79**. It is evident from the survey results that during pre-monsoon and post monsoon season, about ≥80% of surveyed fishermen land their catch on beaches. However, in monsoon due to the submergence of beaches because of high tide, about 70% of the fishermen from Zone 1 use of Vizhinjam fishing harbour. In contrast, 60% fishermen from Zone 2 reported use beaches in the Monsoon season too and only 38% of fishermen land their catches to the harbour.

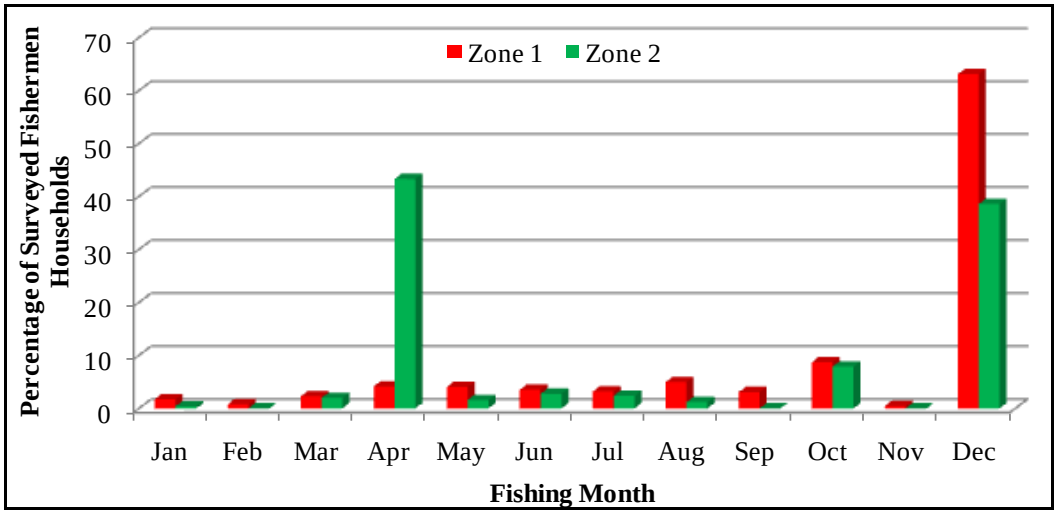


Figure 4-78: Fishing Month

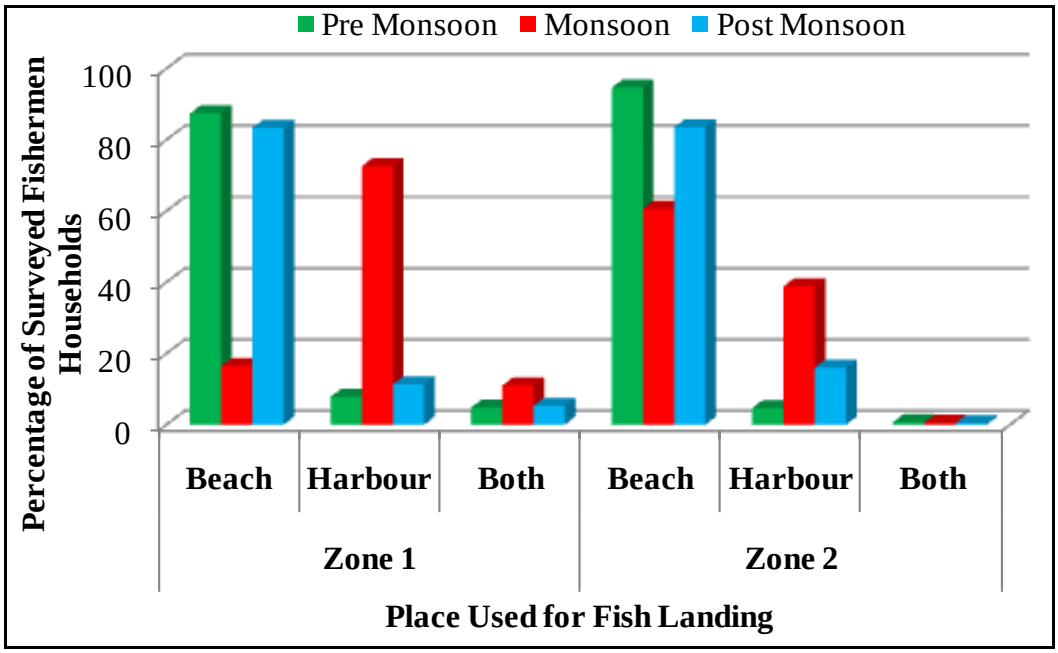


Figure 4-79: Seasonal Variation in Fish Landing Place

4.10.5.1 Fish Catch Details

The data indicates that motorized boats have the maximum number of catches in one year. The total number of catches for mechanized boats is high in April-June period but it reduces drastically during other months. Season wise number of catches per boat information is presented in **Table 4-48**.

Table 4-48: Total Number of Catches in Vizhinjam Centre

Seasons	Non-motorized[20]	Motorized	Mechanized
April-June	1204	39485	3633
July-Sept	1183	38860	385

[20] Non-motorized: Boats/vessels such as Country canoes, Catamarans etc.,
Motorized: Boats/vessels that are fitted without board motors.
Mechanized: Fully mechanized boats/vessels

Seasons	Non-motorized[20]	Motorized	Mechanized
Oct-Dec	1162	39217	352
Jan-March	1190	39485	374
Total	**4739**	**157047**	**4744**

There are 590 boats which land catches at Vizhinjam centre. These include 21 non-motorized, 536 motorized and 33 mechanized boats. Average number of catches per non-motorized, motorized and mechanized boat is 56, 73 and 36 respectively.

Average quantity per catch in quintals varies from around 4.0 quintals for motorized boats to 8.4 quintals for non-motorized. **Table 4-49** shows the season average quantity per catch at Vizhinjam centre.

Table 4-49: Average Number of Catches per Boat

Seasons	Non-motorized	Motorized	Mechanized
April-June	57	74	110
July-Sept	56	73	12
Oct-Dec	55	73	11
Jan-March	57	74	11

Information on catch was collected as part of the household survey. The average fish catch per month in each season is demonstrated in **Figure 4-80**. An average fish catch of 0 -1000 kg/month is caught by 80 to 90% of the fishermen respondents in Zone 1, in all seasons. On the other hand, only 0-500 kg/month (average) quantity of fish is caught by 95% of fishermen respondents in Zone 2.

In Zone 1, 40% of the fishermen respondents catch fish in the range of 501 -1000 kg/month during pre-monsoon season, while 29% and 18% of the fishermen respondents catch fish in the range of 0-100 and 101-500 kg/month, respectively. During the monsoon season, 34% of fishermen catch only 0-100 kg/month of fish, 22% and 32% of fishermen catch fish in the range of 101-500 and 501-1000 kg/month, respectively. The average quantity per catch is given in **Table 4-50**.

Table 4-50: Average Quantity per Catch (Quintals)

Seasons	Non-motorized	Motorized	Mechanized
April-June	8.87	3.65	7.6
July-Sept	9	4.38	8.87
Oct-Dec	8.93	4.16	7.8
Jan-March	6.8	3.7	7.93

As mentioned earlier, the average fish catch in Zone 2 was comparatively lower than Zone 1 (**Figure 4-80**).

The seasonal variation in average fish catch in Zone 1 and 2 is given in **Table 4-51**.

Table 4-51: Seasonal Variation in Average Fish Catch in Zone 1 and 2

Season	Fish catch/month (kg)	
	Zone 1	Zone 2
Pre Monsoon	804	165
Monsoon	743	242
Post Monsoon	533	152

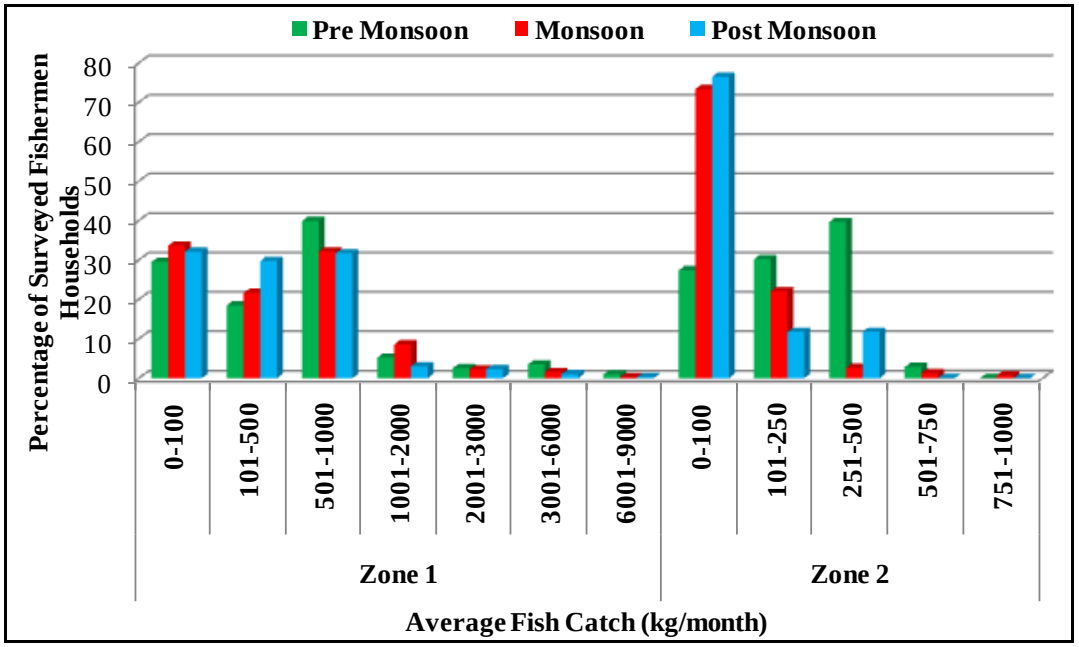


Figure 4-80: Average Fish Catch per Season per Zone

Expenditure on fishing: The report of Survey on Input Cost Prevailed in Fishing Sector in Kerala, 2009 presents information for Vizhinjam fishing landing centre. Disaggregated village wise data on this was not available. Reliable data on this aspect was collected during the household survey conducted as part of this EIA as most respondents did not provide an answer to this question. It is recommended that this information be collected as part of the Census Survey to be conducted. The report indicates that the average expenditure per catch is highest for mechanized boats (**Table 4-52**). While fuel cost is the largest expenditure for motorized and mechanized boats, labour costs constitutes a large part of total expenditure for the non-motorized boats.

Table 4-52: Average Expenditure per Catch (₹) for Vizhinjam

	Non-motorized boat	Motorized boat	Mechanized boat
Average no. of workers	5	4	11
Average wages	187	154	319
Total wages	935	616	3,509
Loading and unloading	183	113	200
Fuel	40	1,533	1,360
Cost of ice	83	100	417
Others	100	142	500
Total	**1,528**	**2,504**	**5,986**

Catch per Unit Effort (CPUE) and Expenditure: Reliable information could not be collected during the socio-economic survey to determine CPUE. However, CMFRI has provided CPUE based on the outcome of experimental fishing carried out for the proposed Project from October 2011 to September 2012. The CPUE in direct Project footprint zone is tabulated in **Table 4-53**. It can be inferred from the table the CPUE was higher in Post Monsoon season followed by Monsoon and Pre Monsoon.

Table 4-53: Average Catch per Unit Effort (CPUE)

Season	Average CPUE (kgs)	Avg. No. of Species
Post Monsoon	18.27	12

Season	Average CPUE (kgs)	Avg. No. of Species
Monsoon	16.02	17
Pre Monsoon	15.66	17

Aswathy, *et al* in their paper on Economic Viability of Mechanized Fishing Units and Socioeconomics of Fishing Ban in Kerala published in 2011 have estimated the labour productivity/ catch per unit of effort in kgs per man/day. For mechanised boats, it is 26 kgs/ man/day for multi-day (more 6 days) to 49 kgs/ man/day for single day mechanised boats. For gillnetters and liners, it is 26 kgs/ man/day for multi-day (more than 6 days) to 53 kgs/ per man/day for a single day.

Secondary information presented in the Department of Economics and Statistics report has been used to calculate catch per unit expenditure (kgs). **Table 4-54** shows that the catch per unit of expenditure is highest for non-motorized boats.

Table 4-54: Catch Per Unit Expenditure (in kgs)

Seasons	Non-motorized	Motorized	Mechanized
April-June	0.58	0.15	0.13
July-September	0.59	0.17	0.15
October-December	0.58	0.17	0.13
January-March	0.45	0.15	0.13

4.10.5.2 Fishing Craft

The details of fishing craft are given below

a) **Catamaran:** Catamaran is made by four pieces of 6.0 m long logs and are powered traditional sail (cotton) kept upright using a bamboo pole as mast. Small outboard engines are also used in catamarans. Typically, hook and line and small meshed gill nets and boat seines are used as gears. Ownership of catamaran is usually individual. In the Project stretch, these are used for mussel collection.
b) **Dugout Canoe:** It is made by scooping out wood from a single of log of wood. Their size varies from 4 - 15 meters. The large dugout canoe use boat seines or encircling net and the small ones use gillnets, cast nets and hook and line. Large dugout canoes can accommodate up to 15 crew members. The ownership of dugout canoes varies depending on its size (smaller ones are usually individually owned).
c) **Plank Canoe:** A plank canoe is made by putting together several planks with coir rope and they are 7-15 meters longs. These are usually jointly owned and can accommodate a crew of 6-15 depending upon the size.
d) **Mechanized Boats:** Mechanised fishing in the study stretch can be further classified as follows: Gill Netting and hook and Line.

Dugout Canoes, Plank Built Canoes, Marine Plywood Canoes and Catamaran are used for traditional fishing. Some of these are fitted with Out Board Motors (OBMs). The common types of gear used are gill nets, purse seines and shore seines. The operations of traditional crafts are confined within a range of 20 km off the coast. But some large Kettuvalloms, which are about 20 meter in length and fitted with two or three OBMs of 25 to 40 HP, operate beyond 20 km. The non-motorized crafts are now being motorized with the assistance from financial institutions.

Ownership of crafts in the Study Area:

Type of Fishing Vessels used in the Project Area: Out of 2112 fishing households surveyed as part of the household from Zone 1, 411 households own fishing vessels, in which 213 had motorized vessels and 140 had manual boats (**Table 4-55**).

In Zone 2, out of 262 fishing households, 82 households had their own fishing vessels, in which 39 had motorized boats and 40 had manual boats. None from Zone 3 had own fishing vessels.

Table 4-55: Type of Fishing Vessels Owned by the Fishermen

Type	Zone I		Zone II	
	Nos.	%	Nos.	%
Motorized	213	51.82	39	47.56
Manual	140	34.06	40	48.78
Not Responded	58	14.11	3	3.65
Total	**411**	**100**	**82**	**100**

As per the Marine Fisheries Census 2010, Kerala Part II-6, there are a very limited number of mechanised craft owned by fishermen in Vizhinjam South. Aside from mechanised craft, fishermen owned a significant number of non-mechanised or outboard-motor powered craft (**Figure 4-81**). There were 1,300 fishermen in Vizhinjam North but only 50 owned crafts. The situation was similar in Pulluvila. Fishermen of Panathura and Kovalam villages did not own any craft. Vizhinjam South had 3,140 fishermen, of which 530 owned crafts, a somewhat better situation.

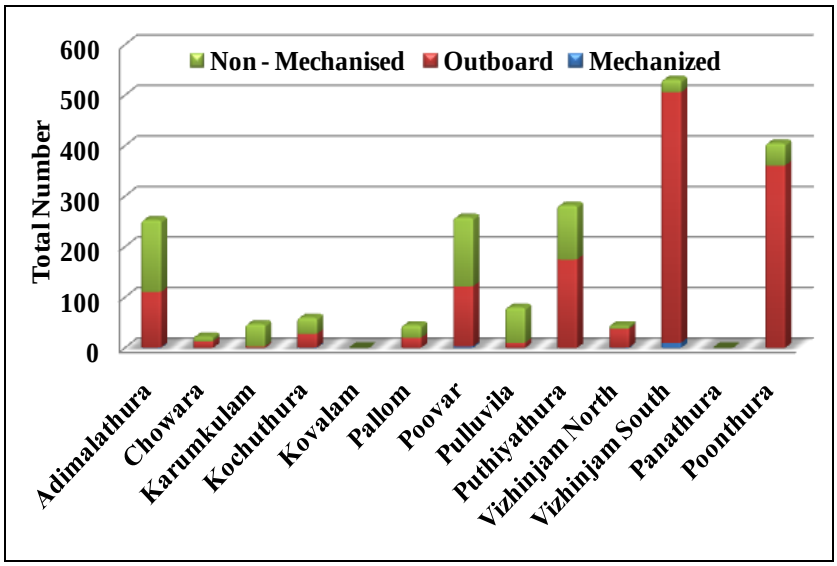


Figure 4-81: Crafts Owned in Vizhinjam South

4.10.5.3 Fishing Gear

The details of fishing gear are collected by CMFRI as part of a marine survey is given in **Table 4-56**.

Table 4-56: Type of Gear Used, Respective Species of Fish Catch and Fishing Months

Type of Gear Used		Dominant Species	Fishing Months
Gill Net	Mackerel Gill Net	Tuna, Mackerel	April to October
	Monofilament Gill Net	Mackerel	-

Type of Gear Used		Dominant Species	Fishing Months
	Sardine Gill Net	-	May to August
	Anchovy Gill Net	-	June to September
	Drift Gill Net	-	-
	Bottom set Gill Net	Flat Fishes, crabs, prawns, croakers, skate, rays and chanks.	-
	Trammel Net	Sole, Croakers, Prawns, Crabs	
	Roll Net		August to October
Hook and Line	Hand Line	Squids, Cuttlefish	October to November
	Light Fishing	Mackerel, Scads, Tuna, Squids, Cuttlefishes	November to March
	Squid Jigs	Cuttlefish	
	Tuna Long Line Fishing	Tuna, Cobia, Grouper, Snappers	November to March
	Long Line for Large Scads	Snappers, Carangids, Lethrenids, Cobia, Rock Cod, *Priacanthus spp.*	November to May
	Reef Long Line	Skates, Cobia, Carangids, Rock cod, *Pristipomoides spp.*	November to February
	Shark Long Line	Bill fish, Sail fish, Sharks, Yellow fin tuna, Rays	November to April
Boat Seine	Thattu madi	Carangids, Catfishes, Clupeids, Pomfrets, Ribbon fishes, *Sillago sihama*, Ballistids, *Lactarius lactarius, Nemipterus* spp.	June to October
	Light Fishing using boat seine	Squids, mackerel, carangids, barracuda, *Decapterus* spp., Prawns.	November to March
Shore Seine	-	Anchovies, silver bellies, carangids, sardines, mullets, mackerel, saurida, squids, *Acetes* spp.	October to May

(Source: Marrine study CMFRI, 2012)

Involvement of family members in Fishing: The survey findings (**Figure 4-82**) reveal that in the majority of the fishing households, only one member is involved in fishing. Similarly, in case of indirect fishing, only one family member is involved in about 75% and 80% of the surveyed fishermen households.

Participation in Alternate Occupation: Reliable information on this aspect could not be covered as part of the survey as around 60% of the fishermen in Zone 1 did not respond to this question. About 36% of the fishermen interviewed reported borrowing money or taking loans from banks. Only 3% of the remaining fishermen reported that they remain jobless in the lean season. In Zone 2, more than half of the population (56%), reported that they remain jobless whereas 24% of the fishermen respondents reported borrowing money or taking loans from banks. Around 7% reported surviving on their savings during the lean season, whilst 3% worked as casual labourers as an alternative occupation during the lean fishing season in Zone 2.

Some observations based on the Household Survey

- Present trends in fishing as an occupation: Out of the total surveyed households (5871), almost 21% people indicated that the number of people involved in fishing as a profession is decreasing with time. In contrast, 12.5% of respondents claimed that this number is actually increasing.

- Availability of fish in the project stretch of sea: According to the 37% of the surveyed population, the availability of the fish in the sea is decreasing, while 5% felt that the catch is in fact increasing compared to previous years.

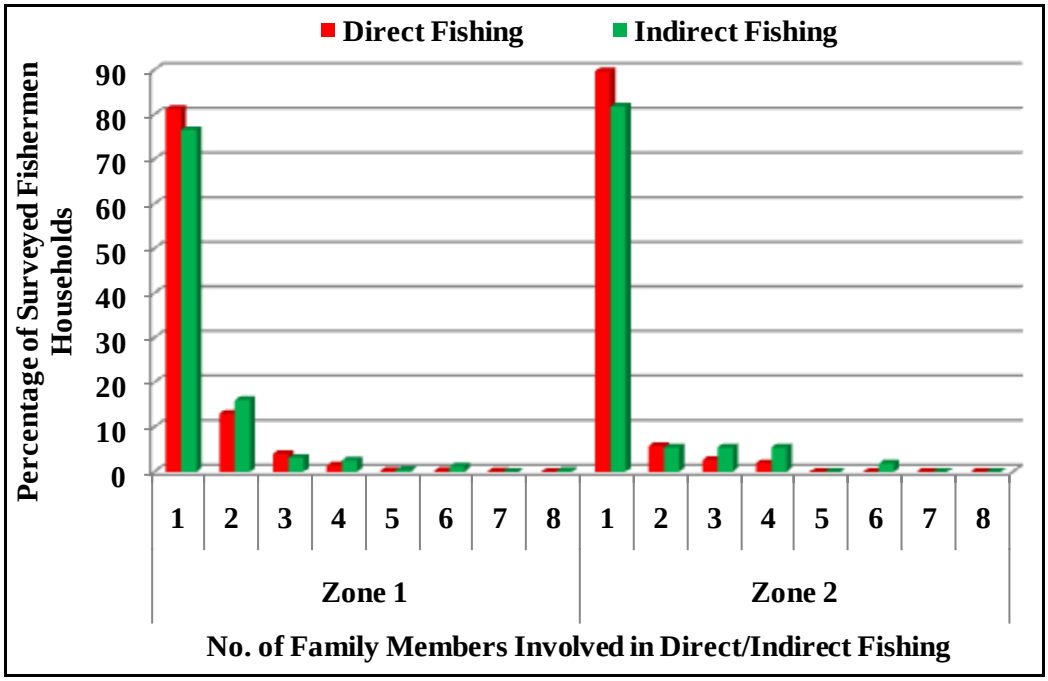


Figure 4-82: Number of Family Members Involved in Direct/Indirect Fishing

Mussel Collection: Out of 3167 number of surveyed household from Zone -1, only 158 (5% of the total surveyed households) of respondents, are engaged in Mussel Collection. Around 95% these mussel collectors are involved in fishing activities in non-mussel seasons. Mussel collection in the study area is restricted to the months of **January, February, March and April**. On an average, one family member from each of the 158 families is involved in mussel collection. The average monthly income from mussel collection is reported to be ₹ 722. Around 90% of the mussel collectors reported that the availability of mussel is decreasing over the period. In contrast, around 83% respondents informed that the number of people involved in mussel collecting is increasing over the year. Approximately, 76% of the surveyed mussel collectors operate within the stretch of the proposed port Project and around 64% of their total catch comes from the same stretch. During off season, 32% of these mussel collectors borrow money from private money lender or from bank, where as 11% earn from fishing as well as also borrow money. Majority (55%) did not respond to this query. In Zone-2, out of 2023 respondents only three are engaged in mussel collection, whereas none was reported as mussel collector in Zone 3.

Lobster Collection: Around 19% (613 respondents) of the total respondents from Zone 1 are involved in lobster collection, out of which around 95% (582 respondents) are also engaged in direct fishing activity. On an average two family members are involved in lobster collecting. Lobster collection is carried out throughout the year. The average income from lobster collection is reported to be INR 2,814/month/member. Around 74% of the lobster collectors informed that the availability of lobsters is decreasing with time but there is an increase in number of lobster collectors over the years as reported by 62% of the respondent. Around 88% of the lobster collectors use the area designated for Port construction and around 47% of their total catch comes from this stretch.

In Zone 2, only 2.7% (54 numbers out of 2023 respondent household) are reportedly involved in lobster collection, and except one all are informed engaged in fishing too.

Shore Seine: Around 24 (outoff 771) of the total respondents (3167) in Zone 1 were involved in Shore Seine activity, (a method of fishing carried out from the shore itself). On an average, 10 family members are reported to be involved in shore seine fishing and shore seine fishing is reported to be carried out throughout the year, **if beach area is available**. The average income from shore seine is ₹ 3014 /month/member in Zone -1. Around 58% of respondents involved in shore seine felt that the availability of fish is decreasing and all felt that despite decreasing availability of fish, more people are getting involved in shore seine activities. Around 71% (549 out 771) of these fishermen reported to use the pocket beaches designated coming under the reclamation area of the port. The catch from the port area constitutes 56.3% of their total fish catch. About 26.8% of people involved shore seine fishing borrow money from private lenders/ banks during off season whereas 1.8% of the shore seine fishermen work as coolie/ helper. The remaining did not respond to this query. Only 10 out of 2023 respondents were involved in shore seine fishing in Zone 2.

Agriculture: The analysis of the social survey data revealed that 14% (438 households), 28% (573 households) and 2.5% (17 households) of the total surveyed population are involved in agricultural activity in Zone 1, 2 and 3, respectively. The summary of the details about agricultural land holding in all three Project zones is given in **Table 4-57**.

The table reveals that percentage of land under cultivation/plantation is higher in Zone-2 (28%) followed by Zone-1 (14%) and Zone-3 (2.5%). In this, the majority (77.63%) has agricultural land holding below 10 cents (404.70 m^2) and only about 3%, has land above 40 cent in Zone-1. In Zone 2, the majority, i.e., 70% (out of 28% total surveyed households) has the area below 20 cents (809.40 m^2) under cultivation/ plantation. In Zone -3, more than 60% (out of 2.5% total surveyed households which have land under cultivation) have the area above 40 cents (1618.8 m^2) under agriculture.

Table 4-57: Details about agricultural land holding in the Project zones

Range (In Cents)	Zone-1		Zone-2		Zone-3	
	No. of HHs	%	No. of HHs	%	No. of HHs	%
Below 10	340	77.63	296	51.66	0	0.00
10-20	64	14.61	104	18.15	4	23.53
20-30	15	3.42	60	10.47	2	11.76
30-40	5	1.14	31	5.41	6	35.29
Above 40	14	3.20	82	14.31	5	29.41
Total	438	100.00	573	100.00	17	100.00
Total	**3167**	**-**	**2023**	**-**	**681**	**-**

Coconut, Plantain (sweet Banana), Rubber, Mango, Tapioca and Jack fruit are the dominant plant species in the study area. The total agricultural land (both plantation and cultivation) in all three zones is about 10,000 cent. **Table 4-58** demonstrates the trend in agriculture across the three Zones. The difference in the type of plantation/ crop between the Project zones is due to the differences in soil quality. Coconut plantations are dominant in Zone 1 and 2, which can be explained by the saline soil of the coastal region. On the other hand, Mango and Jackfruit are the most cultivated trees in Zone 3, whilst Zone 2 had a mixture of both coastal and inland vegetation, which is evident from the cultivation of Plantain, Mango, Rubber and Tapioca along with Coconut.

Table 4-58: Area under Plantation and Types of Plantation

S. No.	Type of Plantation	Area under Plantation in m^2					
		Zone 1	%	Zone 2	%	Zone 3	%
1.	Coconut	21489.57	53.31	186425.06	73.37	121.41	0.11
2.	Plantain	0.00	0.00	27742.185	10.92	24484.35	22.21

S. No.	Type of Plantation	Area under Plantation in m^2					
		Zone 1	%	Zone 2	%	Zone 3	%
3.	Mango	5868.15	14.56	10137.735	3.99	44436.06	40.30
4.	Rubber	0.00	0.00	4734.99	1.86	40.47	0.04
5.	Tapioca	3844.65	9.54	23229.78	9.14	4856.4	4.40
6.	Rice	3439.95	5.53	-	-	-	-
7.	Vegetable	809.4	2.01	-	-	-	-
8.	Banana	2023.5	5.02	-	-	5787.21	5.25
9.	Jackfruit	2832.9	7.03	1335.51	0.53	29887.1	27.11
10.	Papaya	-	-	40.47	0.02	-	-
11.	Lady finger	-	-	404.7	0.16	-	-
12.	Cucumber	-	-	40.47	0.02	-	-
13.	Beans	-	-	404.7	0.37	-	-
14.	Pineapple	-	-	-	-	80.94	0.07
15.	Pepper	-	-	-	-	80.94	0.07
16.	Vegetable	-	-	-	-	80.94	0.07
Total		**40308.12**	**97.00**	**254495.6**	**100.00**	**109855.8**	**99.63**

Quadrant sampling was carried out in the area with the objective to get to know the floral diversity (other than coconut, which is commonly seen in the area).

Economics of Agriculture: The average annual income from agricultural activities in Zone 1, 2 and 3 was ₹ 22,668, ₹ 20,731 and ₹ 6,125, respectively. The average expenditure for the same in Zone 1, 2 and 3 was ₹ 6,242, ₹ 4,565 and ₹ 1,350, respectively (**Table 4-59**).

Table 4-59: Average Annual Income/ Expenditure from Agriculture

Zone	Income (₹)	Expenditure (₹)
Zone 1	22,668	6,242
Zone 2	20,731	4,565
Zone 3	6,125	1,350

Groundwater was the main source of irrigation in the study area, but river, canals and ponds were also used for irrigation. Almost 72% and 55% farmers in Zone 1 and Zone 2 reported the use of groundwater for irrigation (**Table 4-60**).

Table 4-60: Source of Irrigation

Source of Irrigation	Zone 1		Zone 2		Zone 3	
	Nos.	%	Nos.	%	Nos.	%
River/Canal	32	7.31	120	20.94	0	0.00
Pond	41	9.36	7	1.22	0	0.00
Groundwater	314	71.69	316	55.15	1	5.88
Not Responded	51	11.64	130	22.69	16	94.12
Total	**438**	**100**	**573**	**100**	**17**	**100**

Plantation-wise details on total production, average expenditure and income are provided in **Table 4-61**. It can be seen from the table that income from the rubber plantation was higher than the rest of the plantations.

Table 4-61: Plantation Wise Detail on Average Yield, Average Expenditure and Income

Plantation	Average yield (in tonnes)		Avg. Expenditure in ₹/ Annum		Avg. Income in ₹/ Annum	
	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2
Coconut	27	1,208	2,497	3,038	8,922	11,012
Rubber	0	101	0	5,250	0	13,000
Rice	Not Given	0	1,00,000	0	25,000	0
Fruits and Vegetables	205	73	21,989	7,400	30,111	20,856

Tourism: Though tourism is a prominent economic activity in the PIA district, the survey data reveals that it is not the significant profession among the people in the study area. It is observed that only four percent of total surveyed households in the study area are involved in tourism related activities, which represents 132 households among the 5871 surveyed households. This number reflects that 218 out of 25,850 people, covered in social survey, are dependent on tourism (i.e. under 1% of the total number of people in the surveyed households). In this, the highest reliance on tourism was notices in zone-1 followed by zone -2 and only one household was reported to be associated with tourism from zone-3. The details are presented in **Table 4-62**. People who were occupied in the tourism sector are also involved in activities like miscellaneous work in hotel/ resorts, material supply, taxi /auto driving etc.

Table 4-62: Classification of Tourism Related Occupation

General	Zone 1	%	Zone 2	%	Zone 3	%	Total
Number of HHs surveyed	99	3.1	32	1.2	1	0.1	**132**
Number of Members	181	-	36	-	1	**-**	**218**

According to the survey respondents in Zone 1, April-June and October-December are the main tourist season, whereas according to respondents in Zone 2, the main tourist season was April-June and January-March. The variation of tourist season (even in the same Zone) is mainly due to the fact that tourists visit this part of Kerala throughout the year, but the category of tourists varies from season to season.

The data on income from the professions associated with tourism in all three project zones is given in **Table 4-63**. The average monthly income from tourism was ₹ 4888 and ₹ 5193 in Zone 1 and 2, respectively.

Table 4-63: Income from Tourism

Income (₹)	Zone 1	%	Zone 2	%	Zone 3	%
Below 2000	11	11.12	10	31.2	0	0.0
2000-4000	20	20.20	3	9.4	0	0.0
4000-6000	27	27.27	3	9.4	0	0.0
Above 6000	21	21.21	13	40.6	0	0.0
Not Replied	20	20.20	3	9.4	1	100.0
Total	**99**	**100**	**32**	**100**	**1**	**100**
Average	**4,888**	**-**	**5,193**	**-**	**0**	**-**

The data on households, which were involved in tourism and tourism-related activities, is provided in **Table 4-64**. The respondents in Zone-3 were not involved in tourism activities in the concerned area.

Table 4-64: Respondents involved in Tourism Related Occupation

Response	Zone 1		Zone 2	
	Nos.	%	Nos.	%
Yes	62	62.63	10	31.25
No	27	27.27	16	50.00
Not specified	10	10.10	6	18.75
Total	**99**	**100.00**	**32**	**100.00**

About 33% of the respondents which are involved in tourism and tourism-related occupations in Zone 1 reported the decrease in tourism related activities over years in their area but about 58% of them reported the increase of new entrants in this profession. On the contrary, 78% of their counterparts from Zone-2 informed about the raise in tourism activity over the years as well as increase in the number of new entrants in the profession (**Table 4-65**).

Table 4-65: Trends in Tourism Related Activity and Number of People involved in Tourism Sector

Trend	Zone	Increase	%	Decrease	%	Not Specified	%	Total
Trends in Tourism Related Activity	**Zone 1**	21	21.21	33	33.33	45	45.45	**99**
	Zone 2	78	78.13	5	15.63	2	6.25	**32**
	Zone 3	0	0.00	0	0.00	1	100.00	**1**
Trend in Number of People involved in Tourism Sector	**Zone 1**	57	57.58	33	33.33	9	9.09	**99**
	Zone 2	24	75.00	6	18.75	2	6.25	**32**
	Zone 3	0	-	0	0.00	1	100.00	**1**

During the season when tourism experiences quieter months, the respondents depend on other miscellaneous profession, i.e., work as a coolie or driver or they take work in a shop to sustain their livelihood.

4.10.5.4 Educational Institutions

There are many educational institutions like primary schools, higher secondary schools, intermediate colleges and vocational training centres present in the study area. Moreover, there are many small private institutions, such as coaching centres for competitive exams, computer training centres and training centres for Ayurvedic practice.

The information on the total number of various types of school in Thiruananthpuram Municipal Corporation area is taken from the Thiruvananthapuram local government website. The information is summarised in **Table 4-66**. The information on educational institutions present in the rest of the study area was not available.

Table 4-66: Total No. of Schools in Thiruvananthapuram Municipal Corporation Area

S. No.	Category	Government		Aided		Unaided		Total	
		No.	Strength	No.	Strength	No.	Strength	No.	Strength
1	Creche	-	-	-	-	1	20	1	20
2	Day Care	-	-	2	76	16	446	18	522
3	Nursery	1	45	1	43	1	50	3	138
4	LKG	2	68	-	-	12	344	14	412

S. No.	Category	Government		Aided		Unaided		Total	
		No.	Strength	No.	Strength	No.	Strength	No.	Strength
5	UKG	2	60	6	310	61	3,620	69	3,990
6	KG	7	188	3	89	60	2,822	70	3,099
7	LPS	80	12,966	39	7,260	56	9,602	175	29,828
8	UPS	49	11,028	24	6,430	61	16,961	134	34,419
9	HS	14	7,671	21	25,982	21	13,682	56	47,335
10	HSS	34	34,214	22	26,762	38	49,606	94	1,10,582
11	VHSS	15	21,396	1	986	1	796	17	23,178
12	Special School	-	-	1	65	3	168	4	233
Total		**204**	**87,636**	**120**	**68,003**	**331**	**98,117**	**655**	**2,53,756**

Note: LKG – Lower Kinder Garden ; UKG – Upper Kinder Garden ; KG – Kinder Garden, LPS – Lower Primary School ; UPS – Upper Primary School ; HS – Higher School ; HSS – Higher Secondary School ; VHSS – Vocational Higher Secondary School.(Source: http://Thiruvananthapuram.gov.in/~Thiruvananthapuram/index.php/educational-institution)

During the social survey, information was collected on the nearest educational facility. The survey findings reveal that more than 92% of the surveyed population have an education facility within 5.0 km radius of their residence. About 98% have a primary school in the vicinity, 94% have a middle school, 93.5% have secondary schools, 94% have a high school and 85% have a college nearby (**Table 4-67**). The households having Access to Educational Institutions within Five Kilometre Radius are given in **Table 4-68**.

Table 4-67: Total No. of Colleges in PIA District

S. No.	Colleges	Total
1.	Arts and Science colleges	20
2.	Allopathic Medical Colleges	2
3.	Ayurveda Medical Colleges	3
4.	Homeopathy Medical Colleges	2
5.	Nursing colleges	32
6.	Dental college in Government sector	1
7.	Agricultural College	1
8.	Engineering Colleges	11
9.	MCA Colleges	2
10.	Music College	1
11.	Teacher Education College	3
12.	Law Colleges	2
13.	Polytechnics	5

(Source – Thiruvanathapuram Official Website, www.tvmkerala.com)

Table 4-68: H/H having Access to Educational Institutions within Five Km Radius

Zone	Zone 1		Zone 2		Zone 3	
	Nos.	%	Nos.	%	Nos.	%
Primary School	2,625	82.9	1,856	91.7	533	78.3
Middle School	1,996	63.0	1,815	89.7	452	66.4
Secondary School	1,937	61.2	1,822	90.1	447	65.6
Higher Secondary School	1,788	56.5	1,737	85.9	492	72.2
College	297	9.4	573	28.3	203	239.8

(Source: Social Surveys, May 2012)

4.10.5.5 Health Care Facilities

There are about 411 health care institutes like hospitals (private and government), primary health care centres and clinics in Thiruvananthapuram. The total no. of beds is 12,910 (Envis Centre, 2012). Vizhinjam has one government hospital and one veterinary hospital.

The primary social survey findings revealed that 76.3% of the surveyed households have their access to a good quality government health care facility within five kilometre radius of their house. The details are provided in **Table 4-69**.

Table 4-69: Data on Access to Health Care Facilities

Zone	Access to Health Care Facility		Total Respondents
	No. of Households	(%)	
Zone 1	2,181	68.9	3,167
Zone 2	1,736	85.8	2,023
Zone 3	5,63	82.7	6,81
Total	**4480**	**76.3**	**5,871**

(Source: Social Surveys, May 2012)

4.10.5.6 Water Supply

About 28.1% of the respondents in the study area had piped water system in their houses. The major source of drinking water in Zone 1, 2 and 3 were public taps (32.3%), house connections (41.6%) and private hand pumps (31.9%), respectively. About 51.0% and 76.5% of the surveyed respondents were satisfied with the drinking water quality and supply in Zone 2 and 3 respectively. In Zone 1 only 20.1% of the respondents were satisfied with the current water supply situation. The details are provided in **Table 4-70**. **Exhibit 4-39** and **Exhibit 4-40** shows the available water scenarios in the area.

As per the report of Kerala Environment Congress – 2009, most of the areas in the PIA district suffer acute shortage of water for domestic use and Athiyanoor block, which comes under the study area of this Project has the highest water shortage in the district and the State. The villages in the study area, namely Kottukal (92% of the village region), Vizhinjam (95% of the village region), Kanjiramkulam (86% of the village region), Athiyanoor (69% of the village region), Poovar (35% of the village region) and Thirupuram (12% of the village region) experience water scarcity.

Table 4-70: Details on Sources of Drinking Water in Surveyed Households

Type of Connection	Zone 1		Zone 2		Zone 3	
	Nos.	%	Nos.	%	Nos.	%
House Connection	593	18.7	841	41.6	217	31.9
Public Tap	1024	32.4	321	15.9	142	20.8
Private Hand Pump	500	15.8	29	1.4	51	7.5
Well	494	15.6	643	31.8	197	28.9
Public Hand Pump	36	1.1	33	1.6	21	3.2
Public Well	114	3.6	70	3.5	33	4.8
Pond	132	4.2	1	0.0	0	0.0
Others	274	8.6	85	4.2	20	2.9
Total	**3167**	**100**	**2023**	**100**	**681**	**100**

(Source: Social Surveys, May 2012)



Exhibit 4-39: Water Pots Waiting for Collection of Water



Exhibit 4-40: Water Tanker Emptying Water to Water Pots and Vessels

4.10.5.7 Sewerage System

In Zone 1 about 41.7% of respondents did not have access to a sewerage removal system. This percentage decreases to 38.2% and 28.2% in Zones 2 and 3, respectively. Only 13.5%, 3.3% and 4.7% of surveyed households in Zones 1, 2 and 3, respectively had access to underground sewerage pipes. This data is presented in **Table 4-71**.

Table 4-71: Data on Distribution of Drainage Facility in Surveyed Households

H/H	Zone 1		Zone 2		Zone 3	
	Nos.	%	Nos.	%	Nos.	%
Open Kutcha	514	16.2	732	36.2	244	35.8
Open Pucca	828	26.1	395	19.5	216	31.7
Underground	429	13.5	68	3.4	32	4.7
None	1,322	41.7	772	38.2	172	25.2
Not Responded	74	2.3	56	2.8	17	2.5
Total	**3,167**	**100**	**2,023**	**100**	**681**	**100**

(Source: Social Surveys, May 2012)

The majority (84.7%) of surveyed households had toilets in their houses. Zone 2 (95.1%) and zone 3 (93.8%) have higher percentages of households with toilets. About 76% of the surveyed households in Zone 1 had toilets (**Table 4-72**).

About 57.2% of respondents in Zone 1 who do not have a toilet use community toilets, whereas 23.6% defecate outside. None of the respondents in Zone 3 go for outside defecation, whilst 14.3% of the respondents in Zone 2 reported that they do not have any other option than open defecation.

Table 4-72: Zone Wise Distribution of Toilets

Zone	Households with Toilet	(%)	Total No. of Respondents
Zone 1	2,412	76.2	3,167
Zone 2	1,925	95.2	2,023
Zone 3	639	93.8	681
Total	**4,976**	**84.7**	**5,871**

(Source: Social Surveys, May 2012)

In Zone 1, shared and community toilets are common. Zone wise distribution is shown in **Table 4-73**.

Table 4-73: Toilets Availability in Households

Details	Zone 1	%	Zone 2	%	Zone 3	%
Shared Toilet	59	7.8	13	13.3	1	2.4
Community Toilet	432	57.2	15	15.3	2	4.8
Open Area	178	23.6	14	14.3	0	0.0
Not Responded	86	11.4	56	57.1	39	92.8
Total	**755**	**100**	**98**	**100**	**42**	**100**

(Source: Social Surveys, May 2012)

4.10.5.8 Solid Waste Management

About 51% of respondents in Zone 1 practice open dumping and 30% burn their solid waste. The percentage of respondents who burn their solid waste is higher in Zones 2 (55%) and 3 (66%), as shown in **Table 4-74**.

Table 4-74: Details of Solid Waste Management

Type	Zone 1		Zone 2		Zone 3	
	Nos.	%	Nos.	%	Nos.	%
House Collection	158	5.0	105	5.2	10	1.5
Waste Bins	246	7.8	104	5.1	21	3.1
Throw in a Particular Place	142	4.5	168	8.3	75	11.0
Open Dumping	1,621	51.2	341	16.9	45	6.6
In Drain	81	2.5	156	7.7	73	10.1
Burn	823	26.0	1,123	55.5	450	66.1
Not Responded	96	3.0	26	1.3	7	1.0
Total	**3,167**	**100**	**2,023**	**100**	**681**	**100**

(Source: Social Surveys, May 2012)

4.10.5.9 Government Schemes

Around 17% of survey respondents enjoyed benefits of Government schemes, such as the National Rural Livelihood Mission, Kudumbashree units, the benefits of which are generally drawn as loans or as a pension. More than a quarter of the respondents communicated their lack of awareness of such schemes and indicated that they could not secure any loans; another quarter mentioned that they were satisfied with their status, whilst the rest wanted to avoid the complicated procedures. Details from the social survey on this subject are presented in **Table 4-75**.

Table 4-75: Data on Surveyed HH participating in Government Schemes

Details	Zone 1	%	Zone 2	%	Zone 3	%	Total	%
Government Schemes	562	17.7	404	20.0	41	6.0	1,007	17.2
Total No. of Respondent	3,167	-	2,023	-	681	-	5,871	-

(Source: Social Surveys, May 2012)

4.10.6 Cultural/Traditional Practices and Cultural Heritage

4.10.6.1 Cultural Practices

Vavu Bali: The study area is inhabited by various religious groups, each of which has its own festivals. Of these festivals, the Hindu ceremony of Vavu Bali is prominent in the study area, in which deceased ancestors are honoured through rituals performed on the seashore or river banks. Around 2,000 to 3,000 people participated in this ceremony at Mulloor beach, in the proposed Project site, on 18th July 2012. Aside from Mulloor beach, many people perform these rituals annually at Shangumughom, Aruvikkara, Thrikkannapuram, Karamana, Thrivikramangalam, Kadinamkulam, Kelamangalam, Thirukkulangam (Vellayani), Rameswaram (Neyyattinkara), Aniyur (Chempazhanthy) and Chirakkara. **Exhibit 4-41** and **Exhibit 4-42** shows a Vavu Bali ritual at Mullor Beach.



Exhibit 4-41: Vavubali scene -1 near Hundy at Mullor



Exhibit 4-42: Vavu Bali Ritual at Mulloor Beach July 18 2012

4.10.6.2 Ayurveda Practices

Ayurveda is one of the local traditional practices and is integrated with local culture. The literal meaning of Ayurveda is “Knowledge or Science of Life”. It is an age old tradition which dates back to the age of ancient Indian sage *Charaka*. The details about Ayurvedic practices are given in *Charaka Samhita.* Kerala’s climatic condition enhances the effectiveness of Ayuvedic treatment as the tropical and humid climate opens the pores of the skin which helps in absorption of medicated oils. The knowledge of ancient ayurveda itself is a cultural heritage, which is still being increasingly practiced in the study area and other parts of Kerala. The project stretch is dotted with Ayurvedic resorts (as already described under the Tourism section above). *Sirodhara, Pizhichil, Navarakizhi, Thalapothichil,* and *PachakizhiandPodikizhi*are the main ayurvedic procedures followed in the project area. The list of plant species (which are also grown indigenously in the resorts) used in the Ayurvedic procedure in the resorts located at the Project stretch is given in **Table 4-76**.

Table 4-76: List of medicinal Plant Species available in the Project Area

S. No.	Local Name	Scientific Name
1	Valmulaku	*Piper cubeba*
2	Vembada	*Ventilago madaraspatana*
3	Kundhirikkam	*Vateria indica*
4	Jatamanchi	*Nardostachys jatamansi*
5	Thakkolam	*Illicium verum*

S. No.	Local Name	Scientific Name
6	Vayambu	*Acorus calamus*
7	Naruneedndi	*Hemidesmus inidicus*
8	Nilappana	*Curculigo orchioides*
9	Maramanjal	*Coscinium fenestratum*
10	Amukkuram	*Winthania somnifera*
11	Idampiri valampiri	*Helicteres isora*
12	Adakkamaniyan	*Sphaeranthus indicus*
13	Amruthu chittamruthu	*Tinospora cordifolia*
14	Kacholam	*Kaempferia galangal*
15	Kasthuri manjal	*Curcuma aromatic*
16	Thippali	*Piper longum*
17	Ramacham	*Vetivera zizanoides*
18	Muthanga	*Cyperus tuberosus*

4.10.6.3 Cultural Heritage/Religious Monument

The only archaeological monument present in the study area, which was assessed by the Archaeological Survey of India (ASI) and recognised as an archaeological monument, is the Vizhinjam Rock Cut Cave in Vizhinjam and Temples of Parasurama, Brahma, Siva and Matsya in Thiruvallam. The cultural heritage/ religious monuments are given in **Exhibit 4-43** to **Exhibit 4-46**. Well known religious structures considered to be of cultural importance in the study area are listed below:

- **NagaTemple:** A NagaTemple is located on the cliff in the middle of the Project stretch in Mulloor.
- **Azhimala Shiva Temple:** Azhimala Shiva Temple is located on a cliff adjacent to Azhimala beach, at the Southern end of the Project layout.
- **Vizhinjam Rock Cut Cave:** A famous tourist place called the Vizhinjam rock cut cave temple is located towards the NE of the northern end of the proposed breakwater (about 2 – 3 km distance) This is about 200 m from old fishing harbour. The 18th century granite cave encloses a one-celled shrine with a statue of Vinandhara Dakshinamurthi. There are half completed relics of the Hindu God Siva and Goddess Parvathi carved in the outer wall of the temple.
- **Abandoned ruined Shiva Temple (Travancore Dewaswam):** Located within a 100 m distance from existing fishing harbour. This is encroched on all sides but with a compound wall even the gate is used by a Kiosk.
- **Old Vizhinjam Church/Old St. Mary's Church:** The present fishing harbour bay was an ancient trading Port during the 17th century, which was primarily used by the Portuguese for trading in India. St. Mary's church, located at the eastern periphery of the fishing harbour, was built at that time. The church is located at a distance of about 1-2 km NW of the Northern end of the proposed breakwater.
- **Mosques:** Three mosques namely Valiya Palli, Great Mohyyudin Mosque and Kodyil Kalluppalli are located in the northern periphery of the Vizhinjam Fishing Harbour. Photographs of these mosques are included. These mosques are located about 1-2 km from the northern end of the proposed breakwater in a NW direction.
- **Vellayani Devi Temple**, a 700-year old shrine, is located about 9.0 km (NE) from the northern end of the proposed breakwater.
- **Old Pachalloorr Sri Bhadra Kali Temple** is situated at a distance of approximately 7-8 km (NW) of the northern end of the proposed breakwater.
- **St. Bartholomew Church**, which is one of the earliest European churches built in 1503 A.D by the Portuguese, is located about10 km SW of the southern end of the proposed breakwater.

- **Temples of Parasurama, Brahma, Siva and Matsya in Thiruvallam**, which is located about 9 km from the northern end of the proposed breakwater. These temples were built in between 12th and 13th century.

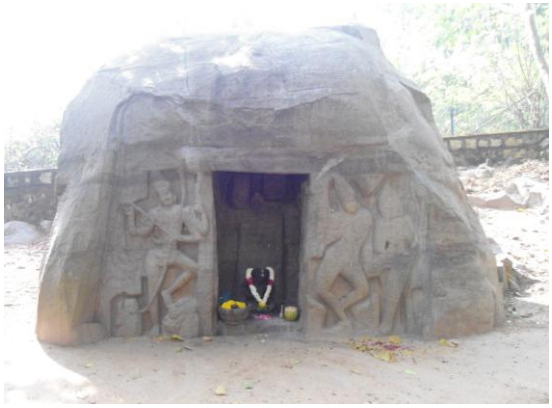


Exhibit 4-43: Cave Temple



Exhibit 4-44: Protected Monument Listing



Exhibit 4-45: Old Vizhinjam Church

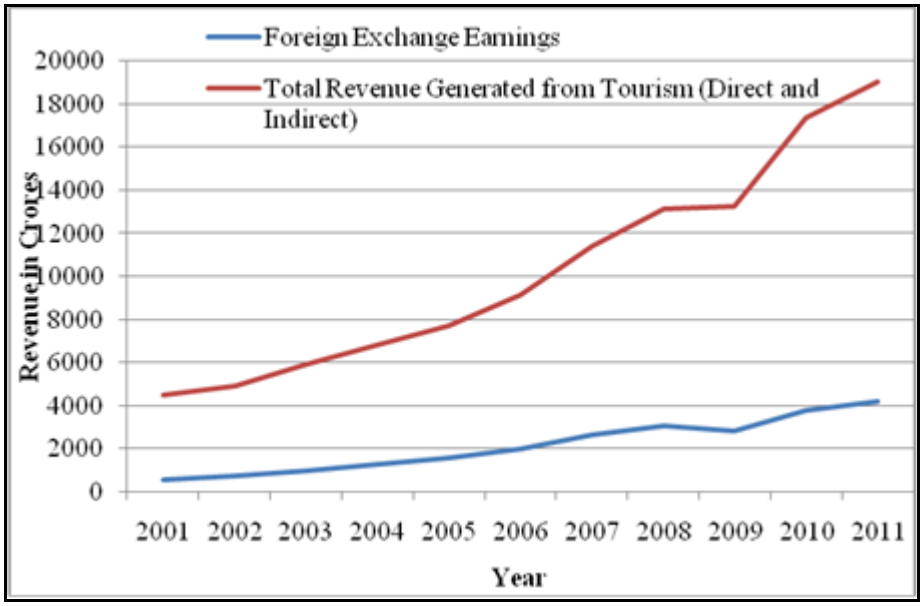


Exhibit 4-46: NagaTemple in the Project Site

4.10.6.4 Tourism

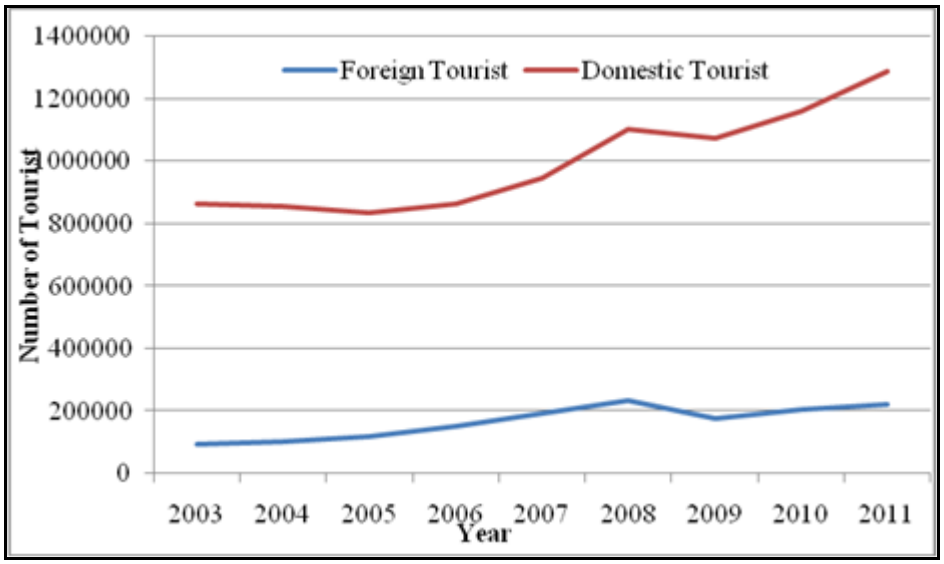
Due to its lush green scenery, charming backwaters and pocket beaches, the state of Kerala has become an international tourist attraction using the brand name **"God's Own Country"** mainly because of its scenic beauty. Kerala's Tourism industry is one of the State's significant revenue generating activities. The total revenue generated in 2011 through the Tourism industry (including direct and indirect means) was (₹ 19037 Crore, out of which ₹ 4221.99 Crores around 22% was earned through Foreign Exchange (Kerala Tourism Statistics, 2010). Total tourism revenue increased significantly in 2011 compared to 2010 by about 9.74%.

PIA District was visited by 15% of the tourists who visited Kerala in 2011 and by around 31% of foreign tourists. Total revenue generation due to Tourism in Kerala is presented in **Figure 4-83**, whilst data on foreign and domestic tourist arrivals in State capital over the years is given in **Figure 4-84**.



(Source: Kerala Tourism Statistics, 2010)

Figure 4-83: Revenue Generated from Tourism



(Source: Kerala Tourism Statistics, 2010)

Figure 4-84: Tourist Flow Data of PIA District

From the data, it is clear that the number of tourist arrivals has been increasing over the years in the Capital city and in turn the total revenue generated through tourism by the GOK had also been increasing.

Kovalam, an important tourist destination, is located 2.0 to 3.0 km NW direction from the Project stretch. Kovalam and adjacent coastal stretches, from Nellikunnu to Adimalathura, are tourist destinations due to their beaches. **Figure 4-85** shows the Kovalam area which is comprised of a 1.7 km crescent-like stretch of coast including three main beaches, namely Samudra, Hawa and Light House beaches, with the latter being the southernmost (and nearest the proposed Port development).

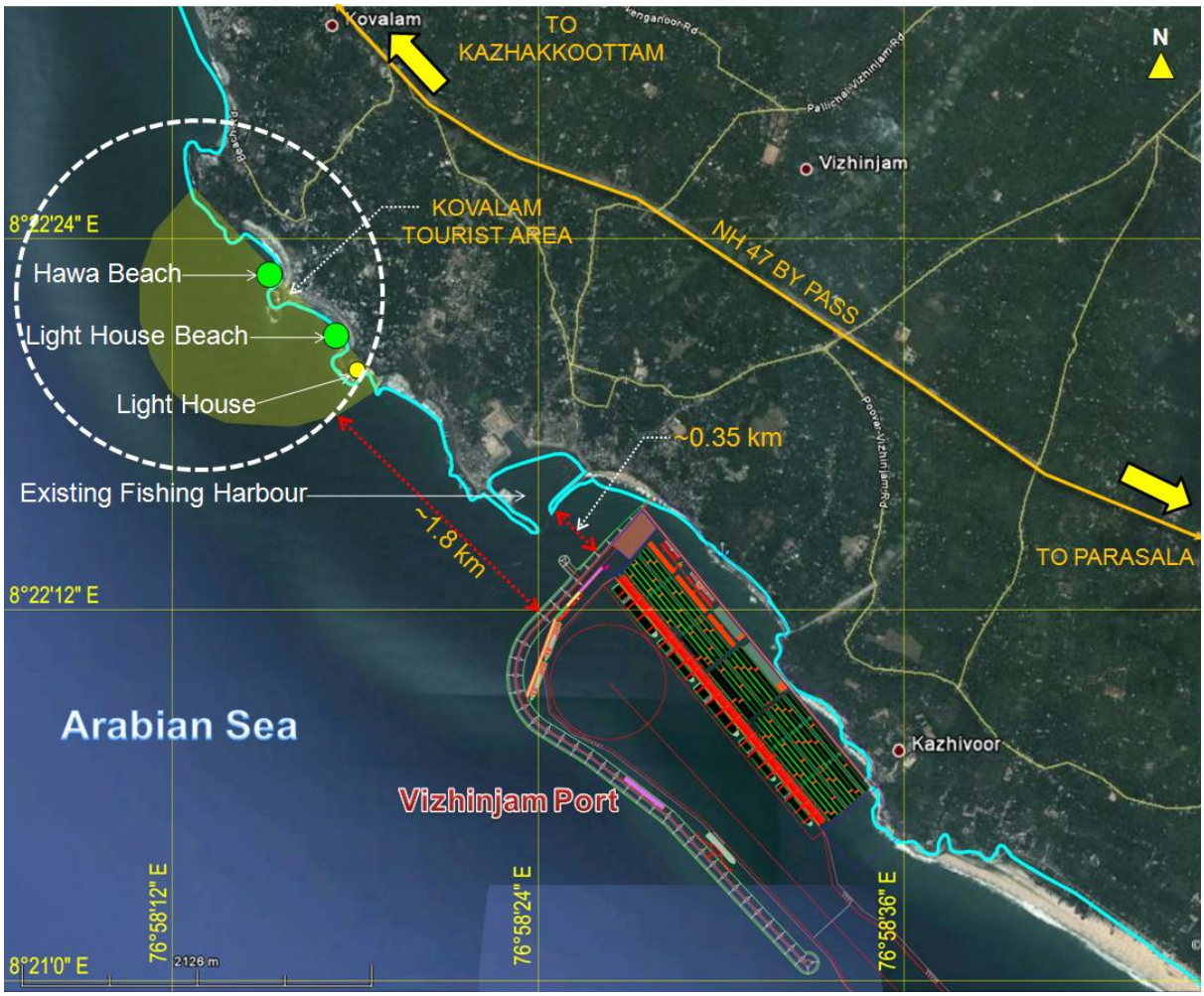
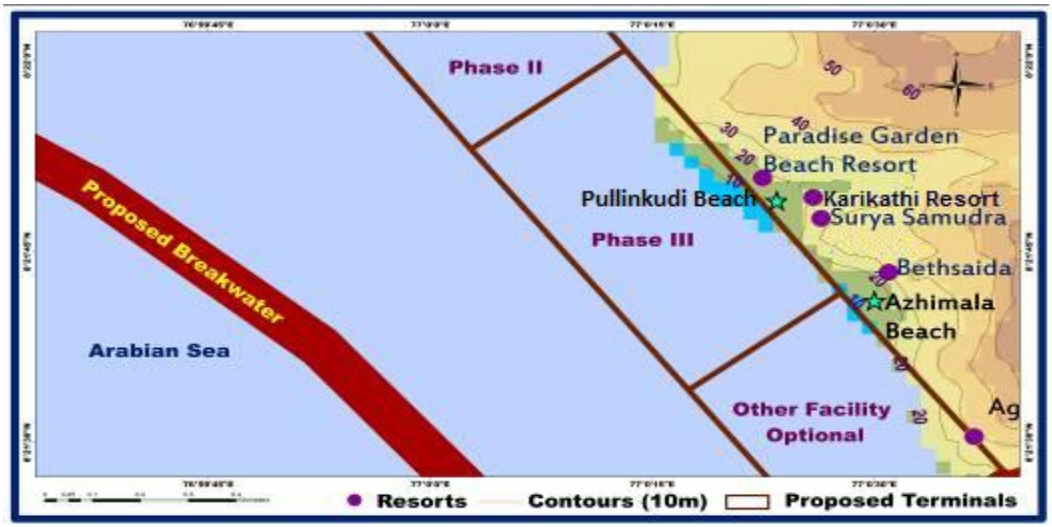


Figure 4-85: Kovalam and the Project Site with the Final Project Layout

4.10.6.5 Details of Resorts

There are 31 resorts situated along the coast in the Project stretch, as per information received from the Kerala Hotel & Restaurant Association (KHRA), Thiruvanathapuram. These resorts offer Ayurvedic treatments and mainly attract foreign tourists from Austria, Germany, Switzerland and other parts of globe. The details of the resorts in and around the project stretch are given in **Figure 4-86**. An attempt was made to gather site-specific tourism information during the social survey. The proforma was circulated to all 31 resorts, but details were received only from 9; these are presented in **Table 4-77**.


Nellikinnu Beach
Merlin Villa
Gods light
Vayalkara Beach Resort
Park House
Padmini Beach Resort
Thapovan Heritage Home
Coconut Bay Beach Resort
Mulloor Beach
Phase I
Phase II
Phase III
Proposed Breakwater
Arabian Sea
Resorts
Contours (10m)
Proposed Terminals


Phase II
Phase III
Paradise Garden
Beach Resort
Pullinkudi Beach
Karikathi Resort
Surya Samudra
Bethsaida
Azhimala
Beach
Other Facility
Optional
Proposed Breakwater
Arabian Sea
Resorts
Contours (10m)
Proposed Terminals


Other Facility
Optional
Agastya Beach
Resort
Travancore
Heritage
Dr. Franklins Panchkarma
Institute
Nikki's Nest
Azhimala Beach Resort
Chowara Beach
Somatheeram
Beach Resort
Sun Tara Beach Resort
Ideal Resort
God's Own
Country Resort
Manaltheeram
Beach Resort
Adhimalathura Beach
Proposed Breakwater
Arabian Sea
Resorts
Contours (10m)
Proposed Terminals

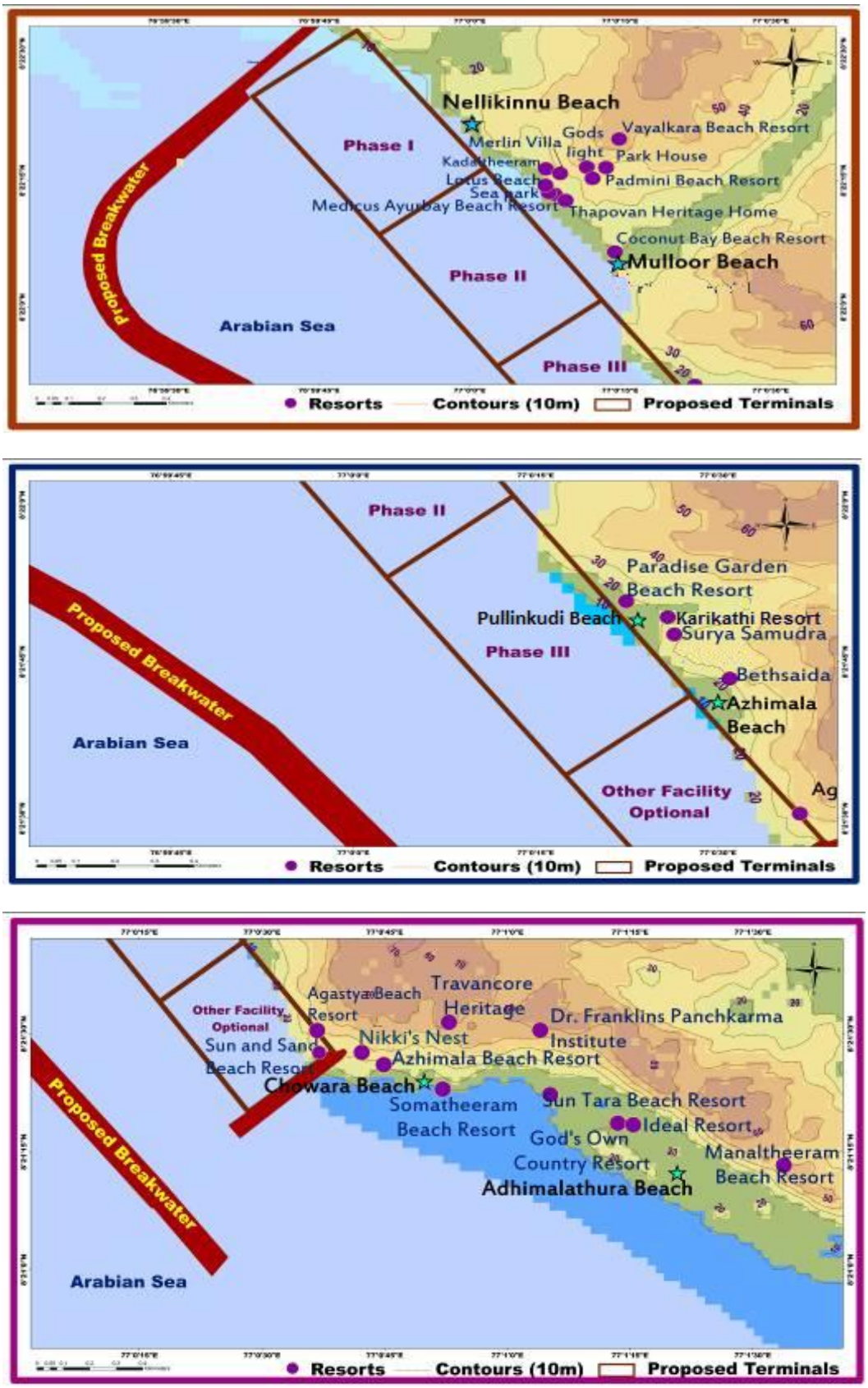


Figure 4-86: Map Showing the Resorts in and around the Project Site

Table 4-77: Details of Resorts received from KHRA Association

Name of Hotel	No. of Rooms	No. of Staff	Date of Commencement
Nellikunnu Beach			
Thapovan Heritage Home	31	75	2000
Medicos Ayur Bay	18	16	2004
Kadaltheeram	6	4	2005
Sea Park	25	18	1998
Padme Beach Resort	10	6	2010
Vayalkara Beach Resort	14	16	2008
Merlin Villa	2	2	2009
Lotus Beach	2	3	2008
Park House	20	12	2008
Gods Light	1	1	2011
Mulloor Beach			
Nandikulam Beach House	4	4	2010
Coconut Bay Beach Resort	27	125	1997
Pulinkudy Beach			
Surya Samudra	30	90	1982
Bethsaida	90	165	1994
Karikathi Beach House	4	4	1997
Paradise Garden Resort	8	6	2004
Azhimala Beach			
Agastya Beach Resort	32	60	2002
Nikkis Nest	47	85	1996
Sea and Sand Beach Resort	9	6	2009
Azhimala Beach Resort	20	25	2009
Sun Tara Beach Resort	13	19	2009
Chowara Beach			
Shin Shiva Ayurveda Ashramam	23	60	1998
Dr Franklins Panchakarma Institute	42	125	
Visaya House	4	7	2009
Somatheeram Health Resort	66	255	1989
Somatheeram Beach Resort	80	400	1985
Manaltheeram Beach Resort	60	300	1985
Travancore Heritage	90	235	2001
Ideal Resort	22	35	1996
Gods Own Country Resort	20	20	2007
Sandal Resort	12	10	2010
Total Staff in Beach Resorts	832	**2189**	

(Source: KHRA)

Details of 12 resorts registered with Kottukal Gram Panchayat are presented in **Table 4-78**. Except Agastya Beach Resort, Shin Shiva Ayurveda and Somatheeram Beach Resort, in the remaining resorts, the number of officially registered rooms is lesser than the number of rooms given by the KHRA.

Table 4-78: List of Resorts as received from Pulinkudy Ward of Kottukal Gram Panchayat

S. No.	Name of Resort	Number of approved buildings/Rooms	Number of Staffs
1	Bethsaida resort	21	Employment tax not being remitted
2	Surya Samudra	29	97
3	Nikkis Nest	24	Employment tax not being remitted

S. No.	Name of Resort	Number of approved buildings/Rooms	Number of Staffs
4	Agastya Beach resort	32	20
5	Shin Shiva ayurveda asramam	27	38
6	Dr Franklins Panchakarma institute	16	38
7	Somatheeram Health Resort	17	77
8	Somatheeram Beach Resort	145	25
9	Manaltheeram Beach Resort	20	21
10	Travancore Heritage	29	92
11	Ideal Resort	10	Employment tax not being remitted
12	Gods Own Country Resort	12	

The number of employees in these nine resorts/institutes ranged from 80 – 280 people and the area of the resorts/institute varied from 0.61 – 3.24 Ha (1.5 – 8.0 Acres). The October to April months represent the tourist season. Most of the tourists (88 to 99%) are foreigners.

Revenue from Tourist Inflow: The primary information, which was provided by the individual resorts, shows that except Coconut bay, Somatheeram Beach Resort and Manaltheeram Beach Resort, all other resorts are showing an improvement in their income over the period from 2009 to 2012. **Figure 4-87** provides comparative results of the annual earnings of the nine resorts from year 2009 to 2012.

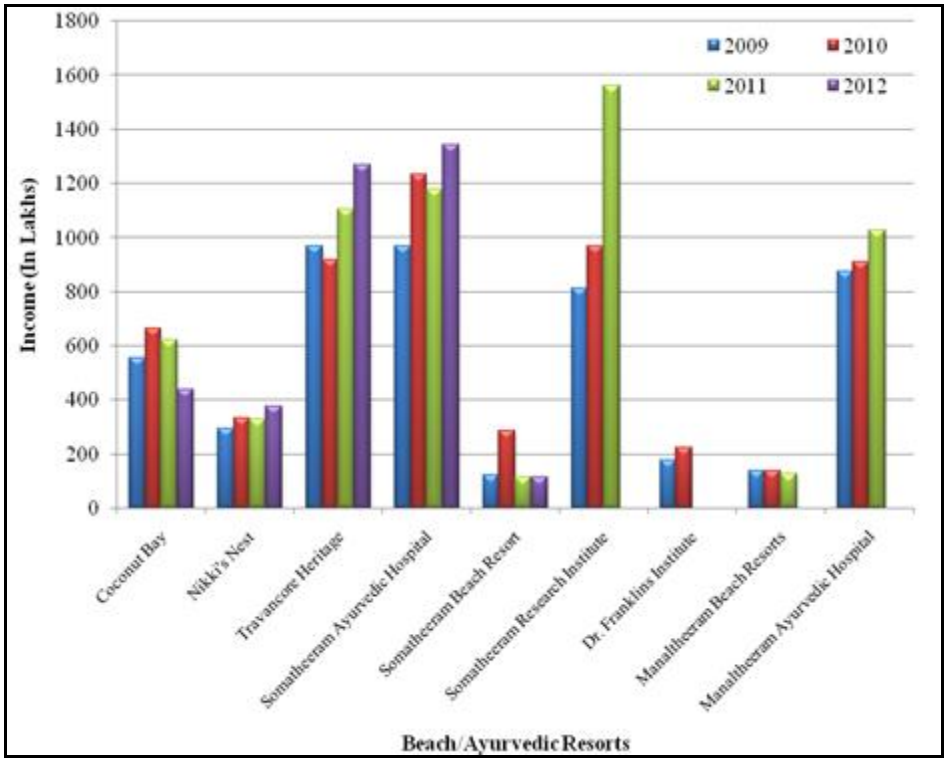


Figure 4-87: Year Wise Annual Income of the Resorts

Tourist Inflow: The arrival of tourists both foreign as well as domestic to the resorts is shown in **Figure 4-88**. The data shows that main tourist season in the resorts starts from October and continues till April. During this period, the number of tourist stay in these resorts was reported high in comparison to the non-tourist season i.e. from May to September. In almost all the resorts, the number of foreign tourist stay was high, which also support the amount of revenue generated by them.

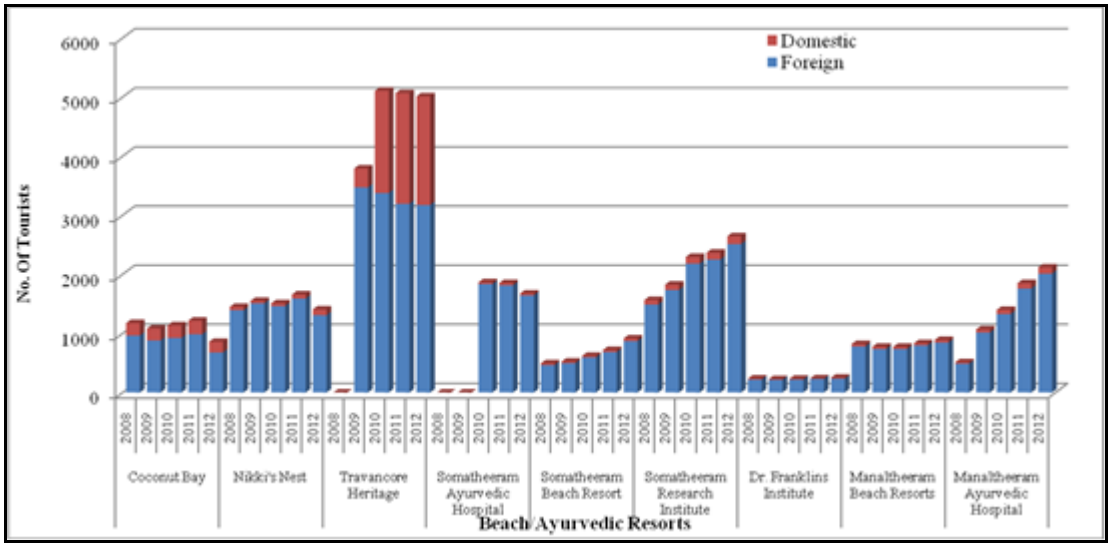


Figure 4-88: Resort wise detail of Tourist Arrival from year 2008-2012

Coastal Regulation Zone and Resort/Hotels in the Project Stretch: The coastal region of the Indian sub-continent is governed by the Coastal Regulation Zone (CRZ) Notification January 6, 2011. These CRZ notifications classify different regions of the coast according to its eco-sensitive nature and location with respect High Tide Line (HTL) and Low Tide Line (LTL).

As per Coastal Regulation Zone (CRZ) Notification 1991, a Kerala Coastal Management Plan (CZMP) was prepared by the GOK in 1995. In which, the Coastal Regulation Zones were demarcated on Coastal Zone Management Planning (CZMP) map, in that the proposed Project site is located in Map No. 2 and 3 (Source: CESS, Thiruvananthapuram, Kerala). Based on this CZMP and primary field investigation, a CRZ map and report was prepared by CESS, Thiruvananthapuram for this proposed Project in 2004. In this report, it is noted that the sea side of the proposed development does not have any eco-sensitive area like corals, mangroves etc., which comes under CRZ I (i) as per CRZ Notification, 1991.

The resorts in the Project stretch were overlaid on the Coastal Regulation Zone (CRZ) map prepared by Centre for Earth Sciences Studies (CESS) in 2013 with respect to CRZ Notification 1991 (**Figure 4-89**). It can be inferred from the map, that many resorts namely God's Light, Park House, Sea Park, Lotus Beach, Medicus Ayurbay Beach Resort, Thapovan Heritage, Coconut Bay Beach Resort, Karikkathi Beach House, Surya Samudra Resort, Bethsaida and Agastya Beach Resort are located within 200 m from HTL line, which is a '**No Development Zone'** as per the CRZ notification 1991.

The location of Nikki's Nest, Dr. Franklin's Institute, Azhimala Beach Resort, Somatheeram Ayurvedic Hospital, Somatheeram Ayurvedic Beach Resort, Someatheeram Research Institute & Ayurveda Hospital, Travancore Heritage, Sun Tara Beach Resort, Ideal Resort and God's Own Country could not be correlated with HTL, as HTL line was demarcated only up to the Southern Breakwater.

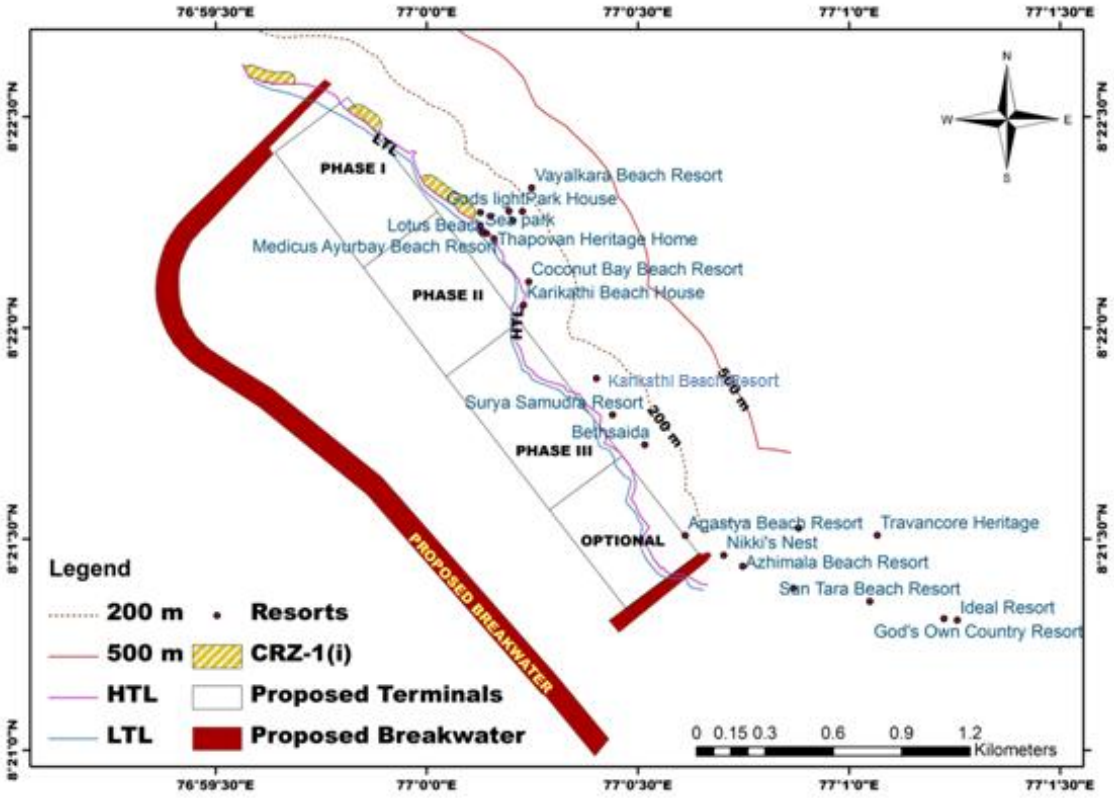


Figure 4-89: Resorts in the CRZ Project Stretch

4.10.7 Other Economic Activities

Local Small Scale Industries: Two local cottage industries were identified in the study area, namely coconut-based businesses and mollusc shell- based businesses.

Coconut based Industry: The study area has abundant coconut plantations. Coconut based cottage industries involving coconut oil extraction, rope, and coir pith-making are present in the study area. The data on the number and production capacity of these units was not available from any official source.

Molluscs Shell based Industry: Since molluscs' shells are available abundantly, shell based cottage industries are present in the study area. Lime and artefacts are the main products manufactured from mollusc shells. The lime produced in this way is used as raw material for white-washing of walls by local people, which protects structures from coastal weather. The artefacts (curios) are sold to tourists, mainly in the beach area. Such shell-based industries represent a secondary source of income mainly for mussel collectors.

Employment and income statistics for these cottage industries were not available.



Exhibit 4-47: Collected Mussels Shells

4.10.8 Public Utilities

For the study area (10 km radius from the project site) specific information on the drinking water supply, solid waste management and wastewater management was not readily available. Only Secondary information pertaining to the generic system of the aforementioned facilities in the Thiruvananthapuram District/Municipal Corporation area was available. The percentage of people in the study area having access to these facilities could not be drawn from the existing data base. However, to ascertain the socio-economic condition (including infrastructural facilities and public utilities) for 5,106,533 people residing in the study area socio-economic survey was conducted in May 2012. This survey covered a population of about 24,854 people, in which number ofpeople enjoying these facilities are ascertain.

In the following sections, the secondary information related to the above mentioned public utilities in general present in the PIA district including Municipal Corporation are described, followed by study area specific information obtained through social survey.

4.10.8.1 Drinking Water Supply

The source of water supply in PIA district is surface water and groundwater. Several water supply and augmentation schemes are in operation/proposed to provide drinking water to the rural and urban areas. At present, 120 and five water supply schemes are in operation/proposed in rural and urban areas respectively, which depends on surface water, lake, other water bodies and groundwater. The water supply schemes cover about 83.86% and 68.99% of urban and rural population of PIA District, respectively. The aforementioned data about PIA District has been taken from the official website of Thiruvananthapuram.

The main source of water supply in the PIA city is the Peppara and Aruvikkara dam. The city area is covered with a protected pipe water supply network, *Thiruvananthapuram water supply scheme,* which was commissioned in 1931. At present, the scheme covers 183.76 km^2 with the complete coverage of Thiruvananthapuram city (141.74 km^2) and partially covers the area of adjoining panchayats of Sreekaryam, Kudappandkunnu and Vattiyoorkavu. The Corporation area and Mannacad define under the study area are also covered by this scheme. The source of water for this scheme is the Karamana River, which is a perennial river. A reservoir of 2.0 MCM capacity was built at Aruvikkara Panchayat. The scheme is fully owned and maintained by the KWA. About 170 lpcd of water is supplied to the people of Thiruvananthapuram. Water is being supplied through 1, 50,000 odd house service

connections, 22,000 non-domestic connections, 34 industrial connections and 4260 public stand posts. The salient features of the water supply scheme are tabulated in the **Table 4-79**. The details about the pumping stations, reservoirs and water treatment plant are given in **Table 4-80**.

Table 4-79: Salient Features of the Water Supply Scheme of PIA district

S. No.	Details	Units	Details
1	Year of commissioning	-	1931
2	Capacity - original (1931)	mld	20
3	Capacity Augmented (2006)		225
4	Source	Mm3	2 dams in Karamana river (70 & 2.0 capacity)
5	Present Scheme Area	Km ^{2}	183.76
6	Population Served (Corporation area)	Lakhs	8.61
7	Coastal Population Area		0.50
8	Status of coverage	% Corporation area	75
9	Status of supply	Hours/7 Days	24
10	Total no. of water connections		172000
11	Distribution network	km	2280
12	Transmission main		72
13	Average per capita supply	lpcd	174
14	Average physical losses	%	35.50

(Source: City Development Plan, Thiruvananthapuram, 2006)

Table 4-80: PIA District Water Supply Scheme

S. No.	Items	Details		
		Location	**Year**	**Capacity (MLD)**
1.	Water Treatment Plants	a. Vellayambalam	1933	20 Augmented to 36
			1962	
		b. Aruvikkara	1972	Augmented to 48
			1983	Augmented to 72
			1999	Augmented to 154
		c. P.T.P Nagar	1992	14 Augmented to 30
			2004	
		d. Paramala	2006	5
Total				225
2.	Pumping Mains (high sizes only)	Item	-	Length
		1200 mm CI	-	8900 m
		1200 mm PSC	-	2422 m
		1100 mm PSC	-	5611 m
		1000 mm PSC	-	4905 m
		900 mm PSC	-	1728 m
3	Reservoirs	Location		Capacity (ML)
		a. Vellayambalam (underground)		19.4
		b. Observatory (over head)		5.00 Ml + 7.00
		c. Peroorkada (over head)		13

S. No.	Items	Details		
		Location	Year	Capacity (MLD)
		d. P.T.P Nagar (over head)		08
		e. Manvila (over head)		6.9

(Source: City Development Plan, Thiruvananthapuram, 2006)

The other areas of the district are dependent either on dug wells or bore wells. About 3135 dug wells and 1047 bore wells are present all over the district. Out of which, 372 and 682 dug wells and bore wells respectively are out of use.

The study area of 10 km radius from the Project site comprises of Athiyanoor, Nemon, Vamanapuram and Parasala blocks. Vizhinjam, Athiyanoor, Kanjiramkulam, Kottukal and Venganoor come under the Athiyanoor block. Balarampuram, Pallichal and Kaliyoor come under Nemom Block. Vamanapuram Block covers the area of Peringamala village and Parasala block, which includes the Poovar and Thirupuram village. The block wise distribution of public and private wells in the study area is given in **Table 4-81**.

Table 4-81: Block Wise Distribution of Public and Private Wells other than Piped Water Supply Schemes in the Study Area

S. No.	Block	Public open wells				Private open wells		Public bore wells		
		Total No.	User Families	Unused	Density	User Families	Density	Total No.	User Families	Unused
1	Vamanapuram	378	7963	66	0.7	35461	84.2	155	387	128
2	Nemom	213	2561	15	1.5	34574	256.9	53	154	30
3	Athiyanoor	250	7680	52	2.7	13518	183.3	85	612	72
4	Parasala	222	11836	3	2.7	13837	168.3	64	2108	31
Total		**1063**	**30040**	**136**		**97390**		**357**	**3261**	**261**

(Source: Kerala Environment Congress, 2009)

New water supply schemes proposed by the GoK in the PIA District to mitigate the water scarcity problem and fulfil the water requirements to urban and rural population:

- ***Integration with Ongoing JBIC Project:*** This Project envisages additional production of 74 MLD of water at Aruvikkara and transmission to the Service Reservoirs in the city, which has been taken up by the KWA at a cost of INR 3119.1 million (Revised cost ₹ 311.91 crores) with loan assistance from JBIC. This Project covers Thiruvananthapuram Municipal Corporation area and six adjoining suburban Panchayats including Vizhinjam;
- ***Water Supply Scheme to Kovalam Tourist Area:*** This scheme covers the tourism stretch in the Kovalam-Vizhinjam area. It includes Kovalam with six wards of Venganoor Panchayat, six wards of Vizhinjam Panchayat and three wards of Kottukal Panchayat using nearby fresh water Lake Vellayani as a source;
- ***Improvement of Water Supply Scheme to Pappanamcode & Nemom areas:*** UsingKaramana River at Thrikkannapuram as a source this scheme is proposed to coverPappanamcode Estate, Nemom, Melankode, Ponnumangalam and part of Thiruvallam with a population of 50,000
- ***Water Supply Improvements to Vandithadam:*** This proposal is to provide improvements in Vandithadam Water Supply Scheme, which covers nearby areas of Kovalam. This scheme consists of an old intake well in the Vellayani Lake, which is now in bad condition. It is proposed to construct a new intake well, a five MLD full-fledged water treatment plant and a replacement of pump and pumping mains to meet the enhanced capacity and quality;

Water Supply Scheme to International Transshipment Terminal at Vizhinjam: The major surface water bodies present within the study area are the Karamana River and Vellayani Lake. Vellayani Lake is a fresh-water lake, which is the source of water for Vizhinjam and nearby areas. The water supply scheme designed by the Kerala Water Authority (DER, August, 2006) is for drawing 3.30 MLD of water from Vellayani Lake and to treat the same at a treatment plant located at Vizhinjam in the land available with the Harbour Engineering Department (HED). As per the report, 3.00 MLD of water will be available after treatment. Further, 2% (0.06 MLD) is required for backwash and 15% (0.45 MLD) is required for UFW (unusable flow water), resulting in a net availability of 2.49 MLD. The Port water requirement in the long term has been assessed as 1.00 MD as follows.

During construction	(1st 4 years)	0.10 MLD
Short term needs	(subsequent 4 years)	0.50 MLD
Medium term needs	(subsequent 3 years)	0.60 MLD
Long term needs	(subsequent years)	1.00 MLD

Further as per the G.O. cited (3), 0.05 MLD of water shall be supplied to the Vizhinjam Fishing Harbour (VFH) from the VISL treatment plant after realising, water charges from time to time. Distribution pipelines, sump/tank for the above supply to VFH will be constructed by the HED at their cost.

Thus after considering the use for the proposed Vizhinjam Port (1.00 MLD) & existing VFH (0.05 MLD), 1.44 MLD will be available. This quantity was set part during the project design to meet the anticipated demand from floating as well as migratory population due to the development of the area around the proposed Vizhinjam port and to improve the supply position of the fishermen as well as other inhabitants in the Vizhinjam area.

A review of the water schemes proposed in the study area revealed that Vellayani lake was proposed to be used as source of water. Though no information could be found regarding the number of water supply schemes implemented using Vellayani Lake as water source.

Even though, there are water supply schemes to meet the demand of the water in Vizhinjam and nearby area, acute water shortage was evident during the social survey period (May 2012). Considering the population within 10 km radius of the Project site, the water demand will be in the range of 357.5 MLD (51,06,533 no. of people @ 70 lpcd for towns with piped water supply but without sewerage system as per Central Public Health and Environment Engineering Organisation, GOI-CPHEEO) to 689.4 MLD (51,06,533 no. of people @ 135 lpcd for cities with piped water supply where sewerage system is existing/ contemplated as per CPHEEO).

Water demand of the surveyed households willbe in the range of 1.7 MLD (24,857 no. of people @ 70 lpcd for towns with piped water supply but without sewerage system as per CPHEEO) to 3.4 MLD (24,857 no. of people @ 135 lpcd for cities with piped water supply where sewerage system is existing/ contemplated as per CPHEEO. Out of the surveyed households, (which is only 0.49% of total population residing in 10 km radial study area), only 28.1% had piped water supply system. The remaining people have public taps (25.3%), hand pumps (11.4%), well (22.7%), pond (3.7%), etc. as the source of water.

The water demand near the Project site (2.0 km radius from the project site) is in the range of 1453 m3/day (20,766 no. of people @ 70 lpcd for towns with piped water supply but without sewerage system) to 2803 m3/day (20,766 no. of people @ 135 lpcd for cities with piped water supply where sewerage system exists/ contemplated). This area comprises of Vizhinjam and Kottukal grama panchayaths, which have about 95% and 92%, water scared area, respectively.

VISL already started to improve the water supply by a 1.5 MLD water supply project to the local people near the project stretch.



Exhibit 4-48: Drinking water at Venganoor Panchayat



Exhibit 4-49: Drinking Piped Water System in Vizhinjam

4.10.9 Solid Waste Management

The Thiruvananthapuram Municipal Corporation Area generates about 265 tons of Municipal Solid Wastes (MSW) per day of which 150 MT is bio-degradable in nature (Centre for Environment Department, 2012). Thiruvananthapuram City Corporation is responsible for collection, transportation, management and disposal of the garbage generated within the city limits. Over 66 wards have door to door collection mechanism, which covers an area of 107 km^2. Residential areas constitute the major part of solid wastes (53%) collected by Thiruvananthapuram Corporation (**Figure 4-90**).

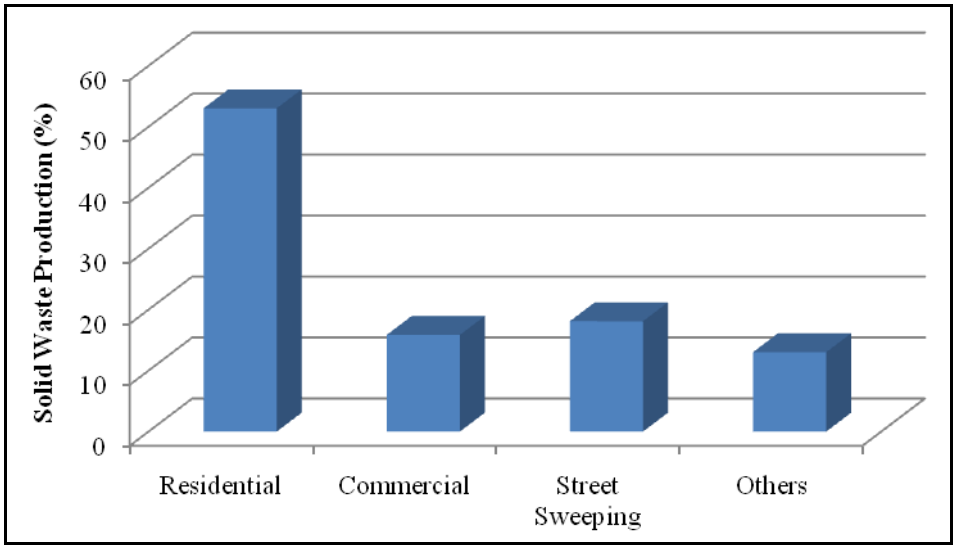


Figure 4-90: Generation of solid waste in PIA District

Capital city has established a centralised solid waste management plant in Vilappilsala, which is situated in the outskirts of the City area, for managing the generated solid wastes. This compost plant was installed by Poabsons's Private Limited (Private Company) in 2000 and later it was handed over to the Thiruvananthapuram Corporation in 2007. Now it is under the control of CED (Centre for

Environment and Development), which is a quasi- government agency. During the social survey, this solid waste management facility was not functional. Openly dumped solid waste in the Project area in two locations in Venganoor Panchayth is given as **Exhibit 4-50** and **Exhibit 4-51**.



Exhibit 4-50: Openly dumped solid waste in the Project area (Venganoor Panchayth)



Exhibit 4-51: Openly dumped solid waste in the Project area (Venganoor Panchayth)

In 2004, Vizhinjam grama Panchayat implemented a decentralised waste management system, under the Kerala Development Plan's decentralised waste management schemes of the National Biogas scheme with the support of Biotech, the nodal agency for the scheme (The Hindu, 2004). In the first phase of the aforementioned scheme, 575 numbers of one meter cube sized domestic biogas plants were installed in selected houses. Through these about 2.5 tons of organic wastes and 5,500 litres of wastewater could be treated daily.

Apart from these schemes, there is no solid waste management facility in the Project area. Piles of openly dumped solid wastes were seen in the Project area during the field visit in May 2012. In the study area approximately 2297.0 MT[21] of solid wastes is generated per day. The surveyed population (0.49% of total population in the study area) generates about 11.2[22] MT per day. About 40.8% of the surveyed household's practices open burning of the solid wastes, whereas only 4.6% and 6.3% have door to door collection facility and waste bin nearby their home, respectively. The remaining population openly dumps the waste in a particular or any other open places.

4.10.10 Wastewater Management

The data for the sewerage system in Thiruvananthapuram is taken from the City Development Plan, Thiruvananthapuram (2006). At present the sewerage system exists only in Thiruvananthapuram Municipal Corporation area. Plans to connect the other areas to sewerage network are under proposal. Presently, the Corporation comprises an area of 141.74 km^2 of which about 30% is covered by a piped sewerage system, which serves the core city area. The sewerage system is controlled by KWA. In 1931, action was taken for investigation of a **"Comprehensive Sewerage Scheme"** on modern lines.

The scheme for the disposal of sullage and sewage is an underground system based on principle of separate system. All the sewerage blocks had been considered to be provided with sewerage network

[21] 51,06,533 x 0.45 kg/capita/day as per the CPHEEO guidelines

[22] 20,766 x 0.45 kg/capita/day as per the CPHEEO guidelines.

draining into a main pumping station, where sewage would be pumped through pumping mains to Treatment and Disposal works situated at Valiyathura (approximately, 12 km North from the location of proposed Port).

The scheme area is divided into seven blocks viz. A, B, C, D, E, F and G[23] for the convenience of execution of sewerage system. Among the above blocks sewerage facility is available fully or partially in the blocks A to E at present.

Block A. Covers an area of 13.84 km^2.comprisingcitiessuch as Kowdiar, Vellayambalam, Vazhuthacaud, Thycaud,Thampanoor, Pazhavangadi, Puthenchantha and Palayam. There are three lifting stations under this block at Thaliyal, Mudavanmughal and Arannoor. The main pumping station in this block is at Kuriyathy from where sewage is pumped to the sewage farm at Valiyathura. The scheme was commissioned in 1945.

Block B. Covers an area of 5.51 km^2. It comprises areas of the city such as Sreekanteswaram, Pettah (east of railway line), Rishimangalam, Vanchiyoor, Kaithamukku, Pattom Valley, Nanthancode and Barton Hill. There is a main pumping station in this block at Pattor from where sewage is pumped to the Valiyathura Sewage Farm. Block 'B' was commissioned in 1965.

Block C. Covers an area of 4.12 km^2 and was commissioned in 1970. All the sewage from this block is collected at the main pumping station at Eenchackkal from where sewage is pumped to a sewage farm at Valiyathura. The system comprises two intercepting sewers.

Block D. Divided into two zones namely Zone- I & Zone- II.

(i) Zone-I on the east side of NH is further divided into two sub zones viz. (a) Kowdiar and (b) Ambalamukku-Muttada. Main sewers in Zone-I are Kowdiar Main, Ambalamukku Main, Muttada Main and Kesavadasapuram Main.
(ii) Zone-II on the west side of NH is further subdivided into three zones viz. (a) Kumarapuram-Kannammoola, (b) Kesavadasapuram-Ulloor and (c) Medical College sub zones.

This block has four pumping stations. The Medical College lifting station catering to the needs of the Medical College Complex, Plamoodu lifting station and the Murinjapalam lifting station discharges sewage to Kannammoola pump house. The sewage is pumped to the Sewage Farm at Valiyathura from the pump house at Kannammoola. Block 'D' was partially commissioned in 2004.

Block E. This block includes four zones as detailed below.

- Zone-I: Comprising areas of Sasthamangalam, Kowdiar, Peroorkada and Mannammoola was commissioned during 2004;
- Zone-II: Comprising areas of Maruthankuzhy, Vettamukku, Pangode, Edapazhanji, Chadiyara and part of Poojappura. Commissioning of Zone-II can be done after the land acquisition process is completed;
- Zone-III: This zone consists of Vattiyoorkavu, PTP Nagar, and Kanjirampara area. Land acquisition process has to be completed for the completion of the sewer pipe line laying works;
- Zone-IV: This consists of Valiyavila area. The work of this zone has not been started.

Block F and G. These blocks are proposed under the Theerapathanam Urban Development Project (TUDP), which covers 20% of the Municipal Corporation area (25 km^2) and stretches along 16.5 km of the coast from Akkulam to Kovalam – TUDP serves 150,000 persons (with 12 out of 37 identified slums in Thiruvananthapuram situated in the TUDP area). The sewage generated from this area as

[23]No figure is available in source

well as from existing sewerage system in the city will be treated in the centralised STP at Valliyathura. The existing and proposed Thiruvananthapuram sewerage system is shown in

Kovalam (an important tourist destination located about 2-3 km from the Project site), is proposed to be provided with a sewerage network. Vizhinjam Panchayat with an area of 12.62 km^2 is proposed to be catered with a sewerage network and a Sewage Treatment Plant of 30 MLD capacity.

About 286.0 to 551.5 MLD of sewage is generated from the study area of 10 km radius from the Project site. In the area within 2.0 km from the Project stretch approximately 1.1 to 2.2 MLD of sewage is being generated. The surveyed population generates about 1.36 to 2.72 MLD of sewage 24 (80% of the calculated theoretical water supply). About 38.6% of the surveyed households did not have a piped sewerage system. Only 9.0% of the people had underground sewage network connection.

Sewage discharges into the sea were common sight in the Project area. The open sewage discharge into the sea at Hawa beach, Kovalam shown in the photograph, separates the Hawa beach and Light house beach, making it difficult for the tourists and other people, to commute via the beach between the former and later.

[24]Vizhinjam used to be called Panchayat. In 2010, Vizhinjam was converted to corporation. Data pertaining to sewage collection scenario in the Vizhinjam area in/after 2010 was not available.
As the area mentioned in CDP could not be correlated with the new Vizhinjam corporation area, the Vizhinjam has been referred as panchayat here.

Chapter 5
Anticipated Environmental Impacts and Mitigation Measures

Chapter 5 Anticipated Environmental Impacts and Mitigation Measures

5.0 General

The earlier chapter provided project descrption and baseline environment and this chapter describes potential impacts and mitigation measures. The entire concept from public point of view is simplified and provided as follows,

(A) Vizhinjam port project concept	(B) 10 km radial study area surrounding Vizhinjam	(C) (A+ B) i.e. when (A) the project is constructed and operated at (B) Vizhinjam region
Proposed project as provided in **Chapter 2** project Description	Baseline environment as provided in **Chapter 4** that includes physical, biological and the socio-economic Environment.	There will be both positive and negative impacts. Potentail negative impacts and the possible avoidance of those impacts or to mitigate or minimise or compensate for such impacts are the subject matter of this **Chapter 5**

All mitigation and avoidance measures are designed or formulated to negate the predicted possible and probable impacts described for all relevant environmental parameters and ecological and physical environmental components. During the whole process the nature, type of the predicted potential impacts likely on the physical, biological and social environmental components are assessed to the extent possible. For the assessment of impacts, the baseline information based on the primary surveys, secondary surveys, field visits and stakeholder consultations relating to various environmental components have been utilised.

Baseline environment for which impacts have been determined include “avoidance” as the best mitigation measure to avoid all major impacts. All such events has been completely addressed at the design stage itself. Further, in addition to the regulatory mitigation measures, all possible environmental enhancement measures which normally could improve the public perception about the project has also been adopted and provided in the following sections. The methodology adopted for the impact assessment is shown in the **Figure 5-1**. The Environmental Impact Assessment (EIA) was focussed on:

Port construction phase activities including

- Construction of breakwaters and terminals
- Dredging and reclamation
  - *Dredging (capital)*
  - *Reclamation*
  - *Disposal of (unusable) dredged material into marine disposal area*
- Quarrying including transportation of quarry materials
- Road & rail connectivity
- Port infrastructure
- Ancillary facilities
- Labour Camp
- Batching Plant

Port operation and maintenance phase

- Container Terminal
- Multi-purpose terminal
- Cruise terminal
- Navy berth
- Movement of tugs and port crafts
- Road & rail connectivity

Project aspects and impacts assessed are:

- Land Environment
- Water Environment
- Marine Environment (Coastal Hydrology/Bottom sediment, Sea/Harbour water quality)
- Air Environment
- Noise pollution
- Biological Environment (Costal and marine ecology)
- Waste Management

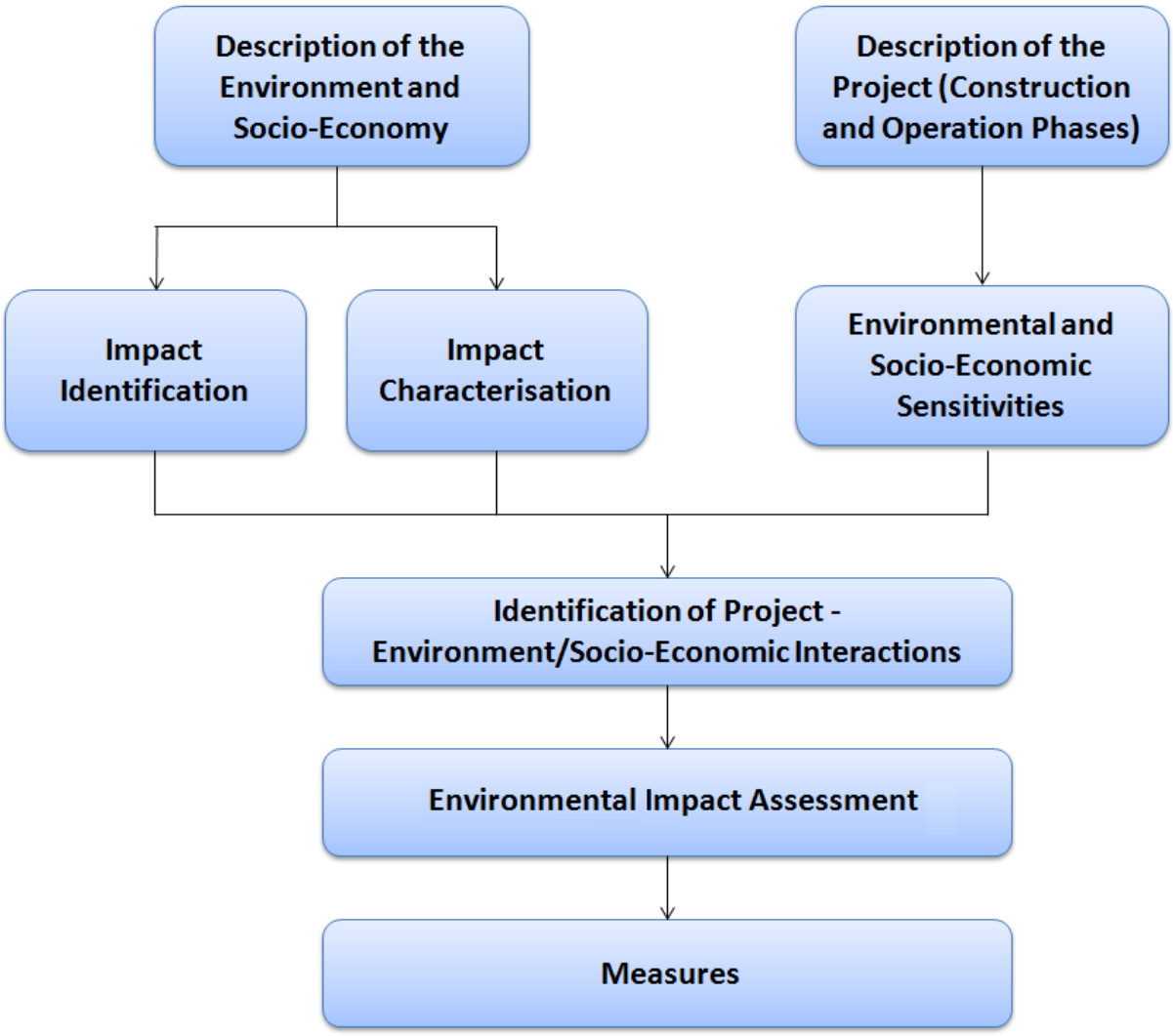


Figure 5-1: Methodology for Environmental Impact Assessment

An Environmental Management Plan EMP) for anticipated environmental impacts is a key to ensure a sustainable environment during the Project construction, operation phases and finally the decommissioning phase. The EMP envisages the plans for the proper implementation of mitigation measures to reduce the potential adverse impacts arising out of the project activities. This proposed mitigation framework has been prepared addressing among others the issues like:

- Pollution control/mitigation measures for abatement for the undesirable impacts caused during the Project construction and operation stages.

For each of the identified impacts specific mitigation measures have been defined. The general rule in designing such measures is:

- **Avoidance of major impacts:** major impacts are generally considered unacceptable, certainly ones that would endure into the long-term or extend over a large area

- Minimization of impacts and reduction of major and moderate risks to “As Low as Reasonably Practicable” (ALARP) by planning, designing and controlling mitigation measures. This implies that technically feasible and cost effective mitigation measures will be applied. The appropriate technologies and measures are established by good international industry practices.
- Where minimization is not possible to compensate or offset residual impacts Implementation of good Contractor practices for impacts rated as minor, in order to ensure that impacts are not neglected, but managed adequately.

Generally, mitigation measures need to be considered in the design of the project through a hierarchy as described below. Similar considerations, in the context of ALARP, will apply to the on-going development of mitigation measures during the development of the port and the detailed design.

Avoid or Reduce at Source	Avoiding or reducing at source is essentially ‘designing’ the project so that a feature causing an impact is designed out (e.g. road re-route) or altered (e.g. reduced working width), often called minimisation.
Abate on Site	This involves adding something to the basic design to abate the impact - pollution controls fall within this category, often called ‘end-of-pipe.
Abate at Receptor	If an impact cannot be abated on-site then measures can be implemented off-site - an example of this would be to install double-glazed windows to minimise noise impact at a nearby residence.
Repair or Remedy	Some impacts involve unavoidable damage to a resource, e.g. agricultural land during road construction. Repair essentially involves restoration and reinstatement type measures.
Compensate in Kind	Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss, damage and general intrusion might be appropriate. This could be ‘in kind’, such as planting new woodland elsewhere to replace what has been lost.

Measures have been defined separately for the various project components and for each project phase (construction, operation and maintenance). Mitigation measures for the decommissioning are comparable with those for the construction phase. As the lifetime of the port is in average 75 years, a proper **Decommissioning Plan** should be drafted according to appropriate principles applicable at that time.

The proposed mitigation measures are based on the design (DPR AECOM, May 2013) and will have to be adapted by the design team.

5.1 Land Environment

Impact to Land resources is one of the most potential impacts due to the construction and operation of the port project and the road/rail component.

5.1.1 Potential Impact due to Port Location

5.1.1.1 Impacts due to Land Acquisition

There is no land acquisition related to the port terminals and is proposed to be developed on reclaimed land. The container terminal requires 36 Ha and Container back up require 30 Ha reclaimed land (Total 66 Ha). Whereas, the infrastructural/ancillary facilities of the port like warehouse, PAF zone, backup areas, rail/road connectivity, etc. requires land acquisition.

It is estimated that the total existing land area required by VISL for phase-I development is around 140.42 Ha out of which around 84.77 Ha for ancillary sites. Apart from the port infrastructure, the project also envisages acquiring land for the road and rail connectivity which in total is another 55.65 Ha; which includes 9.97 Ha for the road alignment and 45.68 Ha for the railway alignment.

5.1.1.2 Impacts due to Changes in Land Use Pattern

The proposed port is planned to be developed completely on reclaimed land however the ancillary sites of the port such as backup areas and Raod/Rail Connectivity etc will be developed on the landside adjacent to the reclaimed land of the port. An area of about 66.00 Ha in the sea will be reclaimed for development of port phase I. Most of the land cover of the landside area of the port is covered with coconut trees and built up area and will be retained wherever possible and the rest will be impacted. Neverthless few building for defense, Coast gurad and port Operator and cruise will be required. Some of the acquired building of the resort wil be retained after a through engineering Audit of the infratsrcure with regards to its fitness for port use. There could be few roads connecting these buildings and offices. The existing land use and the proposed land use are discussed in the Chapter 4 and Chapter 2 respectively. Land acquisiation, Compensation and R&R details for road & rail and acillalary facilities of port related are discussed in **Chapter 7**.

5.1.1.3 Mitigation Measures - Land Use

The land use of the backup areas may not be changed and the facilities and other building will be constructed as per the existing landscape without any major cutting and filling and hence will not be impacted. All planning will be in accordance with land scape planning concepts to minimise major land scape changes.Land reclamation and change in land use pattern will be limited to the proposed port limits and will be carried out in such a way that to ensure the proper drainage by providing surface drainage systems including storm water network, etc.

With regards to the road and rail connectivity the change in land use has been depicted in the environmental strip plan prepared using satellite imagery (google image was used). The entire strip of land along a 2.0 km road (45 m wide) and 14.73 km for rail (31 m wide) will be transformed to port owned transportation land. This will be generally available for the public use.

5.1.1.4 Impacts due to Changes in Coastline/Shoreline

The coastal geomorphology of the Vizhinjam coastal area consists of the pocket beaches, rocky coasts, headlands, bays and medium to low cliffs. Habitats and establishments in the close proximity to the shoreline is a noticed in the areas adjacent to the proposed port. Therefore to study the current status/trend of the shoreline change INCOIS and LTR has carried out Assessment of Long Term Shoreline Changes in and around the Proposed Port at Vizhinjam. The Assessment of shoreline change is based on the data acquired during the period 1992-2011 by means of Indian Remote Sensing Satellite (IRS) and Landsat Thematic Mapper (TM)/Enhanced Thematic Mapper (ETM).

Measurement of coastline changes was made by comparing historical maps and charts provided based on accurate surveys. With the coastal configuration shown on modern maps, aerial photographs or satellite imagery, it is possible to evaluate such changes. Thus, Remote Sensing and GIS techniques can be effectively used for the assessment of shoreline changes. Various approaches (Satellite imageries, Google images, one dimensional and two dimensional numerical models and Survey of India (SoI) maps) were used to study the shoreline changes along the Vizhinjam coast.

The satellite data from Landsat TM and IRS-P6 LISS-III pertaining to the study period (1992-2011) were imported into ERDAS Imagine environment. All these data sets were geo-rectified using the reference image in order to assign real world co-ordinates and projected on to UTM projection system and WGS-84 datum. The shorelines pertaining to individual period were extracted using the Infra red (IR) band by on-screen digitization technique. The shorelines of individual period were stored in the individual ESRI shape file. The digitized shoreline of the year's 1992, 1997, 2001, 2006 and 2011 in the vector format were generated for further assessment in the GIS environment. The running Shoreline Changes Rate (SCR) during the period of 1992 to 1997, 1997 to 2001, 2001 to 2006,2006 to 2011 and net 1992 to 2011 were estimated using DSAS tool based on 30 m transect interval along the coast line to calculate the shoreline change rate.

Table 5-1: Satellite Data used to Evaluate Shoreline Changes

Satellite	Sensor	Spatial Resolution in meters	Date of Acquisition		
			Month	Date	Year
Landsat	TM	30	March	11	1992
IRS-P6	LISS-III	23	February	17	1997
IRS-P6	LISS-III	23	March	15	2001
IRS-P6	LISS-III	23	March	28	2006
IRS-P6	LISS-III	23	March	02	2011

(Source: Shoreline changes study LTR, 2012)

The shoreline change rate pertaining to the periods 1992, 1997, 2001, 2006 and 2011 were thus estimated and final maps showing the distribution of the spatial changes were prepared. The positive values on the map represent the accretion and negative erosion. The shoreline change rates were classified as high rate of erosion (erosion more than 5.0 m/year), low erosion (Erosion 2.0 - 5.0 m/year), no change (erosion and accretion up to 2.0 m/year), low accretion (Accretion 2.0-5.0 m/year) and high accretion (more than 5.0 m/year).

The results of the shoreline change assessment around 15.00 km either side (Total 30.0 km) of Vizhinjam port during 1992 - 2011 revealed considerable dynamics of the shorelines in terms of the spatial and temporal variations. The shorelines pertaining to individual period were overlaid on the corresponding False Colour Composite (FCC). The shoreline in the area depicts the spatiotemporal variations during the study period 1992 - 2011. It was observed that the northern parts of the Vizhinjam show dominantly eroding tendency, whereas the southern parts show dominantly stable to accreting tendency during 1992 - 1997. During the period 1997 – 2001 the results revealed the dominant accretion phase except few stretches near Vizhinjam, Kovalam and Poonthura. However, during the period 2001 - 2006 shorelines recorded the erosion in the northern and central parts of the study area. But, during the period 2006 - 2011 the shorelines were recorded dominantly low erosion to no change except few stretches around Poonthura, Adimalathura and south of Poovar in the southern parts. The net changes in the shoreline rate during 1992 - 2011 reveals dominantly stable to accreting tendency except few stretches around Poonthura in the northern parts of the study area **Figure 5-2**.

- Overall, the shorelines experienced maximum accretion (as observed) during 1997 – 2001, and
- Maximum erosion was observed during 2001 - 2006 and erosion comparatively reduced during 2006-2011.

However the net shoreline change rate for most of the coastal stretch in the area is found to be accretion.

The data for the shoreline evolution study was obtained from Google Earth images available for the periods of 26-Jan-2003, 19-Jun-2006, 25-Sep-2009, 19-Mar-2011 and 05-Apr-2011 which cover the

stretch from river Karamana to Adimalathura as shown in **Figure 5-3**. It is inferred from the images that no significant change in the shoreline is observed in the pocket beaches at Kovalam. Vizhinjam fishing harbour is located on a coastal stretch which typically has cliffs fronted by narrow sandy beaches in pockets and coastal stretches protected by seawall. Each pocket beach can be considered as littoral cell and does not contribute any significant littoral sediment to the adjacent coast.

It is observed from the images that the beach at Adimalathura is formed mainly during the fair weather and erodes during both the monsoons. The building up of the beach takes place during the post-monsoon period which is prevalent for a coastal stretch of approximately 3.5 km.

National Centre for Sustainable Coastal Management and Institute for Ocean Management (NCSCM) prepared shoreline changes assessment for Kerala coast as part of mapping entire country's coast line to identify areas of shoreline changes. Shoreline change assessment of Kerala. coast represents long term shoreline changes for a period of 38 years from 1972-2010 is given **Figure 5-4** for the South of Vizhinjam port site and in **Figure 5-5** for the area North of Vizhinjam port site.

The shoreline change studies conducted using the long term multi-temporal and multispectral satellite data from IRS LISS-III and Landsat TM data provides useful insights in understanding the broad shoreline behaviour and their relative positions.

- Shoreline change rate in the study area (total 30 km) assessed for the different time-frames shown large variations in their rates of erosion and accretion
- Area in general is experiencing **accretion** to **no change** at places
- Shorelines experienced maximum accretion (as observed) during 1997-2001 and Maximum erosion was observed during 2001-2006 and erosion comparatively reduced during 2006-2011. However the net shoreline change rate for most of the coastal stretch in the area is found to be accretion.
- Southern parts of the coasts were reported dominantly stable to accretion
- Current study confirms the shore as **no change** category (±2 m/y)
- Net changes in the shoreline rate during 1992-2011 reveals dominantly stable to accreting tendency

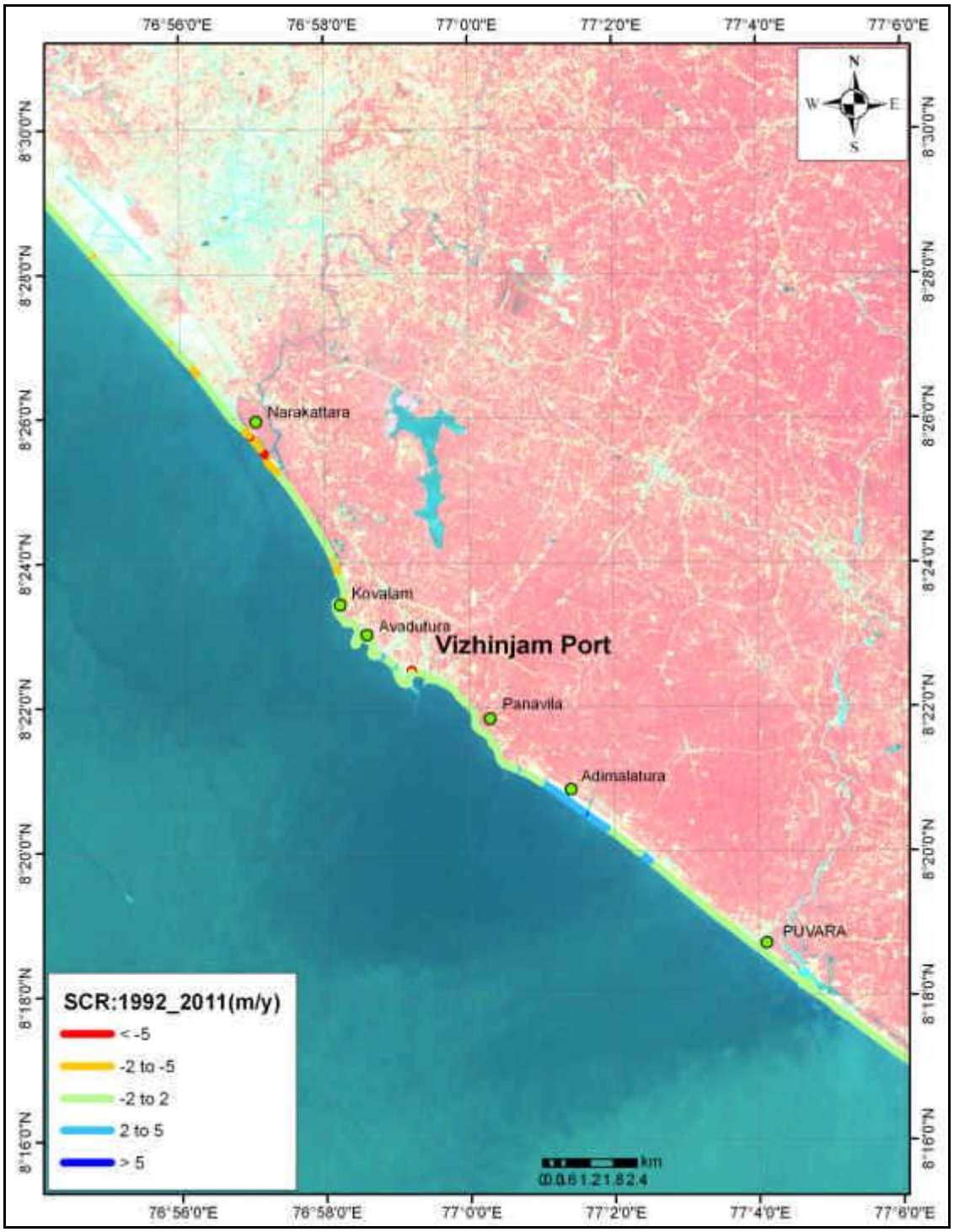


Figure 5-2: Map Showing the Shoreline Change Rate in m/y during 1992-2011

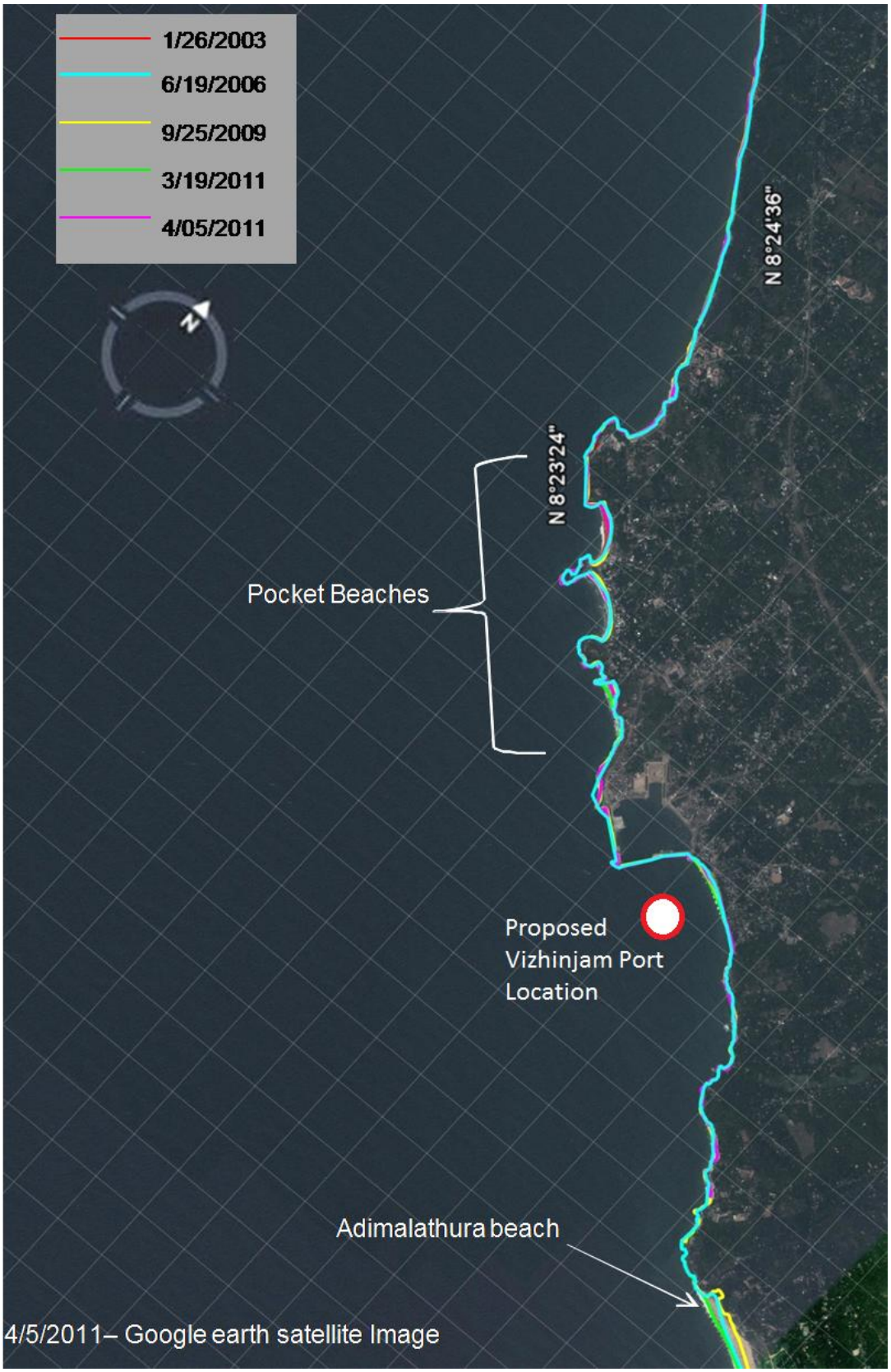


Figure 5-3 Shoreline Position In and Around Vizhinjam



Figure 5-4: Shoreline Position South of Vizhinjam

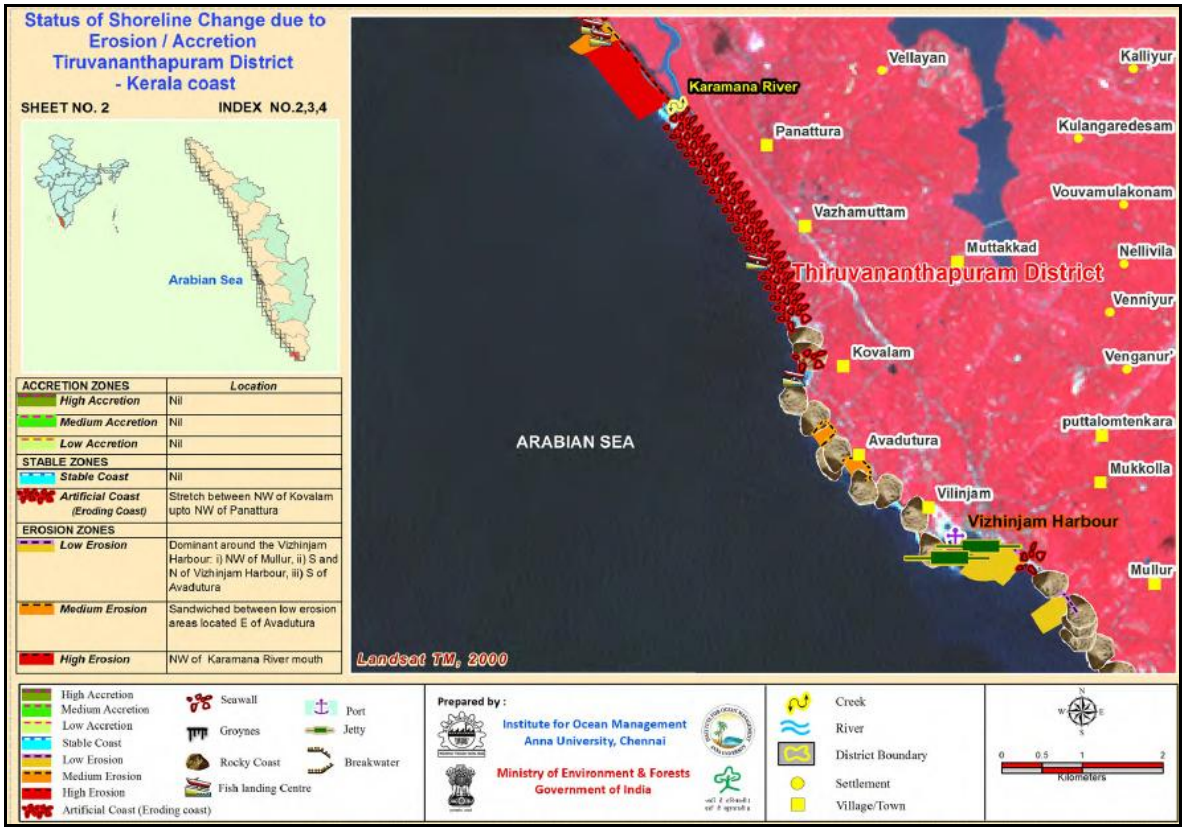


Figure 5-5: Shoreline Position North of Vizhinjam

5.1.1.5 Land Reclamation

Land reclamation will be carried out within port limits. About 7.6 MCM of the dredged material will be used for reclamation. Land reclamation with capital dredged material is likely to impact the reclamation area/site with the turbid water. Predominantly the port land proposed to be reclaimed is an intertidal zone which is saline in nature and also low lying area having slope towards sea. in phase-I, entire dredged material will be used for port reclamation and unusable material will be disposed off in the designated marine disposal location..

To check the suitability of dredge material for reclamation, detailed study on characteristics of dredge material was studied by a marine bore hole study. Analysis was carried out to study the quality of dredge material in terms of toxic metals and in accordance with schedule II of the hazardous waste management rules 1989 as amended. Analysis was done for toxic/ heavy metal concentration in/near the dredging area is given below.

The sediment was found to be sandy in nature with percentage of sand ranging from 97 to 99%. Mercury (Hg) and Dibutyl Tin (DBT) were found to be below the detection limit (detection limit for Hg and DBT is 0.05 ppm and 0.2 ngSn/g). The concentration of Chromium, Copper, Nickel, Lead and Zinc were in the range of 5.32 -11.22 ppm, 1.16 – 1.40 ppm, 0.05 - 0.49 ppm, 1.37 – 2.68 ppm and 2.89 – 5.04 ppm respectively.

Results of the analysis shown that the concentration of the toxic/heavy metals in the material to be dredged, is within the acceptable concentration limits. Hence based on this analysis, the dredged material can be suitably used for reclamation and any excess material can be safely disposed in appropriately selected offshore location.

5.1.1.6 Mitigation Measures

Judicial planning of port facility will be carried out. Reclamation bunds and setting ponds shall be constructed, the dredged material will be pumped into the reclamation area enclosed by reclamation bunds wherein the solids will be allowed to settle and the return water will be directed into sea through appropriate return channel/pipelines. The dredge fill will be covered by gravel before hard standing. After completion of the reclamation and hard standing, necessary development shall be carried out.

In order to prevent the seepage of return sea water into the groundwater, suitable impervious liners such as LDPE will be provided all along the return water channel. Also minimum required retention time of return water in the reclamation area as well as in the return channel will be ensured.

But predominantly the port land proposed to be reclaimed is an intertidal zone which is saline in nature and also low lying area having slope towards sea. Hence, the impact due to this activity will not be significant. In order to study variations in groundwater quality of nearby villages due to reclamation, regular water quality monitoring will be carried out.

5.1.2 Potential Impact during Construction

During construction phase changes in Land use/land cover may arise, Topography changed. Due to construction activity and Soil compaction, consolidation may cause in loss of vegetation and tree cover, soil pollution and even flooding also. These details are discussed in sections below.

5.1.2.1 Impact on Local Infrastructure

During construction phase, significant amount of construction material will be required, particularly quarry stone for the construction of breakwater, bunds, buildings, etc. This will be obtained generally by excavating from the quarry sites. It is imperative that these sites be treated, once the excavation of construction material is completed. The ideal measure for treatment is the refilling of these sites to its original level and their re-vegetation.

The viable option for rock quarrying and transportation which is socially acceptable, environmentally being and technically feasible is transportation of rocks to the site through barges. The potential quarry areas which have been zeroed in are Kolachal fishing harbour in Tamil Nadu (about 36 km (via sea south of Vizhinjam) and Muthalappozhi fishing harbour (about 36 km (via sea) north of Vizhinjam). The quarrying of 6.5 MMT in phase-I of the project will change the topography of Kadavila/ Theviyodu quarry region permanently.

- Thottiyodu Quarry site at Kaduvathopu, around 8.0 km from NH 47 at Thackalay (Tamil Nadu) (about 13.5 km by road to Kolachal fishing harbour)
- Kadavala quarry site, around 5 km from NH 47 at Attingal (Kerala) (about 20 km by road to Muthalapozhi fishing harbour)

The final selection of quarry will depend on the EPC contractor. **Figure 5-6** describes the transportation process assumed for rock required for breakwater and shore protection construction.



Figure 5-6: Transportation from Quarry Site

The following measures will be implemented to minimize adverse impacts on environment during quarrying:

- Quarrying will be done from approved/legitimate quarries to minimise impacts.
- Quarry operations will be restricted to daytime to reduce the impacts from increased noise and will be minimized to reach the threshold levels stipulated by CPCB at the nearest habitations.
- It will be ensured that quarry sites and borrow pits be of a regular shape and if possible, of equal size.
- If possible, their location would be at least 1.6 km away from the nearest habitation.
- Runoff water collected in the lowest pits will be drained in to the nearest water body by a drainage system.
- Only rocky outcrops will be quarried and quarrying below the general ground level, surrounding the rock will be avoided.
- Some localized road improvement measures will need to be undertaken near the quarries and near the project site to enable moving of the large quantity of stones by road using trucks.



Figure 5-7: Selected Quarry Sites, barge loading Location with respect to proposed port location

Borrow Areas:

VISL and EPC Contractor has to ensure the sourcing of borrow material shall not lead to any potential impact to the local communities

- Borrow pits would be located along the natural drainage course and not across the natural drainage;
- Borrow pits will be in a series, so that they can be inter-connected leading the collected water to the lowest level of the pit, which will be of sufficient size to hold the discharge from the upstream pits. The bottom of each pit will be gently sloped towards the next pit below in the series and the inter-connections will be done by pipes or open drains filled with broken stone, to prevent scouring of drains;
- Top fertile soil shall not be used for construction material

***Transportation of Construction Material*:** Transportation of quantities of construction material for construction of berths, administrative buildings, etc. results in use of public infrastructure like roads, drainage, water and power supply which in turn results in congestion. In order to minimize the strain on the existing infrastructure in the region, VISL has party completed construction of the 2.0 km road corridor to the NH 47 bypass

Construction Workers Camp: There will be a requirement of about 1,000 work force (excluding service providers) during the construction phase (about 36 months). With regards to the impacts due to construction worker camps, to ensure there is no strain on the existing infrastructure, the worker camps will be self-sufficient and would not rely on any local resource. This would also ensure that there is no conflict with the local population. To mitigate impacts from health hazards, sanitation

facilities will be provided. Further, the worker camps will be located away from the coast and habitations

5.1.2.2 Mitigation Measures

The roads which will be used for rock material transport will be widened and strengthened. Similarly the harbours used for rock/ material transport will be strengthened. VISL will provide necessary budgetary provision in the civil construction contract.

To mitigate impacts from transportation of construction material, existing roads will be strengthened wherever necessary.

- Temporary approach roads may be developed with prior permission from competent authority
- Trucks with construction material susceptible for fugitive suspension will be covered with tarpaulin covers
- Transportation management will be adopted for movement of dumpers transporting quarry stones and construction materials and traffic will be regulated
- Vehicles deployed will conform to emission norms (air/noise) of CPCB and have valid Pollution Under Control (PUC) certificates
- Dumpers and trucks will comply with standards for exhaust emissions and noise levels
- All vehicles used will be in good condition with all valid number plates and documents. Older than 15 year vehicles will not be allowed to use in any of the construction sites
- Worker camps will be adequately equipped with necessary facilities such as water supply, power supply, wastewater collection, solid waste collection and sanitation, fuel supply, etc.
- Domestic wastes generated from worker camps will be collected properly treated and disposed after complying with the norms stipulated by statutory authorities
- No borewells will be driven to meet the water requirements to avoid impacts on groundwater resources.

If there are any accidental spillages of hazardous substances on soil that may pose the risk of contaminating run off, such areas will be immediately remediated.

5.1.2.3 Impact Due to Road and Rail Corridor Development

A major extent of the planned road and railway alignment is covered with agriculture land. Mostly the fertile agricultural soil will be impacted due to the conversion of land use from agricultural to transportation land.

The development that the proposed road/rail will bring with it will induce a chain reaction towards change in land use. The change in land use will lead to an increased price of land by speculation and by the time the project materialises the price will be expected to be stabilised.The road, which is flanked by agricultural fields, will witness high price selling of these lands. The positive impact could be the reduced transportation costs and availability of high-class transportation facilities for cargoes.

The terrain in the entire study area is undulating with small flat hillocks and valleys. There will be a change in the existing terrain features due to construction of rail and road connectivity.

Also for rail connectivity the clearing and felling activities will lead to erosion of fertile soil. This will be more acute in the starting chainages close to Nemom where a hill will be cut. In all, throughout the alignment except along the beach towards the terminal area, the clearing, felling and later construction activities could trigger lots of erosion.

Compaction of soil will occur in the pre-construction stage (particularly during site clearance) due to movement of heavy machinery and vehicles. Transplantation of big trees in the acquired area if carried out shall involve very heavy machinery to uproot trees and haul them to the site of transplantation. Similarly, compaction will take place during setting up of construction camps and stockyards. However, this impact is applicable only till the end of short construction period. Compaction shall occur beyond the rail carriageway and within the vegetated area of the RoW by the movement of vehicles and heavy machinery.

Contamination of soil in the pre-construction stage may be considered a short-term residual negative impact. Soil contamination may take place due to solid waste contamination from the labour camp set up during pre-construction stage. This impact is normally significant at locations of construction camps; stockyards, hot mix plants, etc. However since the road project size is too small, no such potential impacts anticipated. Contamination of soil during construction might be an important long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to water bodies in case of dumping being done near to water body locations.

In regards with the road & rail corridor, the following criteria were adopted for identification of the suitable rail corridor alignment: Here avoidance was the main criteria used for mitigation of major impacts.

- Minimum connecting distance to existing as well as proposed railway line
- To avoid passage through habitations, sensitive places such as hospital, school and places of worship
- Minimum crossings at canals and rivers
- Minimum land acquisition and minimal R&R
- Future expansion possibilities

Impacts to Ambient Air Quality: During the construction phase ambient air quality along the adjacent villages may get disturbed due to various construction related activities such as:

- Site clearance and use of heavy vehicles and machinery
- Transport of raw materials, borrow and quarry material to construction site
- Earthworks
- Handling and storage of aggregates
- Asphalt mixing plant operations

These activities mainly generate dust and emissions such as CO, SO_2, NO_X from construction machineries and also due to other vehicular movements during construction. During the operation phase the anticipated impacts on Air quality is due to the movement of vehicles used for transportation of cargo and transportation of other materials.

Impacts to Ambient Noise Level: During construction phase, there will be an increase in the Ambient Noise Levels due to the various construction activities and use of the large number of heavy machineries. However, these construction phase impacts are short term in nature, realised in the immediate vicinity and will cease upon completion of construction. This will occur along the construction corridor as well as at the secondary sites which include construction camps, asphalt mixing plant etc. During the operation stage, incremental noise level will be due to the increased traffic volume and cargo movements.

Impacts to Water Quality: During construction phase, anticipated impacts are due to spillage of construction materials such as cement, POL, bitumen, etc., falling in to the water bodies and drainage

channels from workshops, construction camps etc. During construction phase the natural drainage system may get disturbed and reduction in the capacity of the natural stream may occur. Runoff from the construction sites and labour camp can increase the risk of pollution in the natural watercourse if not handled properly. During operation phase degradation of water quality during normal operations is not anticipated. Spillages, if any, can impact the water quality. Also the entry of vehicles to streams/nallah/rivers for cleaning could be an impact during operation phase. Surface runoff will be expected due to paved surface.

Impacts to Land Use: The proposed road/rail alignment will traverse mostly on the agricultural land. During the construction stage accidental spills of fossil fuel and other hazardous material can increase the risk of soil pollution. Contamination of soil may also take place due to solid waste generated from labour camps. Soil compaction will take place due to the movement of heavy vehicles and other vehicles. During operation phase degradation of soil quality during normal operations is not envisaged. Spillages if any can impact the soil quality.

Ribbon Development: The new port connectivity road of 2.0 km could trigger massive ribbon development if not carefully planned that could not only geo paradise the security of the port but also will bring in an ugly look to the new infrastructure.

5.1.2.4 Mitigation Measures

Mitigation measures to address adverse impacts on the air quality, noise quality, water quality, soil quality and land environment are listed below:

- Asphalt plants, crushers will be sited at least 1.0 km in the down wind direction of human settlement along the rail corridor.
- During and after compaction of the sub grade, water will be sprayed at regular interval in order to avoid fugitive dust generation.
- Vehicles carrying fine and coarse aggregate shall be covered with tarpaulin in order to avoid the spills.
- Pollution Under Control (PUC) certified construction machinery and equipments will be used and checked at regular intervals.
- Tree plantation along the Right of Way (RoW) also will act as a major sink of pollutant due to the plying vehicle through corridor.
- Ambient air quality will be monitored at regular intervals during construction and operations phase of the rail corridor.
- During the operation stage dust generation will be minimum because most of surface will be covered by paved shoulder.
- Regular maintenance of the road, during the operation phase will reduce any negative impacts to an absolute minimum.
- Timely vehicle maintenance and use of unadulterated fuels shall be ensured.
- During construction, noise levels will be maintained below threshold levels stipulated by Central Pollution Control Board (CPCB) by selecting appropriate equipment, machinery and using enclosures.
- Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A).
- Well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used.
- Personnel exposed to noise levels beyond threshold limits will be provided with protective gear like earplugs, muffs, etc.

- Ambient noise levels will be monitored at regular intervals during construction and operations phases of the rail corridor.
- During operation phase noise levels will be significantly less because of smooth paved shoulders and presence of trees along the RoW.
- Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation, etc.
- Construction along the water courses will be carried out in the lean flow periods.
- Water especially groundwater will not be extracted from the local resources. Requirement of the water will be met from the ample available resource.
- Construction site will not be sited nearer to the surface water or groundwater resources.
- Control of the access of Vehicles to the water bodies will be ensured.
- Road safety will be strictly ensured to keep the accident quite low.
- Water quality will be monitored at regular intervals during construction phase of the project.
- All the top soil up to 150 mm shall be blended with other barren land where applicable to convert in to arable cultivable land and will be utilized for landscaping along the corridor.
- Restriction of the movement of vehicles and machineries in the cultivable land.
- Soil quality will be monitored during construction and operation phase of rail/road corridor.

5.1.2.5 Impact on Soil and Geology

Compaction of soil during construction of site roads, lay down area and temporary site offices; Erosion of unconsolidated, exposed and stockpiled soils during a monsoon period; Disturbance and dispersion of soils due to movement of construction traffic and equipment over unsealed tracks and exposed, unconsolidated soils; Contamination of soil due to spills or leaks of fuels, lubricants and / or chemicals stored and used on site; Contamination of soil due to leaks from wastewater; Contamination of soils due to poor storage and management of solid and liquid wastes prior to disposal; and Contamination of the soils due to leaks of fuels and lubricants from construction vehicles and plant (e.g. concrete batching plant).

These impacts might be permanent if not remediated.

The quarry area will require clearance from vegetation, as well as the execution of excavation works using heavy equipment. In addition to the quarrying activities inappropriate construction practices and soil protection measures may induce or accelerate erosion, leading to soil instability and landslides in hilly areas. Furthermore, contamination of soils may occur as a result of spillage of fuels, lubricant chemicals, sanitary wastewater, etc., as well as from leakage from inadequately protected solid waste storage facilities and sites.

5.1.2.5.1 Mitigation Measures - Geology and Soil

- Proper planning of works and work design (avoid some works in rainy season), to avoid or minimise erosion.
- Early establishment of cut-off trenches, storm water velocity inhibitors and comparable measures;
- Planting of vegetation on barren and/or sloping surfaces.
- Channel runoff from hardened surfaces to well designed and properly maintained drains.
- Special care should be taken not to cause spreading of erosion material over the non-project areas.
- Minimising areas that are cleared for construction.
- Collection of sewage/solid waste/construction wastes.
- Sewage/solid waste/construction wastes should be treated and disposed or sold to authorised recyclers as per the MoEF guidelines.

- Minimising areas that are cleared for quarrying.
- Solid non-hazardous waste to be transported to and dumped in a dedicated landfill in e.g. Vilappilsala when reopened. Otherwise a new one, based on international standards, should be developed in the area.
- Quarries generate large volumes of waste. Structures such as waste dumps and containment facilities should be planned, designed and operated such that geotechnical risks and environmental impacts are appropriately assessed and managed throughout the entire quarry cycle.
- In addition, proper sanitation facilities and bins should be provided in the quarry area for collection of sewage/solid waste.
- Hazardous waste should be handled by specialised providers (in accordance with regulatory permits) of hazardous waste management facilities specifically designed and operated for this purpose.
- Hazardous materials should be handled, stored, and transported so as to avoid leaks, spills or other types of accidental releases into soils, surface water, and groundwater resources.
- Possible dump of quantities of overburden or waste rock should be well managed in a way that protects human health, safety and the environment.
- Proper environmental operating practices should be assured through regular inspections and audits of the quarries.
- Proper planning of works and work design to avoid or minimise erosion in the quarries.
- Planting of vegetation on barren and/or sloping surfaces.
- Special care should be taken not to cause spreading of erosion material over the area.

5.1.3 Potential Impact during Operation

During operation phase, soil pollution may happen if solid and liquid waste not managed properly. Flooding may happen if drains are not properly maintained. The details are discussed below.

5.1.3.1 Discharges from Ships on Land

No discharge of wastewater/waste from the ships calling at Vizhinjam port will be permitted into the port area. Facilities for discharge of waste oil will be provided at the port. The ships will have their own sewage reception/treatment facilities on board and hence no discharge of sewage will be done at the port. In addition, the ships are expected to discharge sewage in deep seas as per defined procedures for International ship movements. This will ensure the ships have their own storage capacities in their on board sewage receptions to handle wastes generated during the period/days the ship is at the port. Ships shall conduct ballast water exchange at least 200 nautical miles from nearest land and in water at least 200 m in depth prior to calling at a port. Where ballast water exchange at 200 nautical miles to nearest land is not possible, exchange should take place at least 50 nautical miles from nearest land and in water at least 200 m in depth. Each ship shall have on board a ballast water record book which may be an electronic recording system. Port officers may inspect the ballast water record book.

5.1.3.2 Impacts due to Changes in Coastline/Shoreline

Coastal structure similar to a groin or a breakwater when introduced into the sea interrupts wave-induced littoral sediment transport in the direction of flow. The obstruction of sediment transport leads to sediment built-up and acts as platform for evolution of shoreline. The coast downstream of obstruction has deficit sediment supply thereby leading to erosion. These aspects are studied

individually in the context of proposed developmental activities which is detailed in the following section.

GENESIS Shoreline Change Model: GENESIS is used to examine long-term shoreline change due to the proposed breakwater. GENESIS is an elaborate one-dimensional numerical model, which simulates changes in shoreline position due to spatial and temporal gradients in longshore sediment transport. The model considers the motion of sediment as uniform over the entire active profile between two well-defined limiting elevations i.e. the top of active berm and the depth of closure (the seaward limit of significant sediment transport). GENESIS can simulate changes in shoreline position due to the presence and combinations of beach fills and nearshore structures such as groyne, jetties, seawalls, and breakwaters. The model allows for sand bypassing around and through groyne and jetties. The model also accommodates wave diffraction by long groins and offshore breakwaters and wave transmission through breakwaters. Wave conditions, which drive the model, consist of wave height, period and direction and can originate from multiple independent generation sources.

GENESIS shoreline change model is suited for coastal stretches where longshore sediment transport is dominant. The shoreline change produced by cross shore sediment transport such as that associated with storm events cannot be simulated. GENESIS is best suited to situations where there is a systematic trend of long term changes in shoreline position such as shoreline regression and advancement due to the coastal structures like groin, breakwater, seawalls and detached breakwater. The prediction of the GENESIS model is deterministic, the quality of which depends on the input data and good calibration. The model produces representative values and the accuracy of results is linked to the quality of data inputs.

GENESIS Model

GENESIS (13) considers longshore sediment transport due to breaking waves. The dynamic equation or the statement of the longshore sand transport rate, Q is

$$Q = (H^2 C_g)_b [a_1 sin2\theta_{bs} - a_2 cos\theta_{bs} \frac{\partial H}{\partial x}]_b$$

$$a_1 = \frac{K_1}{16(s-1)(1-p)(1{,}14116)^{5/2}}$$

$$a_2 = \frac{K_2}{8(s-1)(1-p)tan\beta(1{,}14116)^{7/2}}$$

Where H is the breaking wave height, C_g is the breaking wave group velocity, x is the longshore direction, and θ_{bs} is the angle of breaking waves referenced to the shore perpendicular direction, a_1 and a_2 are the non-dimensional parameters, p is porosity of the sand on the bed, s is ratio of density of sand to density of water and *tan* β is the average near shore bottom slope. The first term considers sediment transport generated by the longshore component of the breaking wave energy flux. The second term modifies the transport rate to account for longshore gradients in breaking wave height. K_1 and K_2 are the two dimensionless calibration factor for controlling the longshore sediment transport and offshore wave breaking.

Model Inputs

- Bathymetry for the coastal stretch - Bathymetry for the study was prepared using the inputs as described.
- Wave data - The wave data required for the study has been extracted from SWAN model results at 60 m contour depth. Then the extracted data were transferred to a depth of 25 m nearshore, using STWAVE model developed by USACE.
- Shoreline data - Initial shoreline position, is an essential input to simulate shoreline evolution was extracted from latest Google Earth Imagery of the project site.
- Sediment size - The D_{50} sediment grain size of 0.25 mm was considered for the model study.

Model Simulation:

The shoreline evolution model study has been carried out for existing condition incorporating all the existing coastal features (manmade and natural). A shoreline stretch of 25 km evenly distributed near the vicinity of the proposed port has been studied. A grid resolution of 30 m×30 m was used for the simulation of shoreline evolution using GENESIS. The calibration parameters, K1 and K2 were varied to close correlation with existing shoreline evolution.

The calibration parameters were fixed to correlate with the existing shoreline evolution was further used in simulation incorporating the proposed port breakwaters. The simulation was carried out for a period of ten years. Simulations for longer period (more than ten years) may lead to unrealistic results as there may be chances of coastal development which cannot be accounted in the model study.

Results and Discussion:

The shoreline evolution model study has been carried out for existing condition incorporating all the existing coastal features (manmade and natural). The simulated results in existing condition without the port were compared / correlated with the analysed data from Google Earth imagery, and are found to have similar trend.

The model considers a 25km coastal stretch for the simulation of shoreline evolution in the vicinity of the proposed port. The simulated result from the model indicates erosion near Karamana River (**Figure 5-8**) and accretion at Adimalathura south of the proposed port. These results are consistent with the findings of the report on “Assessment of Long Term Shoreline Changes In and Around Proposed Port at Vizhinjam”.

Based on the analysis of the simulated results in existing condition, it was noticed that the average rate of accretion is 4.4m/year at Adimalathura, which is towards the south-east direction of the fishing harbour. In the north-west (north of Kovalam) of study area beyond the protected stretch the rate of erosion is observed to be 1.4m/year. Apart from these two stretches the net shoreline evolution is insignificant in the entire study domain. It is observed that the shoreline evolution along the coast is influenced by the two monsoons which govern the direction of sediment transport and shoreline evolution rate. The coast is having a tendency to regain its beach during the non-monsoon season, even though it loses the beach during monsoon season. These results are verified / correlated with data from Google Earth.

The influence of proposed development was simulated by introducing the proposed breakwaters and keeping all other parameters same as those used in the existing condition. The yearwise shoreline evolution over ten years to the south of the proposed port for phase I layout has been is tabulated in to **Table 5-2** and are presented in **Figure 5-8** It was observed that there is no significant change to

shoreline evolution due to proposed port in the stretch between proposed port and the fishing harbour. The simulated result from the shoreline evolution model for each phase of construction of proposed port indicates that the shoreline gets stabilized over the years.

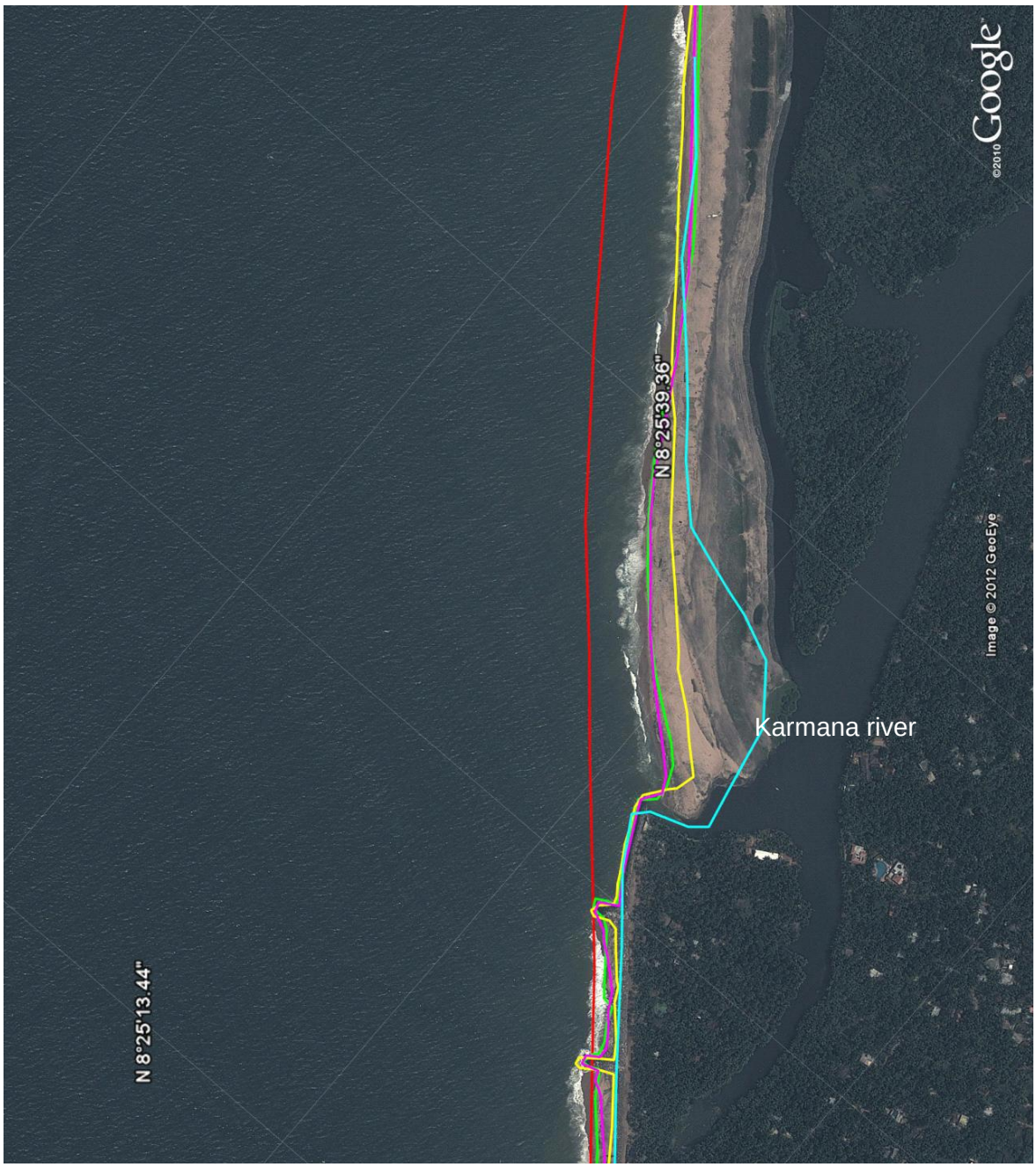


Figure 5-8: Shoreline position from Google earth imagery

Analysis of simulation results shows the influence of proposed port has negligible effect on North-West side of the fishing harbour, whereas there is an accretion on southern side of proposed port for a coastal stretch of about 2.2 km. The shoreline evolution is presented in **Figure 5-8** and stretch wise evolution is tabulated in **Table 5-2.** The revetment on the south-east of Phase-I port layout is considered as 0m chainage. The evolution is tabulated for a stretch of 2.2km at 200m interval from 0m chainage to further south-east. In the table accretion (+) is taken as positive and erosion (-) is taken as negative. The result from **Table 5-2** indicates that the average rate of accretion adjacent to the south-

eastern structure (revetment) is 21.6 m/year in the first year of the phase I construction which gradually reduces to 0.5 m/year by end of tenth year.

Table 5-2: Predicted shoreline evolution for Phase-I to the south of proposed port

Year	Shoreline evolution in m (cross shore direction)										
	0-200	200-400	400-600	600-800	800-1000	1000-1200	1200-1400	1400-1600	1600-1800	1800-2000	2000-2200
First year	21.6	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6
Second year	23.0	2.3	2.3	1.8	2.2	2.2	1.5	0.6	0.1	0.0	-0.1
Third year	22.9	3.9	3.9	4.9	4.9	4.4	2.8	1.3	0.6	0.2	0.2
Fourth	23.0	6.2	6.2	7.3	7.3	6.5	4.4	2.5	1.4	0.8	0.5
Fifth year	24.0	8.2	8.2	9.4	9.3	8.3	5.9	3.7	2.4	1.5	1
Sixth year	24.3	10.0	10.0	11.3	11.2	10.0	7.3	4.9	3.4	2.2	1.5
Seventh year	24.7	11.8	11.8	13.0	13.0	11.6	8.8	6.1	4.4	3.0	2.1
Eight year	25.2	13.4	13.4	14.7	14.6	13.1	10.1	7.3	5.5	3.9	2.8
Ninth year	26.3	15.0	15.0	16.3	16.2	14.6	11.5	8.5	6.5	4.7	3.4
Tenth year	26.8	16.5	16.5	17.8	17.7	16.0	12.7	9.6	7.5	5.6	4.1

(Source: Modelling Report, LTR, 2013)

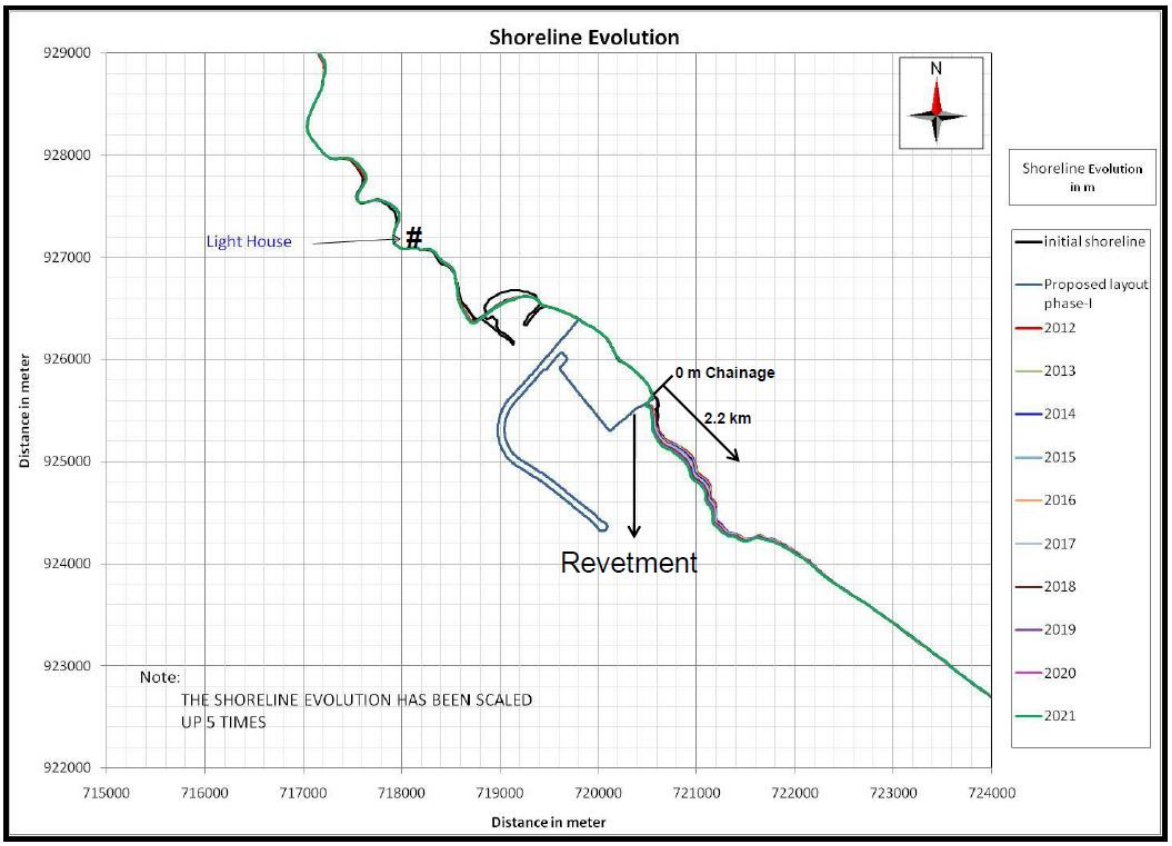


Figure 5-9: Predicted Shoreline along the Vizhinjam Coast

5.1.3.3 Mitigation Measures

- Continuous monitoring of shoreline with the help of high resolution satellite imageries during operation phase.
- Fixing of shoreline just prior to construction phase by latest satellite imagery and then ground truthing on a regular basis with close monitoring and ground markings.

- Based on the monitoring results, appropriate techniques such as sand bypassing from accreting area to eroding area, if found shall be carried out to maintain the stability of coast.
- Based on the monitoring results, the sand trap may be created where the high accretion is observed.
- Any other intervention such as construction of groin will be explored at VISL cost if logically proved as ***'Port induced effect'***

Efforts will be made to aggressively monitor the highly eroding areas far north of Vizhinjam. Dredging of the area to be accreted/ sand trap shall be carried out regularly (as a part of maintenance dredging) and the material shall be used for maintaining the eroding coastal stretch, if observed. The excess/unusable material shall be disposed at the identified offshore disposal location.

5.2 Water Environment

5.2.1 Potential Impact Due to Port Location

5.2.1.1 Impact on Existing Water Resources

Daily water demand for the phase-I development is estimated to be around 0.5 MLD. Out of this the potable water demand is 0.52 MLD which will accommodate the requirements for the port personnel, township with balance being the raw water.

As indicated in Chapter 2, the source of water shall be mainly be from Vellayani Lake. The plan is for drawing 3.30 MLD of water from Vellayani Lake and to treat the same at a treatment plant located at Vizhinjam in the land available with the Harbour Engineering Department (HED). As per the report, 3.00 MLD of water will be available after treatment with a net availability of 2.49 MLD. As part of the port development a total of 2.49 MLD of potable water have been allotted to cater to the port requirements, of which 1.49 MLD of water from the proposed water supply scheme of Vizhinjam Port shall be distributed to the locality as part of initiation of the implementation of Corporate Social Responsibility (CSR) activities of VISL. This component has been implemented completely (**Exhibit 5-1** and **Exhibit 5-2**).



Exhibit 5-1: Water Supply Scheme for Vizhinjam International Seaport Project



Exhibit 5-2: Inauguration of the Water Supply Scheme

5.2.2 Potential Impact Due to Construction

5.2.2.1 Surface water

A preliminary assessment indicates that daily demand for potable water will be around 0.1 MLD in the construction phase. Project authority informed /confirmed that there has been no additional water withdrawal from the lake after 2000, other than the proposed 3.0 MLD water requirement for this project. So, Vellayani lake is the source of water for construction phase.

Litter and construction waste carried by wind, dewatering runoff or periodic rainfall, effluent and fuel through accidental spills, inadequate storage and management, vehicle wash down and overuse of water for site road wetting.

There are a number of activities associated with construction of the proposed Project, which could have impacts on surface water:

- Poor control of run-off from site activities leading to siltation and eventual blocking of drains caused by excessive sand and silt in the storm water run-off
- Pollution of surface water caused by improper handling and disposal of other types of construction site wastewater
- Contamination of surface water sources if wastes and wastewater from labour camp not managed properly
- Blockage of the four outlets (two natural streams and two polluted streams) by the reclamation or otherwise by solid structures may lead to ponding in the area behind the actual Port. The design should therefore cater for a free flow of the discharge water, even in the wet season
- Surface water regimens may be altered because of potential changes to the drainage pattern. Water pollution may result from wastewater produced by the quarry activities and by the accidental spillage of fuel, lubricants and other chemicals used in the quarry process.

5.2.2.2 Mitigation measures

- Two polluting streams joining sea at new proposed fishing harbour site will be treated with appropriate methods.
- Project Water Management Plan should be developed in order to secure the project sustainable water balance and in the project region in the construction phase, including as main water source the Lake Vellayani and other artificial water sources in use as of today.
- A surface water monitoring program shall be implemented during the construction phase.
- Effective water conservation measure should be followed.
- Implementation of rain water harvesting/ storm water management in the projection region.
- Providing water & wastewater treatment facilities at construction camp.
- Regular monitoring of surface water for quality and quantity water needs should be limited through recirculation and reuse, implementing closed-circuit systems from sedimentation ponds to the quarrying process.
- Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.

5.2.2.3 Groundwater

There are a number of activities associated with construction of the proposed project, which could have an impact on groundwater:

- Spillage or infiltration of oils, fuels and hydraulic fluids from plant maintenance and refuelling areas into the soil.
- Blockage of the four present drains in the port area will lead to higher groundwater tables and a permanently changed drainage pattern.
- New drainage structures due to the quarry activities might affect groundwater levels and quality.
- Where blasting is used in quarry, there is a potential for infiltration of nitrate and ammonia residues, in groundwater. This should be managed through appropriate blasting design and procedures, including ensuring the correct burning of explosives.
- Satellite imagery study has revealed a fault line (not active) connecting the Gangayar area with Vellayanai lake (Ref: ESIA for Road/Rail connectivity)

5.2.2.4 Mitigation measures

- Baseline review of the existing groundwater resources and current consumption in the project region..
- A study should be initiated to investigate the change in hydro-geological conditions, the available aquifers and safe yield levels.
- A groundwater monitoring program should be implemented during the construction phase.
- When (deeper) aquifers are exploited the phreatic aquifer should not be affected.
- In addition, a water quality monitoring programme should be developed.
- Gangyar near fishing harbor is the seepage/spring water from groundwater that is being recharged continuously from the Vellayani lake.
- There will be rainwater harvesting and borewell/large diameter well just south of existing women bathing cum washing area along Gangayar (rail alignment)

5.2.2.5 Impact on Marine water quality

5.2.2.5.1 Impact due to Stagnation of Wastewater in Harbour

The construction of marine structures such as breakwaters will change the current patterns and results in tranquil conditions suitable for the operation of the port. In case, the untreated wastewater from the domestic/industrial activities in the vicinity of the port flows into the harbour, it can result in stagnation of water. This condition may deteriorate Harbour water quality through increase of phytoplankton and a decrease of dissolved oxygen, resulting from eutrophication of water, caused by effluents containing nutrient salts (chemical compounds including N and P). Anaerobic water leads to the generation of hydrogen sulphide (H_2S). Breakwaters shall be constructed in a way to maintain good tranquil conditions.

5.2.2.5.2 Mitigation Measures

The wastewater and sewage generated during construction at site and at labour camp will be collected in holding tank and periodically transferred to nearby Sewage Treatment Plant (STP). In case of non availability of nearby STP, septic tank with soak pits is recommended during construction phase.

Surface run-off from the construction site should be discharged via sand/silt removal facilities such as sand or silt traps and sediment basins. Channels, earth bunds, or sandbag barriers should be provided on site to direct storm water to such silt removal facilities.

Special provision will be made to select Contractor with proven ability in implementation of EMP provision for a contractor's waste water management plan will be incorporated.

10% payment provision shall be linked to the successful planning and implementation of EMP including good contractor and labour camp will all EMP facilities.

5.2.2.6 Impact due to Land Reclamation/Wastewater Generation

Generally, reclamation of low lying areas with capital dredged material is likely to affect groundwater quality due to intrusion of sea water. The proposed port is predominantly to be developed on reclaimed land and is separated from any crop land. Also partly the port land proposed to be reclaimed is an intertidal zone which is saline in nature. The slope of port site is towards the sea and chances of intruding sea water into groundwater are envisaged to be negligible. Hence, no significant impacts are anticipated due to land reclamation on groundwater.

5.2.2.6.1 Mitigation Measures

Return seawater quality from the reclaimed area shall be monitored during reclamation phase.
Groundwater quality of nearby villages will be monitored during construction phase.

General Mitigation Measures/ Wastewater Management During Construction Phase

An adequate drainage system will be provided at the site with separate collection streams to segregate the storm run-off from roads, open areas, material storage areas, vehicle wash water. and other wastewater streams. Suitable measures will also be taken to prevent the washing away of construction materials into the drainage system.
Contaminated storm water will be collected and conveyed to sedimentation tank for removing grit.

5.2.2.7 Road & Rail Connectivity

Most important prevailing issue (This is not a project impact) of the Vizhinjam Urban Area (part of Thiruvananthapuram corporation) is scarcity of water not only for drinking but also for meeting other domestic (bathing, washing, etc.) requirements. The Vizhinjam area which is part of Thiruvananthapuram Urban Area (TUA) is over exploited as per the **Figure 5-10**.

One of the main reasons for this is the hard rock terrain wherein there is less water availability (both surface and groundwater). For hard rock region a special study had been carried out during the period 2006-2007 by AGES with financial support from State Science and Technology, GoK to understand the hard rock hydrology in Vizhinjam and northern area on 1:250,000 scale. This provides a very general idea about the water availability in the region and could collate lot of data already available for this region. There was hardly any drilled data or any other groundwater related information very specific to the 5.0 km radius of the Vizhinjam port project site.

Due to several intrusive rocks and other hard rock and recent rock formations the geology and hydrogeologiacl aspects need to be studied very closely to ascertain the water resources especially groundwater.

5.2.2.7.1 During Construction Phase

Road Alignment: The proposed road connectivity passes through temple pond, which has been traditionally used as source of water. People believe that because of this perennial water body all the nearby wells remain wet in acute summer season also. Details of the water bodies and nallah crossing are given in **Table 5-3**.

Water requirement will be minimum for proposed road construction as the entire length of the road is less than 2.0 km. The peak water requirement for construction phase for roads could be a maximum of 10 m^3/day. This will not lead to any resource depletion in the area especially when the road itself is located along a water rich valley area. Nevertheless acute water scarcity being an important issue for the local people, the project need to address the issue to the extent possible by including it in Corporate Social Responsibility (**Box No. 5.1**). Being worked with several satellite imageries consultant had tried to map the Lineaments with in this area largely covering Vizhinjam and Vengnaoor over exploited area. Both road and rail alignments passes through lineaments. (Lineaments are subsurface fracture zones which are usually good aquifers due to the several kilometres of linear connection to fractures in hard rock area). However the past tectonic activities had resulted in the complex relationship with other recent geologic formations such as Varkala formation.

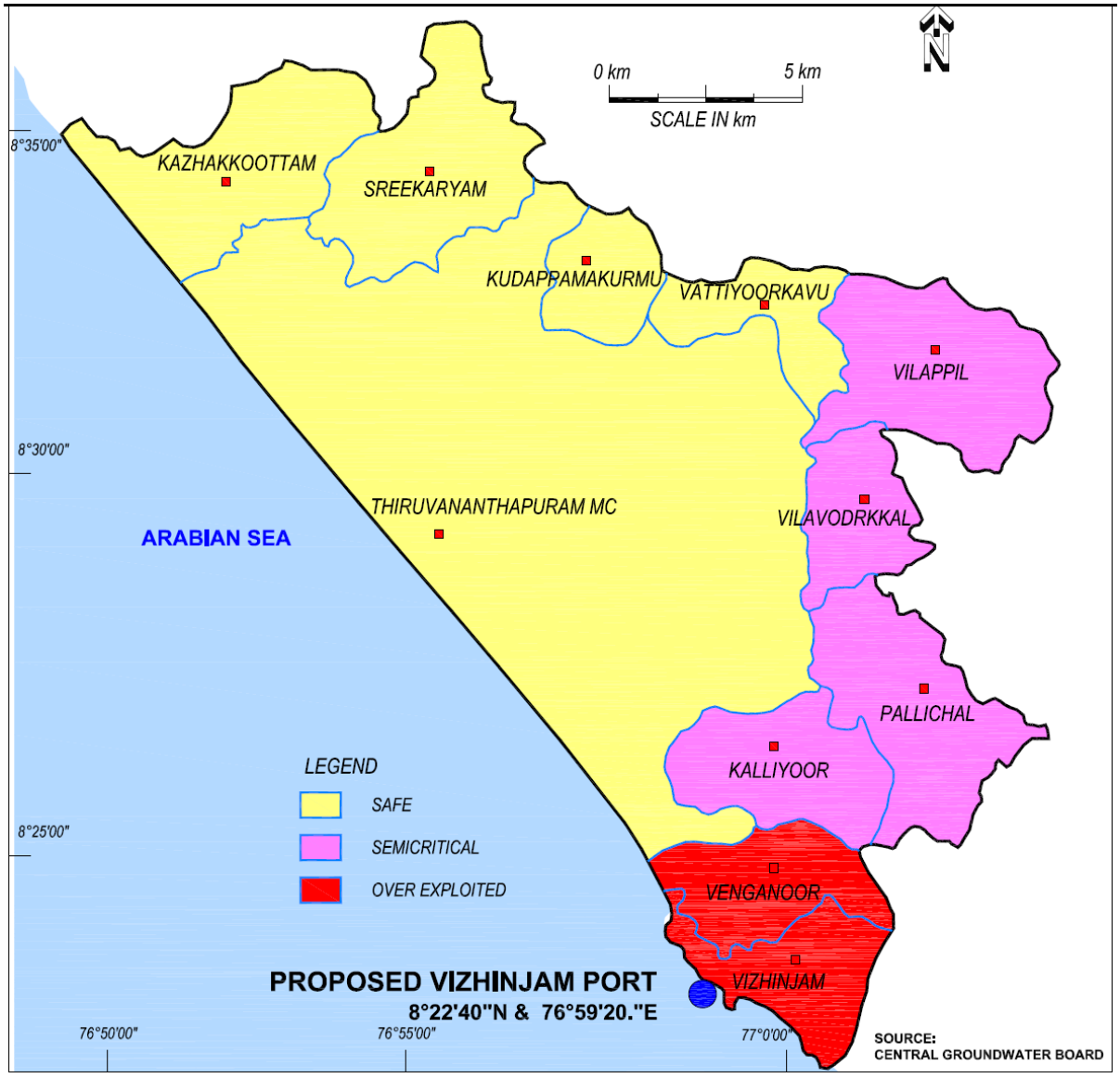


Figure 5-10: Overexploited Vizhinjam Urban Area (Part of Thiruvananthapuram)

Figure 5-11 is the lineament map of the region interpreted from the satellite imageries available for the Vizhinjam hard rock region. Most of these lineaments are identified as potential groundwater zones in the Vizhinjam area. The hard rock outcrops are visible up to Adimalathura region covering the entire port area including the approach channel up to Kottukal river mouth.

Table 5-3: Water Bodies along Road Alignment - Impacts and Mitigation Measures

S. No.	Road Alignment			Impacts	Area Impacted (in Ha)	Suggested Mitigation Measure
	Start Chainage (km)	End Chainage (km)	Details			
1.	0.900	1.000	Natural drainage	Cross drainage	-	Cross drainage (CD) structure
2.	1.200	1.275	Temple pond	Partially impacted, direct filling required for the alignment	0.16	Compensate for the lost area and design adjusted
3.	1.750	1.800	Pond	Entire pond impacted	0.20	Another Pond to be constructed
				Total Area Affected	**0.36**	

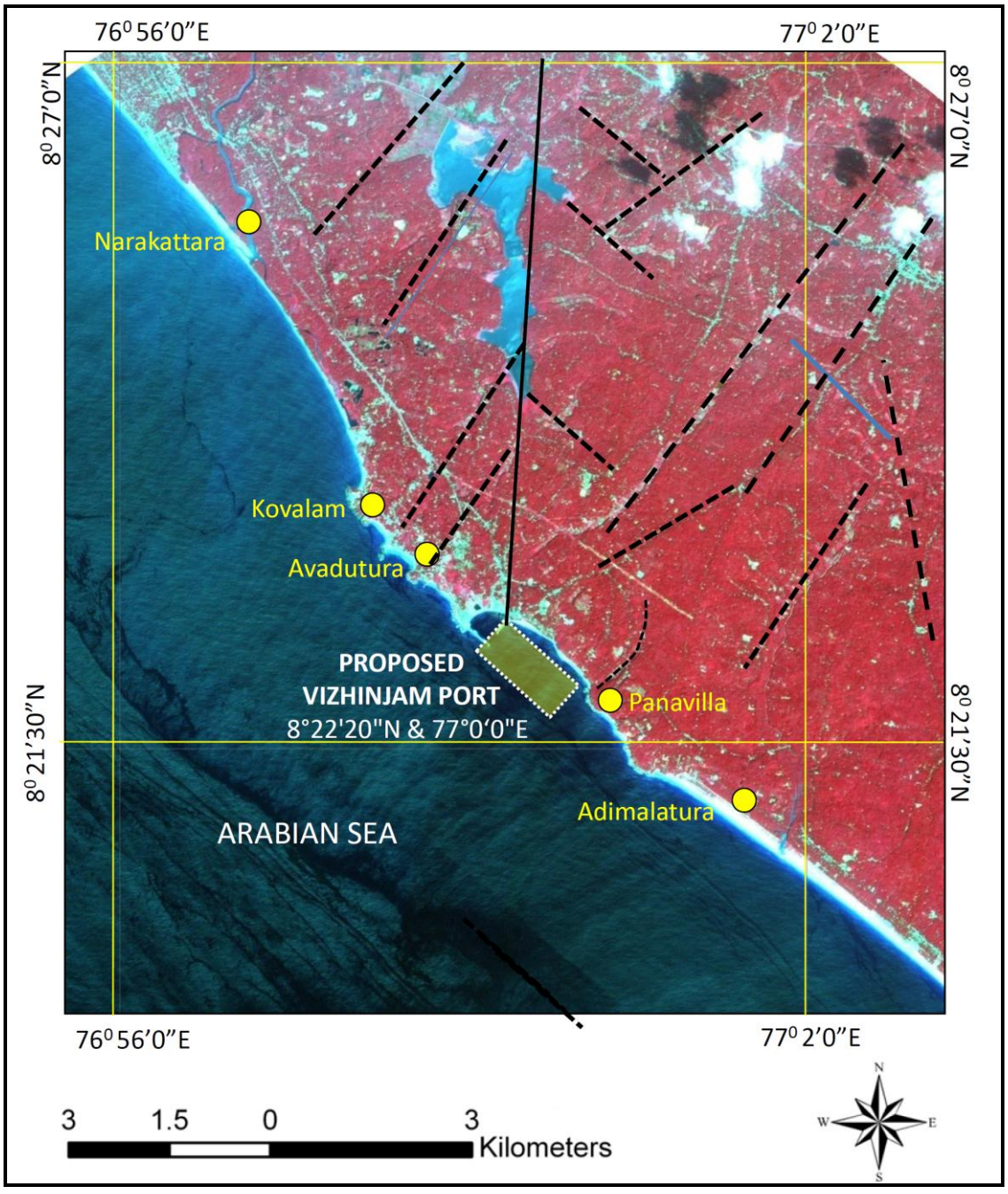


Figure 5-11: Lineament Map of the Region

Apart from siltation of water bodies and natural streams with sediments, during construction phase water pollution could be there from construction camps, POL from vehicles, etc. to the temple pond at (Chainage km 1.200). Part of the temple water pond will have to be filled to accommodate the planned road alignment. This alignment is found to be the best to avoid impacts to the temple (LHS) or the settlements (RHS).



Exhibit 5-3: Partially Impacted Temple Pond - Road Alignment



Exhibit 5-4: Totally Impacted Panchayat Pond - Road Alignment

- Impacted pond area can be bridged with suitable structures at ground level to avoid plugging of springs and connectivity to the phreatic aquifer (e.g. use of a gabion structure may be evaluated).
- A hydrological study of the area surrounding the pond should be conducted to know more about the aquifer conditions in the area. This will provide valuable information to decide on the type of structures that can be provided to connect the corridor across the pond.
- Compensation to the reconstruction of the pond with an equal area of pond by digging or excavating on the left side of the proposed road alignment or increase the embankment height in all directions.

Most important mitigation measure is avoidance of impacts by changing the alignment or planned activity. Further a consultation meeting was held with all stakeholders that include institutions, local public and also with the temple committee. This meeting also decided on the need to avoid high embankments for the road stretch to join National Highway at the same level. Details are discussed in the **Chapter 7**.



Exhibit 5-5: Impacted Pond along Rail Alignment Chainage km 5.900



Exhibit 5-6: Impacted Pond along Railway Alignment near NH 47

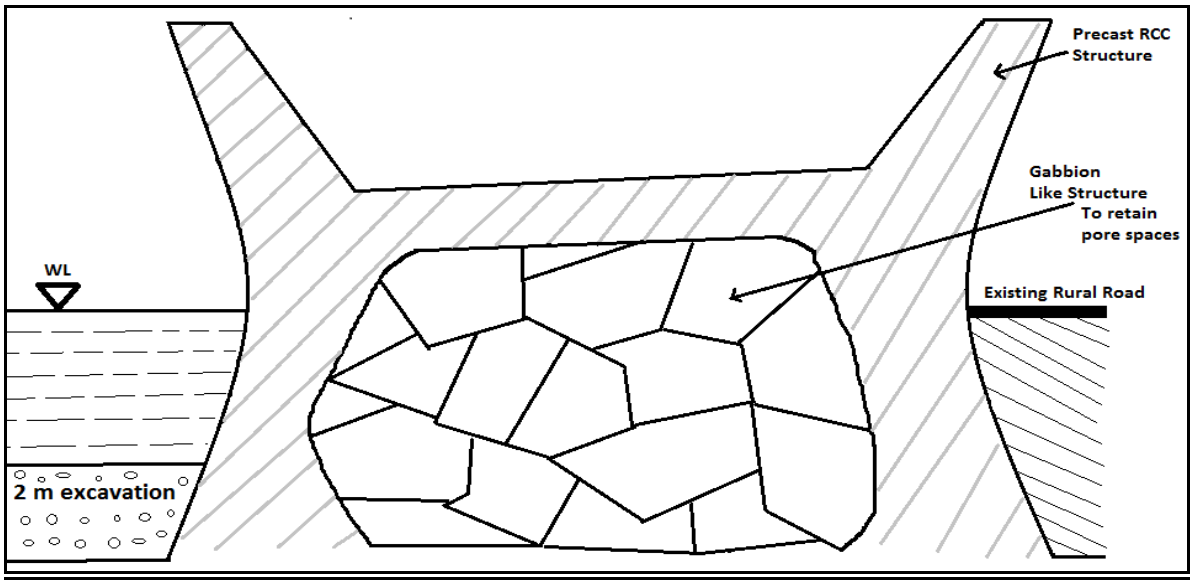


Figure 5-12: Illustration on the proposed Filing/Bridging of the Temple Pond

Rail Alignment: Several water bodies will be impacted as provided in **Table 5-4**. The peak water requirement for construction could be 10 m^3/day. The water requirement for construction of the proposed rail alignment (including for the structures) if abstracted from local resources during dry season could lead to drying up of the local drinking water sources of the area.

One of the most important impacts along the road stretch is the impact. The construction activities including excavations could lead to subsurface disturbance to the aquifer geometry and could lead to seepage or drying up of pond at chainage km 5.900.

Table 5-4: Water Bodies along Rail Alignment - Impacts and Mitigation Measures

Rail Alignment (km)		Details	Impacts	Impacted Area (Ha)	Suggested Mitigation/ Avoidance
Start Chainage	End Chainage				
5.900	5.950	Kalathakulam pond	A corner of the pond impacted	0.08	Compensate for the lost area for the pond and avoid seepage
6.100	6.400	Irrigation canal	Canal along the RoW	0.16	Relocate to outside RoW
6.550	6.650	Village pond (Madavurpara)	Crossing through middle at ground level	0.04	An equal area of 0.54 Ha will have to be compensated
7.600	7.610	Stream (And Village Road)	Crossing RoW	0.04	CD structure
8.200	8.480	Stream	Flowing along RoW	0.24	Relocate to outside
9.270	9.300	Pond	A small corner impacted	0.04	Compensate for the lost area and avoid seepage
10.900	11.190	Stream	0.200 km	0.3	CD structure
11.780	12.150	Stream	0.500 km	0.6	Relocate and provide CD structure

Rail Alignment (km)		Details	Impacts	Impacted Area (Ha)	Suggested Mitigation/ Avoidance
Start Chainage	End Chainage				
12.470	12.580	Stream	0.100 km	0.08	CD structure
12.800	12.890	Stream crossing	0.100 km	0.08	
14.100	14.250	Gangaar	0.800 km	0.8	Elevated corridor
			Total Area	**2.46**	

Box 5.1 Comprehensive Water Resources Development of Vizhinjam – A CSR Priority



If any budget is allocated for the CSR activity under this project, the first priority shall be for the Water resources development of the Vizhinjam region. Consultants could see the scarcity of water during an interaction with potential water buyers from tanker lorries that sold water at Rs 3/- per port. One pot contains 4.0 litres of raw water. The consultant has found an urgent need to carry out a much more detailed study for Vizhinjam hard rock region for a scale either 1: 25,000 or at least on 1: 50,000 scale. A remote sensing analysis had been carried by the consultant using various satellite data available for different studies such as shoreline studies, land use and high resolution Google imagery. These results are provided in the respective section. All other environmental enhancement measures are provided in the appropriate sections. There are immense possibilities in the area. For example the development of a quarry area with proper design located at the Vizhinjam - Kovalam road junction can be developed to meet most of water requirement by gravity for meeting the domestic water requirement of many people in the fishing village. Besides there are several other water resources development prospects for the region. These studies can be undertaken for the overall improvement of freshwater availability in the region. An integrated development strategy with rainwater harvesting, water resource mapping and enhancement, etc. could give the desired input for water resources management of the region.

Many water bodies located in the PIA can be developed as a potential source of water for the local communities. The lineament mapping carried out by consultant as shown in **Figure 5-11** also revealed that the Vellayani Lake is formed along a major lineament (possibly a fault line) extending up to the port site through Gangayar. The geotechnical study (Fugro Geotech 2011) has confirmed that this is not continous towards the sea bed. This is a perennial stream used by local Fisher women for washing and bathing. Inspite of its small catchment the steam is perennial because of the tectonic connection to Vellayani Lake. The water retention of Vellayani Lake could be attributed to the relatively close nature of the fractures towards the coast due to complex folding and possibly due to a fault line. All these are due to the presence of several hard rock (especially intrusive/plutonic/ igenous) geologic formations here. This is a very important finding of the consultant study but need to be studied further with the help of GSI and CGWB with an ultimate aim of estimation, conservation and enhancement of water potential of the otherwise dry region. Remote sensing study with highest resolution imagery shall be used for any such new efforts. The lineament mapping also revealed that that present fishing

harbour area was evolved/ formed due to this fault movement. The eastern block along Gangayar vertically moved upwards towards North (displacement could be of the order of 0.3 to 0.7 km) with a small angle of rotation (From NNE to exactly North) and the Western block moved vertically downwards (towards South). This has resulted in the formation of the present bay (fishing harbour). The western block movement could be either nil or could be a minor displacement. All along this lineament (10 to 15 km long) satellite imagery reveals this particular displacement. This requires detailed geophysical study using earth resistivity methods also.

The second major lineament is the rail alignment. This is a shear fracture zone and is adequately wide to develop almost a 0.5 km wide valley fill area which was originally paddy fields till a couple of years ago. The presence of a dozen water storage structures formed out of springs from fracture zones are also an indication of Lineament along the railway line.

Apart from siltation of water bodies and natural streams with sediments, during construction phase water pollution could be there from construction camps, POL from Vehicles, etc.

5.2.3 Potential Impact During Operation

5.2.3.1 Impact on Water Quality due to Cargo Operations

Since the proposed port is container and multipurpose port and no dusty cargo /dry bulk Cargo such as Coal and Iron Ore etc. will be handled at port and hence direct impact on water with cargo handling will be insignificant. Marine water may get polluted as a result of releases of contaminants, if any into the marine system including. If the four present outlets (two natural streams and two polluted minor streams) in the port area will be kept and discharge continues in the Port, Port water quality will be adversely affected on a permanent basis, even more than at present since the discharge water will be contained by the breakwater. The leakage/ spill of oil in port and its surrounded area will impact water quality.

5.2.3.1.1 Mitigation Measures

- The streams in port area which are connecting sea will be treated in upstream side of the stream. Treated water will be discharged into sea water after meeting marine discharge standards prescribed by MoEF.

- Port operators should prepare a Spill prevention, control, and counter measure plan consistent with the IMO Manual on Oil Pollution Section II – Contingency Planning.

- All ship related waste with a potential to cause pollution to the marine environment should be disposed of according to the guidelines stipulated by the MARPOL Convention.
- Port authorities will apply appropriate procedures, in agreement with National and international regulations, for the handling and storage of hazardous cargoes and waste generated by handling and storage of this type of cargoes.
- Ships used for the project should be registered with Lloyds or a similar shipping register, obeying all international maritime conventions such as MARPOL.
- Good operational practices such as good positioning and protection of (fuel) stores, use of drip trays, proper maintenance of plant and equipment.
- Careful storage and usage of fuels, oils (and chemicals).
- Consider whether fuel storage is needed on-site, how much is to be stored and how.
- Check whether sub-contractors have adequate fuel storage facilities.

- Fuel and oil stores must be located away from the site drainage system and the shoreline. If this is not possible, ensure adequate measures are identified to prevent or contain any spillage (e.g., blocking drainage points).
- Oil and chemical-handling facilities will be located with consideration of natural drainage systems and environmentally-sensitive areas.
- Hazardous materials storage and handling facilities will be constructed away from active traffic and protect storage areas from vehicle accidents.
- Fuel dispensing equipment will be equipped with – breakway
- Hose connections that provide emergency shutdown of flow should the fuelling connection be broken by movement.
- All ancillary equipment (e.g., valves, hoses) should be contained securely within the bund when not in use.
- Ensure that tanks are correctly marked/labelled as to their contents and capacities.
- Keep a store of spill response equipment at the fuel facility and bowsers.
- Standard operating procedures that reduce or eliminate the chance of a spill, even in the case of equipment failure.
- Routine maintenance and testing schedules should be determined for all aspects of port operation particular attention paid to product storage and handling, and fuel transfer systems.
- General awareness of all workers should be increased through training and safety meetings with focus of Environmental Management systems and practices with “Zero Waste Tolerance” planned with an objective of achieve as much as we can.
- Port operator should be required to develop system for holding and collecting storm water runoff and surface runoff produced by site activities and its treatment before discharge.
- Waste water should be treated up to the standards for discharge (Prevention and Control of Pollution) Act 1974).

5.2.3.2 Road & Rail connectivity

In general the fully operational port with its entire infrastructure is going to build further pressure on the already depleted water resources due to the tourists and other port staff and traders dependency.

Road Alignment - Impacts: There is a perennial temple water pond (**Exhibit 5-3**) which could be impacted by solid waste disposal from the travellers. Travellers/tourists people have the habit of throwing waste material to water bodies. This is more important because the road users could be not only from various part of the country but also from all over the world (Ref: Cruise terminal at Vizhinjam port).

Rail Alignment - Impacts: The only major planned cargo transport is containers. Other than the bunkering of fuel for the port requirements no major hazardous cargo or liquid terminal is planned for this port. Therefore no spillages are expected from either the incoming or outgoing container traffic. However, the impact from loosely closed or damaged containers at the larger pond close to NH is imminent.

5.2.3.3 Mitigation and Enhancement Measures

In order to avoid the littering of waste material into the water bodies / nallah; it is recommended to put out of sight the exposure of the water bodies from the road user by constructing a protective wall along the sides of the bridges / culverts. In addition to the proposed function, the protective side wall will also serve as noise barrier. An expensive schematic representation of protective wall is given in **Figure 5-13**. In this case a cost effective design can be easily formulated using fibre glass opaque material.



Figure 5-13: Protective Side Walls for Proposed Road/Rail Corridor along Water Body Crossing

In this case a cost effective design can be easily formulated using fibre glass opaque material.

Rail Alignment: Although not directly impacted at Chainage km 5.900 and at Chainage km 9.290 a retaining wall and RCC slab is proposed to prevent seepage at pond location. This will arrest any possibility of drying up of the water in the pond. The Madavurpara pond at chainage km 6.600 was earlier planned to cross by an RuB but due to the monorail crossing along NH crossing (**Figure 5-14**), GoK has finally decided that the Vizhinjam rail alignment will cross at a ground level at this location (**Figure 5-15**). This will result in the filling of 0.54 Ha of water area. This being a community resource, an equivalent area of the pond needs to be constructed towards the north eastern side of the alignment. In order to minimise the loss, a vertical retaining wall need to be constructed.

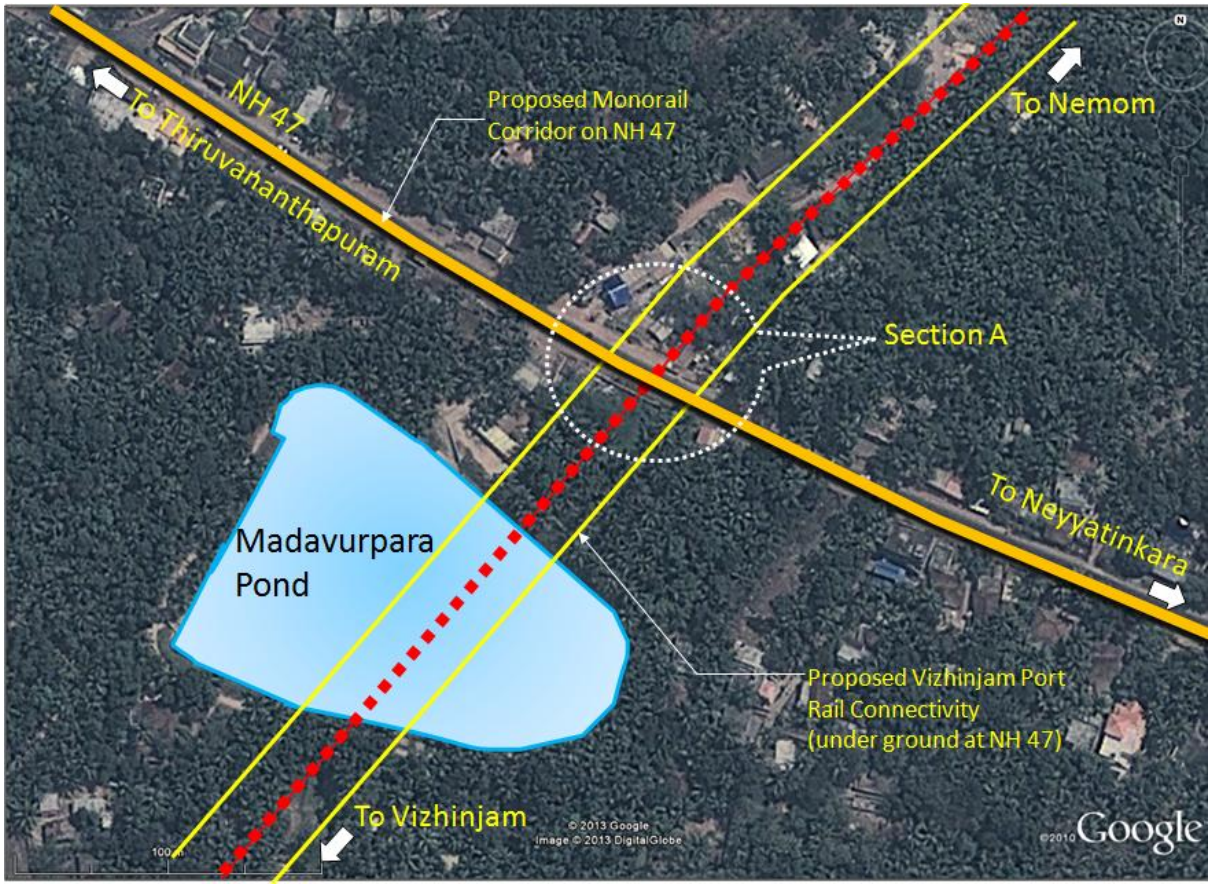


Figure 5-14: Intersection at NH 47 and Proposed Railway Alignment through Madavurpara Pond

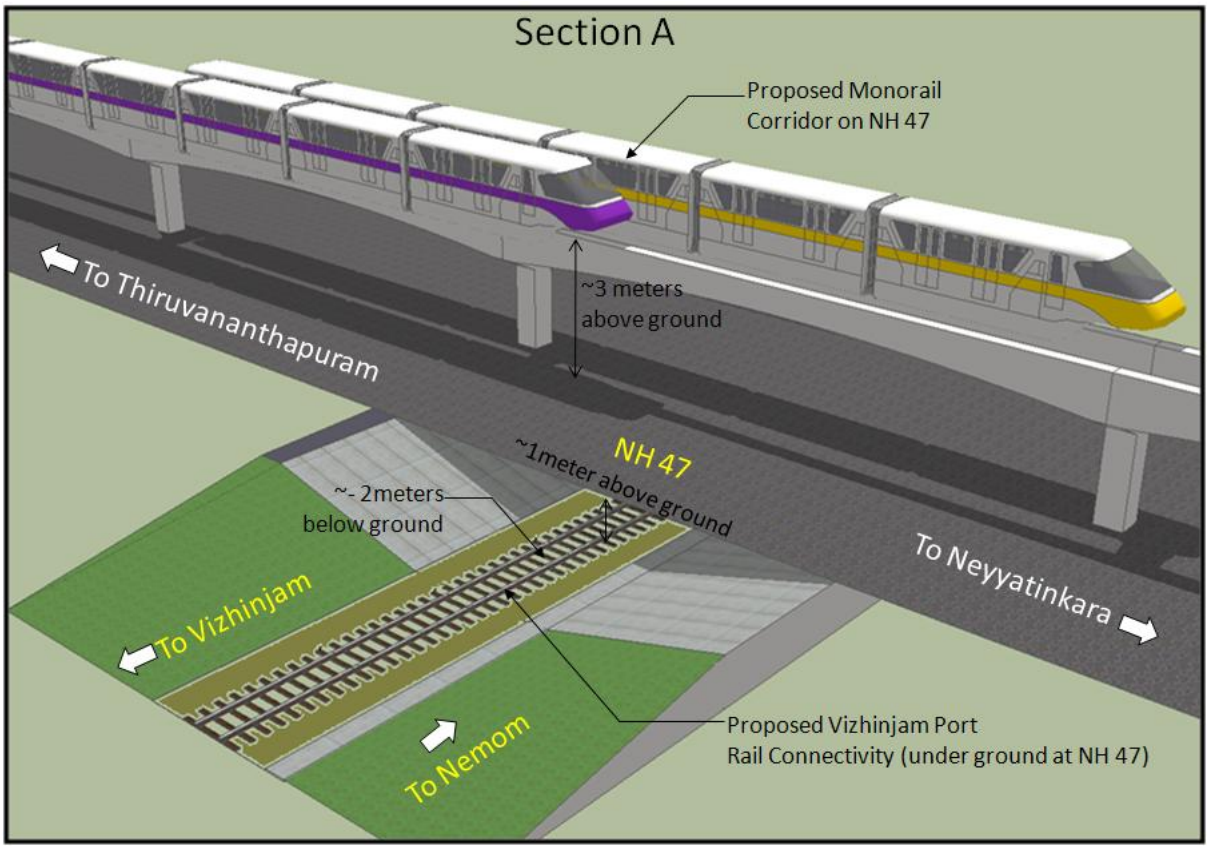


Figure 5-15: Vertical Cross-section of NH 47, Monorail & Proposed Railway Alignment Intersection

5.3 Marine Environment (Coastal Hydrology/Bottom Contamination, Sea/Harbour Water Quality)

5.3.1 Potential Impact Due to Port Location

5.3.1.1 Littoral Drift/Sediment Transport

Sediment transport is a complex coastal process that results from the combination of interaction within the waves, current and wind. The sediment particle are transported by currents (tide driven, wave driven or wind driven), wave motions and combinations of the two. Waves, due to their orbital velocity, keep the coastal sediment in suspension, which are then transported by tidal flow or coastal currents. This results in erosion or accretion of sediments and subsequent modification of the morphology till equilibrium is reached between various acting forces. Any modification to this equilibrium in the form of new developments in the coastal zone leads to changes to the seabed and coastal morphology. In order to investigate the fate of suspended sediment in coastal and estuarine waters as well as the evolution of sea or river beds, sediment dynamics need to be studied thoroughly. It is a widely accepted practise to use numerical modelling tools to predict the sediment transport patterns in the vicinity of coastal projects and to assess its impacts like the amount of annual maintenance dredging or the behaviour shoreline, etc.

5.3.1.1.1 Approach and Methodology

The flow field and associated current speed in the coastal process govern the movement of fluvial, littoral and suspended sediments. TELEMAC-2D has been used to setup and calibrate the hydrodynamic flow field with reasonable accuracy. The simulated flow from the hydrodynamic model was calibrated using observed tide data and flow conditions under various representative environmental scenarios (combination of wind and wave) were simulated. The results were used as inputs flow field for sediment transport modelling.

In the coastal zone, the effects of wave modify the bottom boundary layer structure and largely enhance the sediment transport rates in the littoral zones due to wave induced alongshore circulations. The waves have significant contribution to the sediment transport by virtue of the wave induced currents. The orbital velocity induced by wave provides momentum to the sediment into suspension to be carried along with tidal currents. The near shore wave transformation model TOMAWAC is used for transformation of waves and to compute orbital velocity induced by waves.

The information of flow and representative waves were used to derive the wave induced circulation pattern near the coast during the various wave events. The flow field from combination of environmental scenario is used to drive the sediment transport model for different sediment types and the results were merged to obtain the annual sedimentation pattern and the requirement of maintenance dredging at the fishing harbour due to the construction of the proposed port. The general methodology adopted for the present study is illustrated with a block diagram and is presented in **Figure 5-16**.

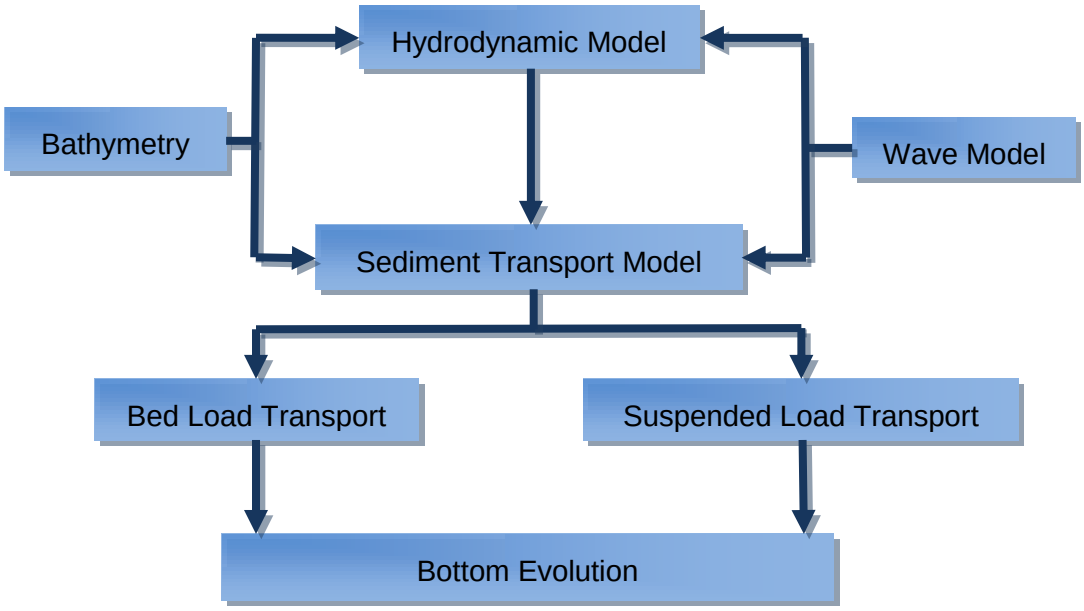


Figure 5-16: Flowchart of Methodology

The subsequent section will provide brief description on the various model used for setting up the sediment transport model.

5.3.1.2 Overview of Models

5.3.1.2.1 SISYPHE - Sediment Transport Model

SISYPHE (9) is the sediment transport module for the TELEMAC system. It is a process-based model: sediment transport rates, decomposed into bed-load and suspended load, are calculated as a function of the time-varying flow field and sediment properties at each node of the triangular grid. The resulting bed changes are determined by solving the Exner equation using either finite-element or finite-volume techniques. SISYPHE is applicable to sand as well as to cohesive sediments or sand-mud mixtures. The sediment composition is represented by a finite number of classes, each characterized by its mean diameter, grain density and settling velocity. Sediment transport processes also include the effect of bottom slope, rigid beds, secondary currents, sliding beds, etc. The effect of bed consolidation can be accounted for the case of cohesive or mixed sediments. SISYPHE can be applied to a wide variety of hydrodynamic conditions from rivers and estuaries to coastal applications, where the effects of waves superimposed on a tidal current can be included. The bed shear stress, decomposed into skin friction and form drag, can be calculated either by imposing a friction coefficient (Strickler, Nikuradse or Chézy) or predicted by a bed-roughness predictor. SISYPHE can be either chained or internally coupled to the hydrodynamic models (TELEMAC-2D, TELEMAC-3D) while including inputs from the wave model TOMAWAC to enable sediment transport modelling.

5.3.1.2.2 Chaining with Hydrodynamic Model

Sediment transport rates are calculated as a function of hydrodynamics and sediment parameters. Since SISYPHE does not calculate the flow field, the hydrodynamic variables can be either imposed in the model or calculated by a previous hydrodynamic computation. It is more convenient to use hydrodynamic modules of the TELEMAC system for compatibility reasons (same grid, same pre and post-processors).

The simplest method is to run both the hydrodynamic and the morpho-dynamic models independently and the results were transferred externally from one model to another. This ‘chaining method’ is indeed justified for relatively simple flows, due to the difference of time-scales, between the hydrodynamics and the bed evolution. SISYPHE uses a very schematic re-actualization of the hydrodynamic, assuming the flow rate to be constant. The computation is stopped, when the bed-evolution reaches a given threshold specified by the user. This acts as a check point and assures the quality of simulated results.

The scope of present study is to estimate the variation in the rate of sedimentation in the fishing harbour due to the construction of the proposed Vizhinjam Port. The study consists of the entire coastal stretch of Vizhinjam in general and fishing harbour in particular. Since the flow fields are found to be simple, the hydrodynamic results are incorporated in SISYPHE using chaining method. The sediment transport modelling are generally difficult to carry out with 100% accuracy as the sedimentation in a region will depend on a number of parameters and are very sensitive to the slightest of variations in the site conditions.

5.3.1.3 Model Setup

5.3.1.4 Sediment Transport Model

From the analysis of deepwater waves 15 wave events were identified. The sediment transport simulations were done for these events separately for typical sand type. The results were then

combined to obtain the annual sedimentation in the region by accounting the probability of occurrence of each wave event. The domain and bathymetry for the sediment transport model is taken same as that of hydrodynamic model, which covers a region of about 30X10 km^2. A mesh size varying from 50 m near the study area to 1200 m in the deep water is used to resolve the geometric features in the study location and the domain is shown in **Figure 5-17**.

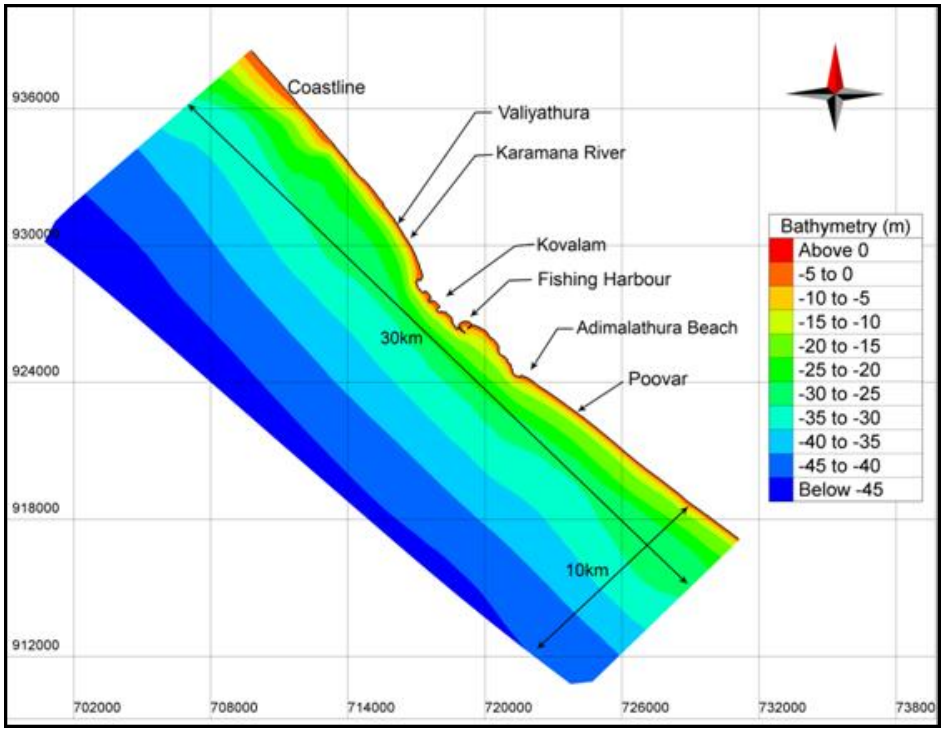


Figure 5-17: Model Domain and Bathymetry for Sediment Transport Model for the Existing Condition

The formulation of Soulsby and Van Rijn for bed load and suspended sediment transport was used to calculate the sediment transport rates. The parameters like relative density of sediment, critical Shields parameter, sediment grain size and grading were specified in the input file.

Simulations are done for the existing condition and with the layout of proposed port to estimate the variation in sedimentation pattern and maintenance dredge quantity in the fishing harbour due to the construction of the breakwater of proposed port. The results obtained from these simulations were analysed and are discussed in the following sections.

The simulation results were compared to estimate the effect of the construction of proposed port in the sedimentation and erosion pattern in the region. The annual sea-bed evolutions for both the conditions obtained from the simulations are presented in **Figure 5-18** and **Figure 5-19**.

The simulation results showed alternate erosion and accretion pattern along the coast. Comparing the results for the existing condition and that with the proposed port layout, it is observed that the deposition inside the fishing harbour has reduced significantly after considering the proposed port for the simulations. The sedimentation inside the proposed port layout is found to be negligibly small. The sedimentation inside the fishing harbour for the two site conditions were estimated from the simulations and are shown in **Table 5-5**.

Table 5-5: Annual Sedimentation Inside Fishing Harbour and the Proposed Port Layout

Scenario	Volume (m^3/year)
Existing Condition	3800
With Proposed Port Layout	200

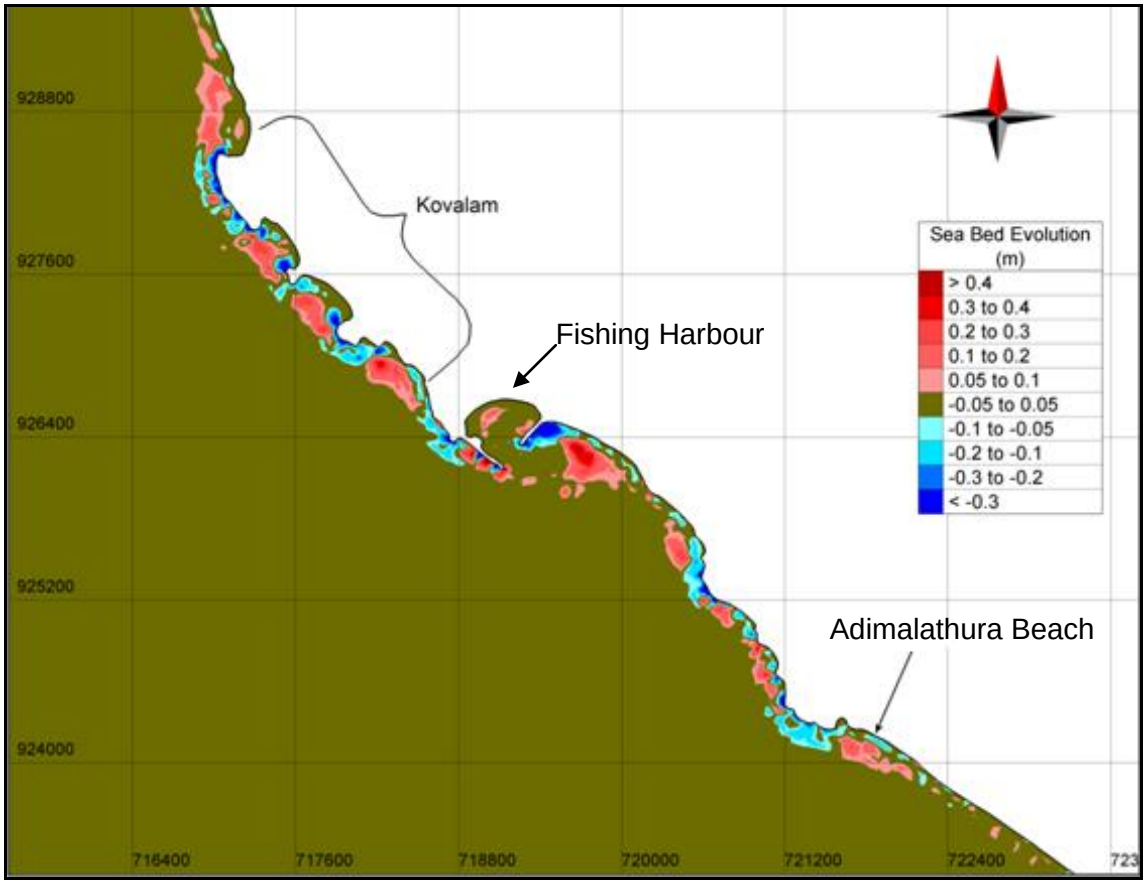


Figure 5-18: Annual Bed Evolution – Existing Condition

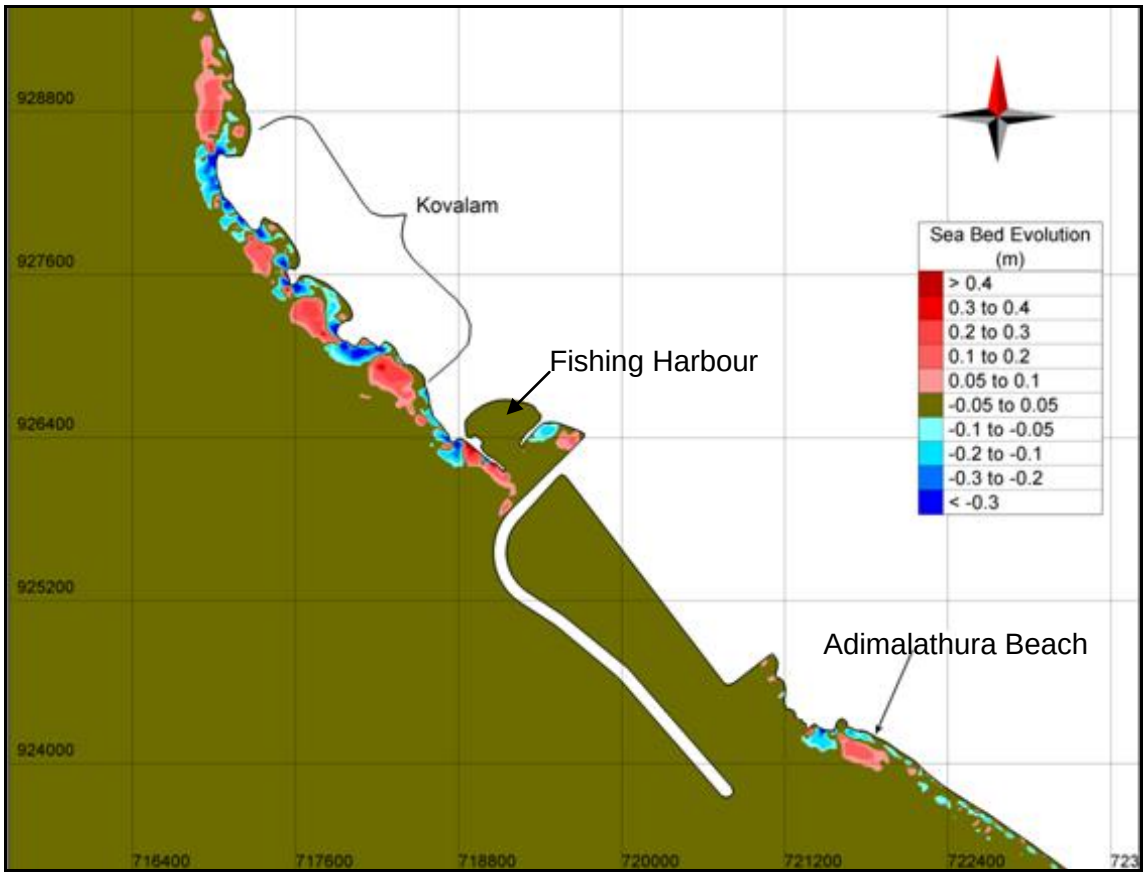


Figure 5-19: Annual Bed Evolution – with Layout of Proposed Port

The shorelines on either side of the study area show no significant variation in the sediment transport pattern for both the conditions. Erosion was observed in the vicinity of headlands and accretion in the pocket beaches at Kovalam. The accretion pattern observed in the fishing harbour is similar to the conclusions derived from the hydrographic survey maps post-construction of the fishing harbour. There is also anecdotal evidence that the harbour gets silted up near the coast and silt is removed post-monsoon. But the amount of dredging is insignificant inside the fishing harbour.

5.3.2 Potential Impact Due to Construction

Developmental activities such as capital dredging, dredged material disposal and construction of approach channel and cargo berths will result in disturbance to marine environment. During these activities, particularly dredging, localised and short term impacts on marine water quality are likely to occur due to increased turbidity from suspended sediment. Further, marine sediment quality indicates that it is free from any significant pollution

As per the preliminary dredging and reclamation quantity estimates for phase-I development, it is expected to have a dredging-reclamation sand balance (i.e. sand required for reclamation purpose to be procured from dredging activity itself). In case of disposal of unusable dredge material, a dredge disposal site would be needed to dump the excess/unusable dredged material with least impact on the existing fishing harbour and environment. So, the dredged material disposal site study has been performed by LTR and its results are given in Mathematical Model Study Report, Apil 2013. Particle Analysis (PA) module of MIKE was used by LTR to assess the fate of dredged material after disposal.

5.3.2.1 Impact due to Capital Dredging and Disposal of Dredged Material

Based on the navigational requirements, estimates the various dredging and reclamation areas for the proposed port. **Table 5-6** provides the various dredge depths and the calculated dredging volumes.

Table 5-6: Dredge Areas for the Vizhinjam Port

S. No.	Dredge Area		Dredge Depth in meters with respect to CD	Dredge Volume (m^3)
1.	Approach Channel	Outer channel	- 20.8	3,254,953
		Inner channel	-18.4	
2.	Turning Circle		-18.4	904,300
3.	Berths and Harbour Basin		-18.4	883,320
			Total	**5,042,573**

5.3.2.2 Dredged Levels

The structural design of the berths shall be carried out for the design dredged level in the ultimate stage based on the design vessel sizes to be handled at these berths:

Table 5-7: Design Ships and Dredged Levels at Various Berths

S. No.	Vessel Type	Design Vessel Size	Design Vessel Dimensions (m)			Minimum Designed Dredged Level at Berth
		(DWT)	LOA	Beam	Loaded Draft	m with respect to CD
1.	Container Vessel	165,000 (18,000 TEU)	400	59	16.0	-18.4
2.	Port/Coast Guard Crafts	1,500	30	9	2.5	Natural Depth
3.	Indian Navy	6,000#	175	32	8.0	Natural Depth
4.	Cruise cum Multipurpose	70,000	268	32	8.0	Natural Depth

Size of the ship considered is the estimated one

5.3.2.3 Characteristics of Dredged Material

The geotechnical investigation borehole data at the site reveals that the subsurface generally consists of marine deposited silty sand for the full depth of exploration in the approach channel area while layers of sand and rock were encountered in the terminal area. Rock was not encountered during borehole investigations in the proposed dredged area with exception of rock found at a depth of around -25 m CD in front of proposed container berths.

The borehole profiles show that the dredge spoils (except the initial surface material up to the depth of approximately 0.5-1 m below the existing seabed) comprise of good quality sand and is suitable for reclamation for the development of the onshore facilities.

However, geophysical survey shows that we may encounter a very dense sand layer beyond depth of -22 m CD in the outer approach channel. It is also observed that rock can be expected along the container berth face at around -20 m CD to -22 m CD. In other areas, very dense sands or weathered

rocks are expected to be found at depths at or below -24 m CD. The dredge depths proposed for the port are shallower than rock levels and very dense sand layer levels and hence it is not expected to encounter any hard material. Dredging methodology is discussed in chapter 10.

5.3.2.4 Criteria for Selection of Dredge Disposal Location

- Dumping ground should be located in sufficiently deep water, so that the sediment plume does not travel towards fishing harbour, recreational area, beaches, navigation channel and other environmentally sensitive areas (if any).
- Maximum distance of the dumping location should be such that the turnaround time to the disposal ground is minimal.
- Existing and proposed facilities close to the dumping grounds (if any) should not be affected by the proposed dumping.
- Construction and maintenance dredging near the port site will remove habitat and species living in it. Recovery (re-colonisation by species from the adjacent areas) will take place, depending on the scale of the impact and on the characteristics of the seabed, within various months up to several years. The impact must be seen in the proportion between land take and the area in which this land take occurs. The impacts will be localised and restricted to the port area and therefore limited. Typical drdgeing instrument is shown in **Figure 5-20**.

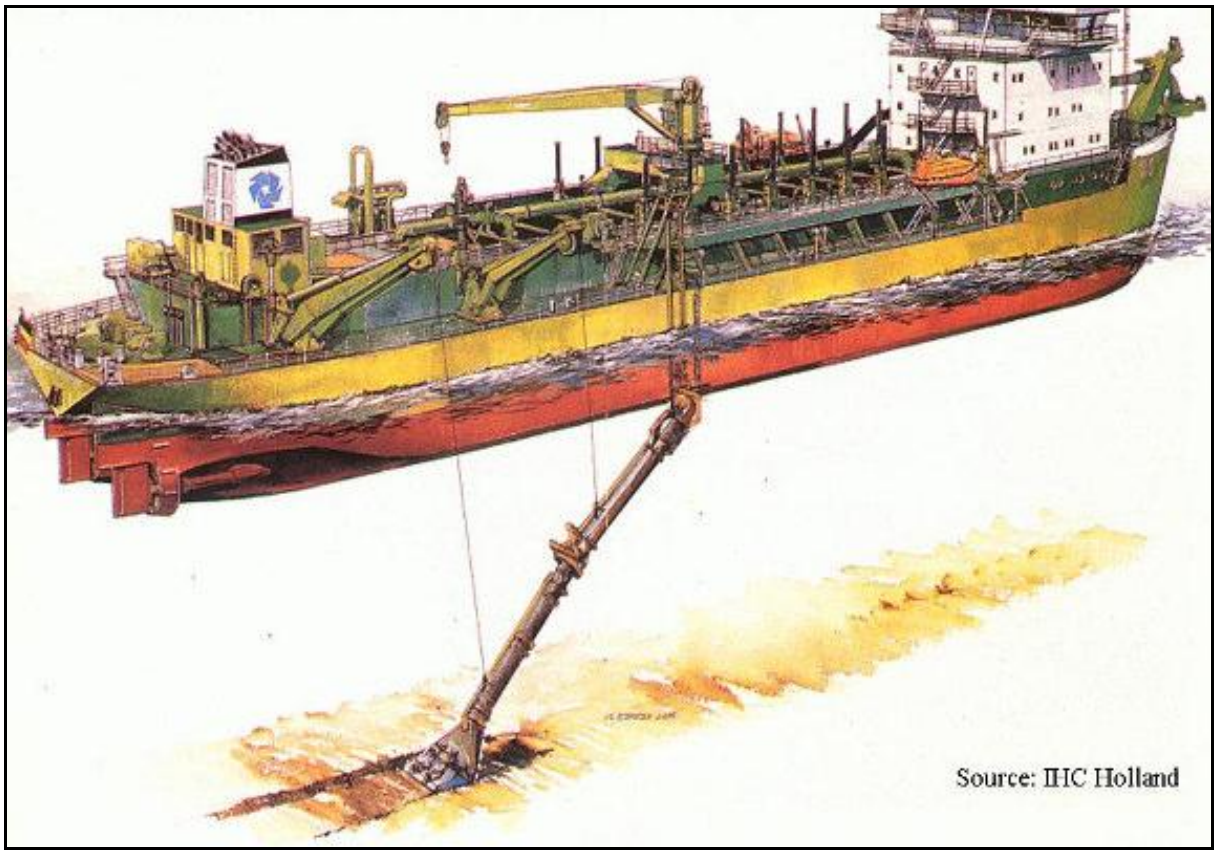


Figure 5-20: Trailer Suction Hopper Dredger (TSHD)

The dumping area for the dredge spoil and the immediate surroundings will also be impacted. Mobilisation of suspended sediment and its consequent deposition (smothering) can damage or kill sessile organisms, especially filter feeders, by clogging feeding and respiratory appendages. Suspended sediments can also cause irritation and abrasion to the surfaces and gills of fish and will cause them to avoid areas with high turbidity. The effect of suspended sediments on marine

organisms depends on the concentration, duration of exposure and the sensitivity of various species. In order to describe this potential impact better a modelling study has been executed in the framework of this EIA. (Modelling Report; LTR, 2013).

Table 5-8: Dumping Ground Co-Ordinates (Co-ordinate System: WGS84)

Points	Location-1		Location-2	
	Latitide	Longitude	Latitide	Longitude
A	76° 58' 30.10" E	8° 21’ 34.90" N	76° 59' 39.07” E	8° 20' 25.48" N
B	76° 59' 16.08" E	8° 20' 48.61" N	77° 00' 25.04" E	8° 19' 39.23" N
C	76° 58' 52.86" E	8° 20' 25.71" N	77° 00' 01.82" E	8° 19' 16.33" N
D	76° 58' 06.88" E	8° 21’ 11.97" N	76° 59' 15.85” E	8° 20' 02.59" N

Based on the environmental conditions and criteria two dredge dumping locations were identified. Disposal sites were located 3.0 km from the shore line at water depth deeper than 30 m with a spatial extend of 2.0 km X 1.0 km. The distance between the dredging zone and disposal location ranged between 2.5km to 4.0 km. Location of dumping ground site is shown in **Figure 5-21**.

The simulations were carried out for a period of 30 days. The results obtained in figures from the PA model are presented in the form of deposition pattern and average concentration from **Figure 5-22** to **Figure 5-31** for the two environmental scenarios. (i.e. SW monsoon and NE monsoon with non monsoon period) for the two locations.

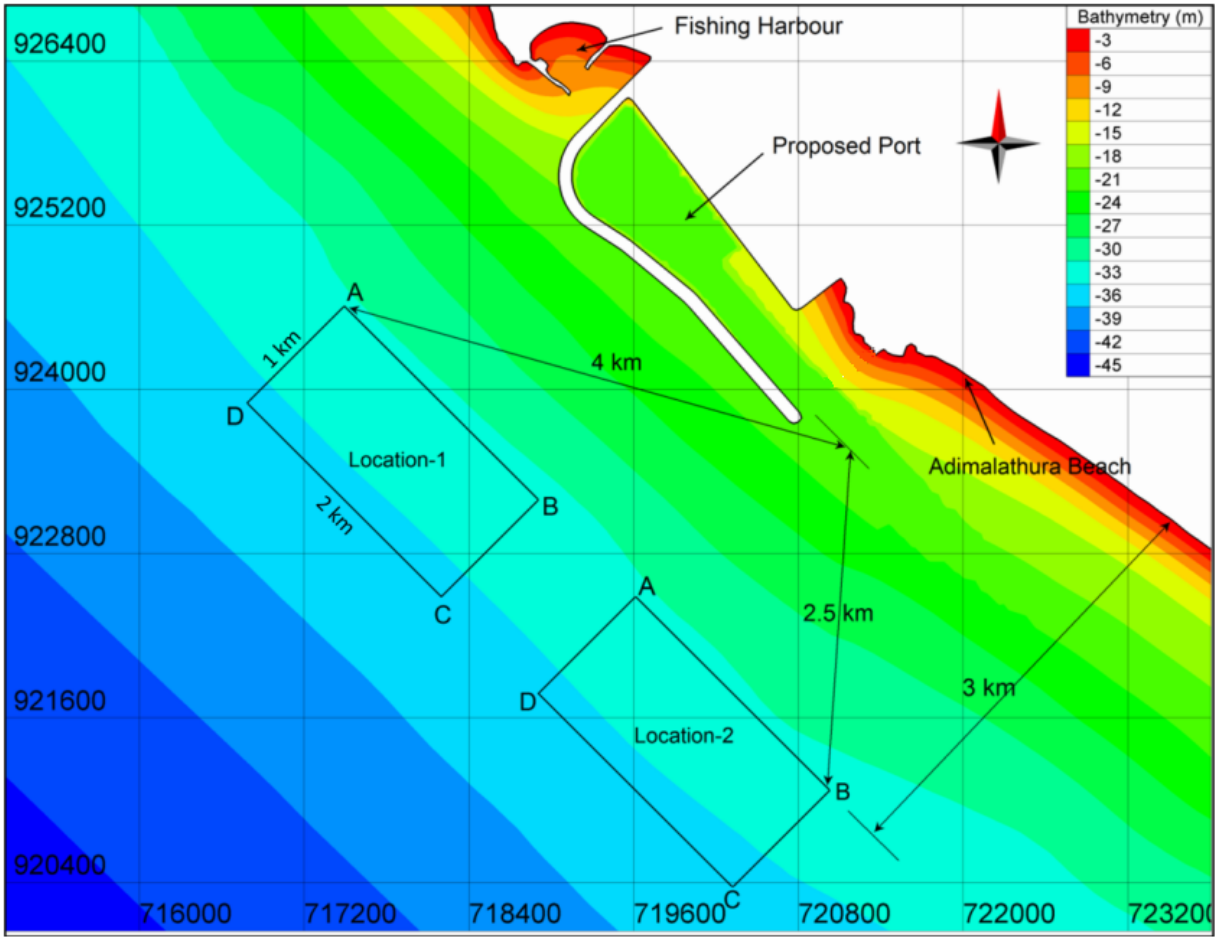


Figure 5-21: Proposed Dredge Disposal Site Locations

5.3.2.5 Scenario-1 (SW Monsoon)

It was observed from the simulated results that during SW monsoon the dredge plume travel towards SE direction. The suspended particles traverse over a stretch of about 10km from the dumping location which is due to the presence of stronger currents in SW monsoon. The average deposition was observed to be less than 0.2 m. Average concentration around the dumping ground was observed to be in the range of 0.2 to 0.3g/l for 22 days. On an average, it takes around two hours to reduce the concentration level to the back ground value. As seen from **Figure 5-23**, **Figure 5-24**, **Figure 5-26** and **Figure 5-27**, the average concentration lasts for a longer duration. However, the probability of occurrences for such events is very low.

5.3.2.6 Scenario-2 (NE monsoon with non-monsoon)

The sediment plume travels towards NW direction for the simulations carried out for Non monsoon. The average thickness of deposition was observed to be in the range of 0.25-0.3 m near the dumping grounds. The average concentration at dumping locations was observed to be less than 0.25 g/l for a stretch of 3.0 km from the dumping ground towards north. The concentration reaches to the background value within an hour. Due to presence of weak currents the sediments are settling near the dumping grounds without travelling to a larger extent and results in reduced concentration level within a short time. From the simulated results, it was observed that there is no impact to the fishing harbour due to dumping operation. The sediment behaviour was observed to be similar for both locations. Considering the proximity to dredging area, dumping Location-2 is recommended as the dumping ground for maintenance dredging. The sediments from the capital dredging which is not suitable for reclamation purpose can also be dumped in the same suggested dumping location. It is recommended to schedule the maintenance dredging activity during the non-monsoon, considering stronger current prevailing during the SW monsoon.

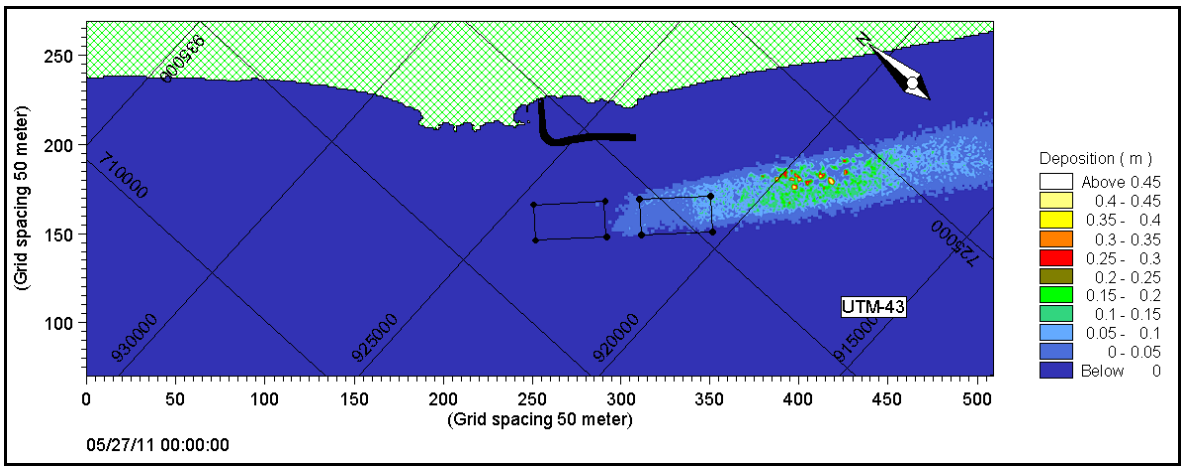


Figure 5-22: Deposition Pattern at Location-1 during SW Monsoon

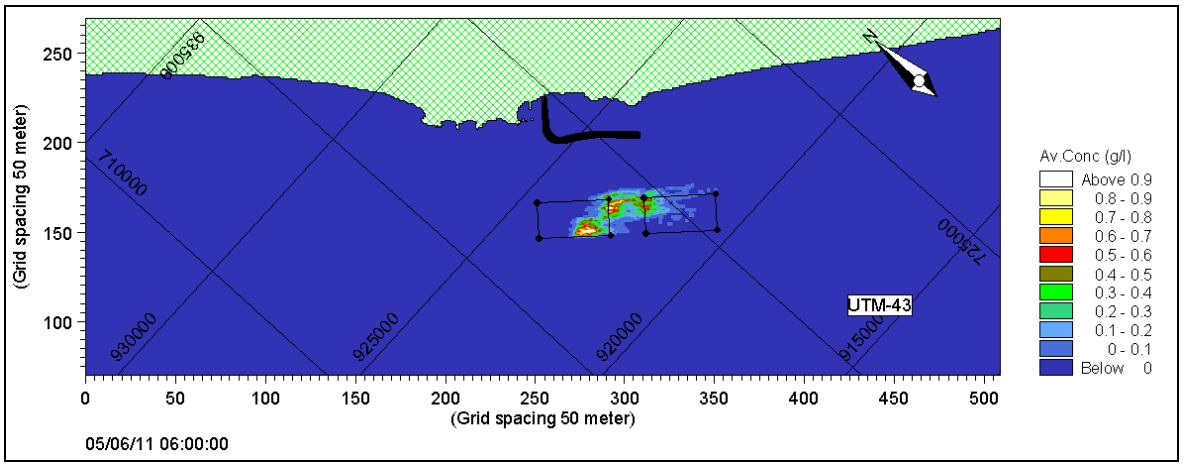


Figure 5-23: Average Concentration 3 Hours after Dumping at Location-1 during SW Monsoon

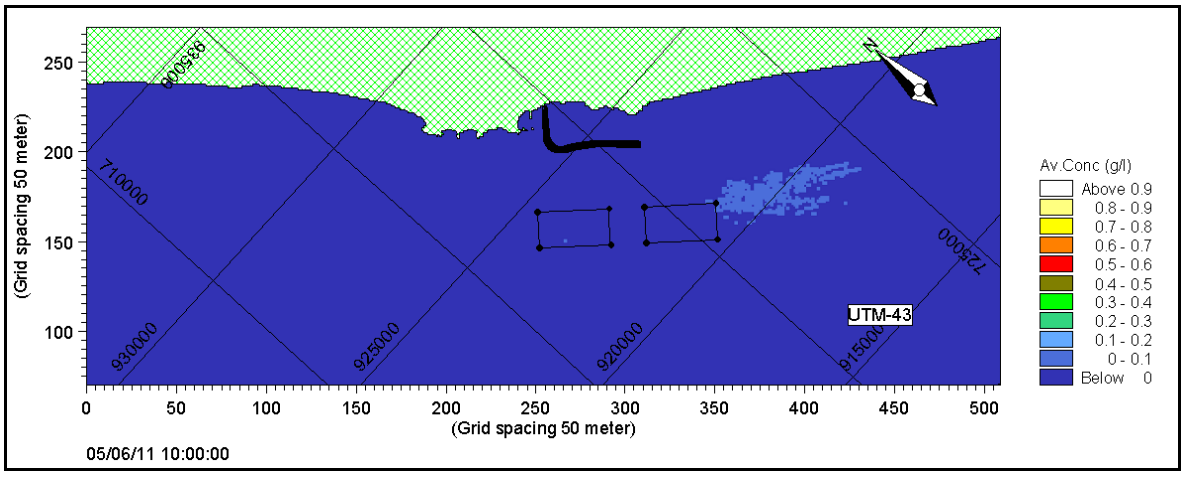


Figure 5-24: Average Concentration 7 Hours after Dumping at Location-1 during SW Monsoon

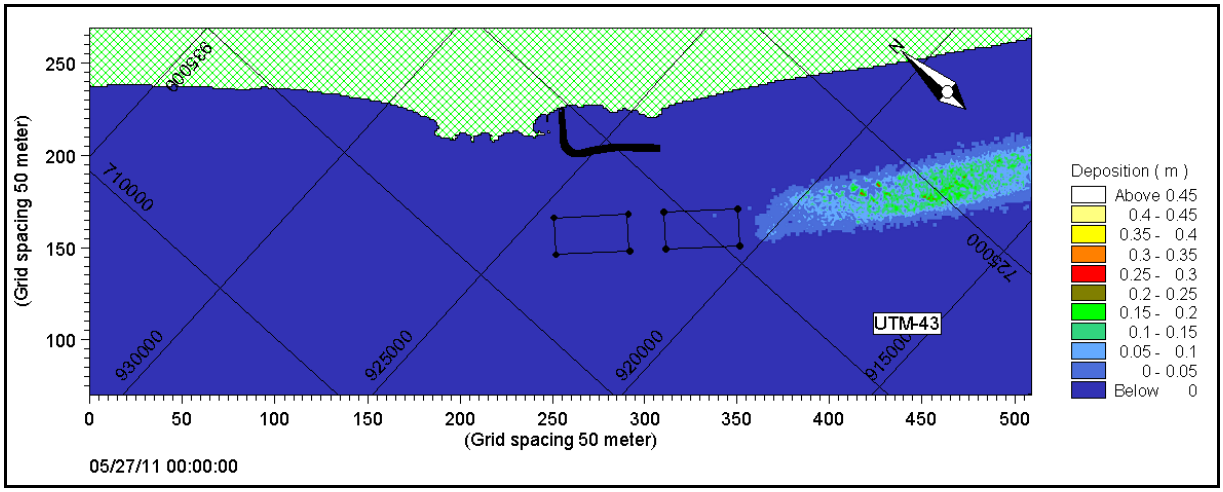


Figure 5-25: Deposition Pattern at Location-2 during SW Monsoon

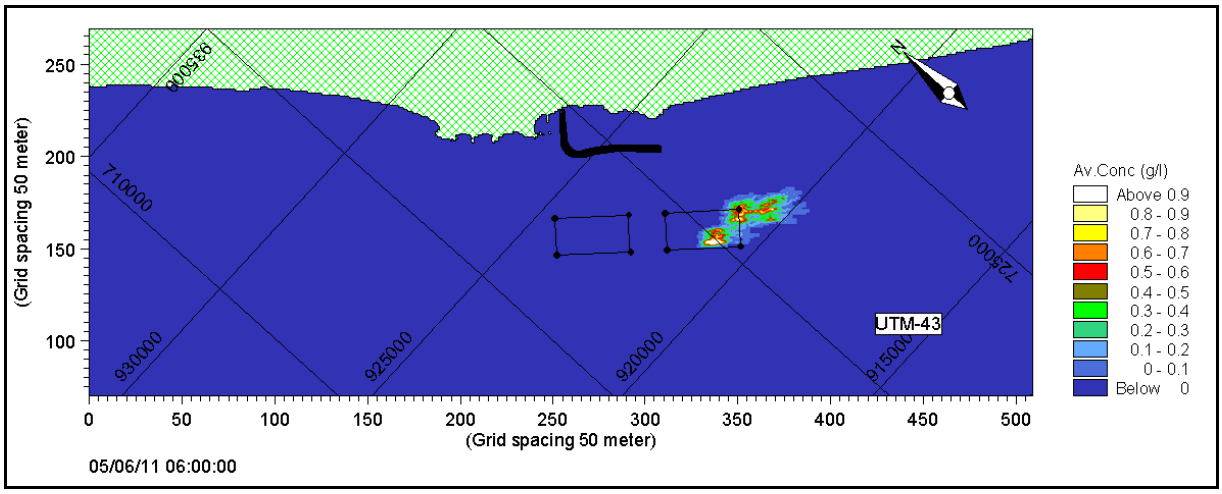


Figure 5-26: Average Concentration Three Hours after dumping at Location-2 during SW Monsoon

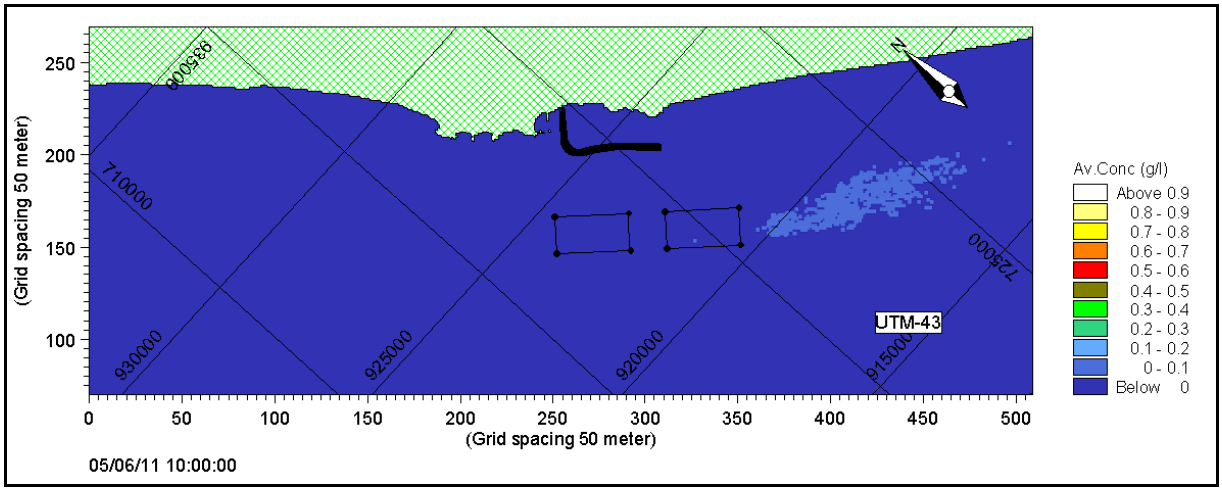


Figure 5-27: Average Concentration Seven Hours after dumping at Location-2 during SW Monsoon

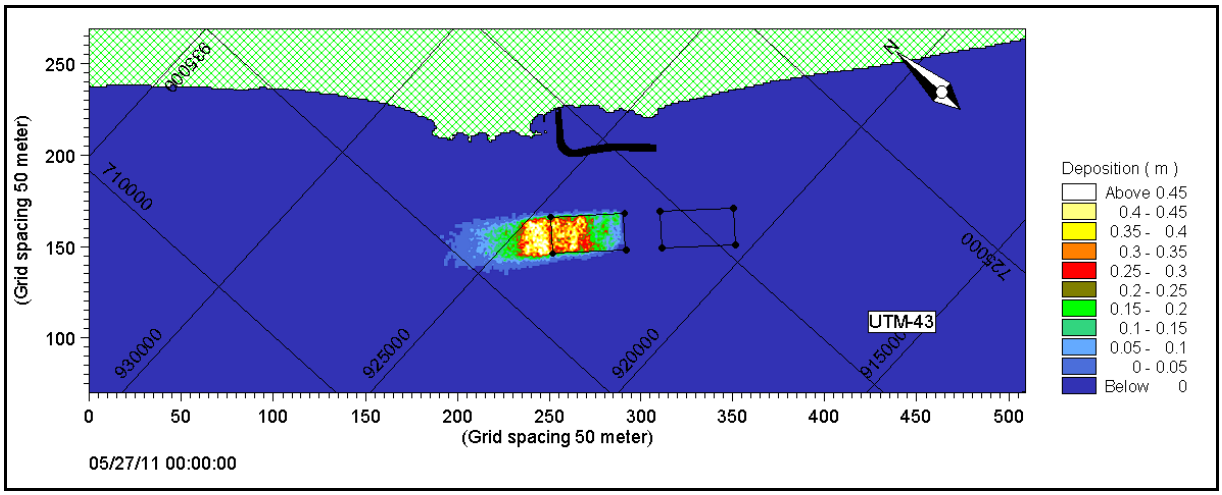


Figure 5-28: Deposition Pattern at Location-1 during NE Monsoon and Non Monsoon

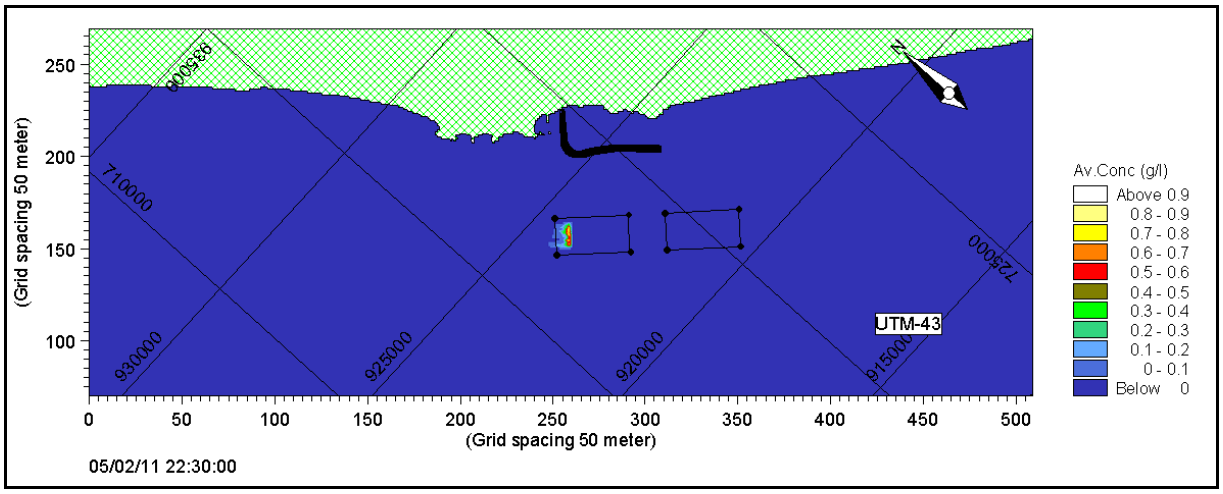


Figure 5-29: Average Concentration 30 Minutes after dumping at Location-1 during NE Monsoon and Non Monsoon

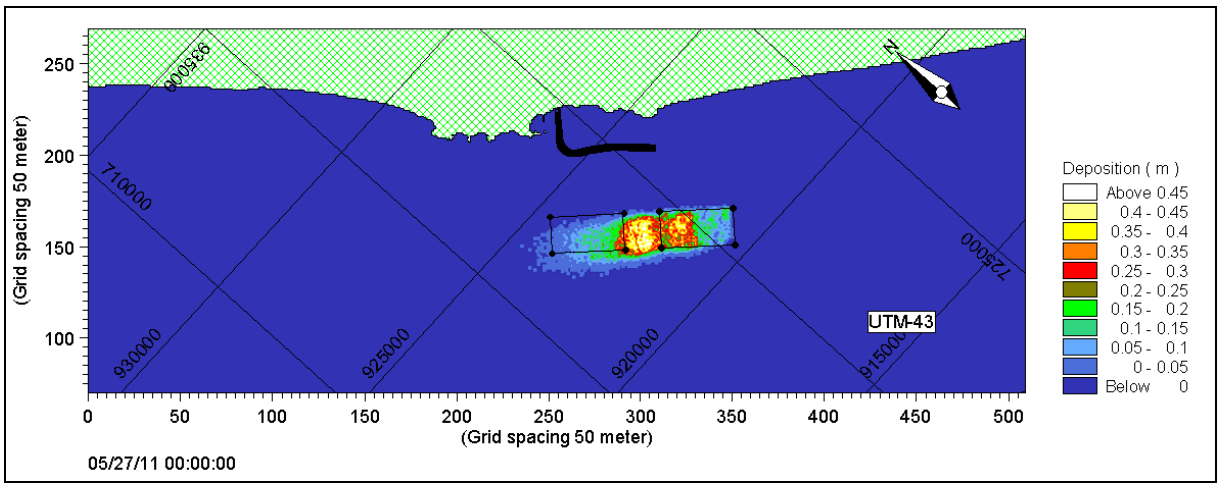


Figure 5-30: Deposition Pattern at Location-2 during NE Monsoon and Non Monsoon

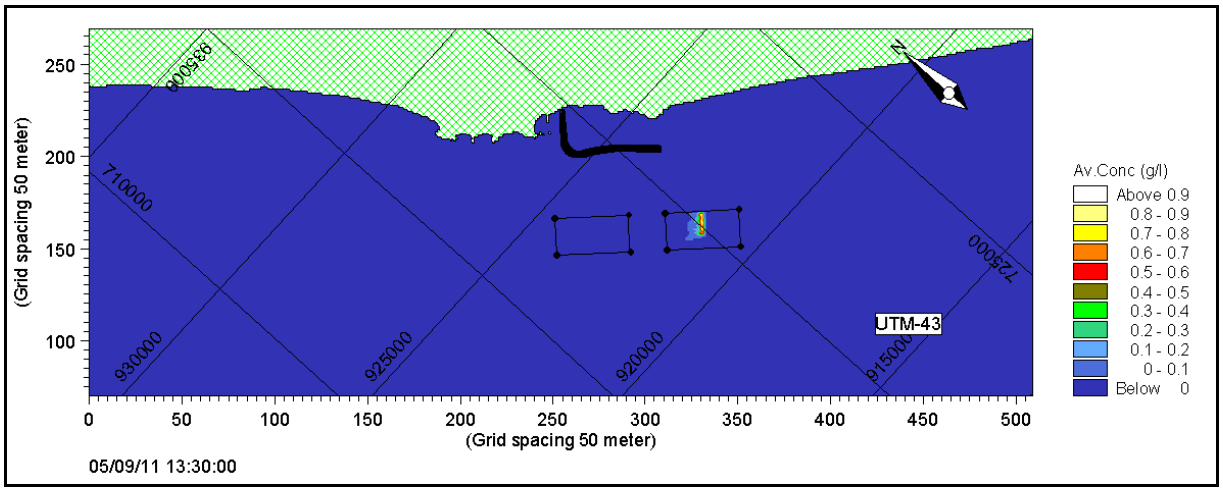


Figure 5-31: Average Concentration of 30 Minutes after dumping at Location-2 during NE Monsoon and Non Monsoon

The dredge spoil disposal study was carried out to assess the impact of dredge spoil dumping and to identify suitable locations. It was found that the sediment plume was confined to the deep water. From

the simulated results, it is observed that there is no impact to the fishing harbour due to dumping operation. Considering the proximity to dredging area, dumping location-2 is recommended for dumping dredged spoils. It is recommended to schedule the maintenance dredging activity if any during the NE and non monsoon periods, considering stronger current prevailing during the SW monsoon.

5.3.3 Potential Impact on the Fishing Harbour

Tranquillity study is important to determine the optimum harbour layout, allocation of berths for various types of vessels and fixing the breakwater configuration. As wave travel from offshore to shallower coastal waters, they are modified by the process of depth-induced refraction and shoaling. As the waves propagate further into the harbour itself, diffraction around the breakwaters and reflection from various harbour structures become important and affect the tranquillity within the harbour. The shallow water process of seabed friction, bed diffraction and wave breaking will also modify the wave conditions.

In the present study, the effect on wave tranquillity due to the proposed structure between the existing fishing harbour and proposed north breakwater is carried out. Moreover, the length and location of the proposed structure will be varied for a number of configurations in order to achieve optimum tranquillity for the fish landing centre and the downtime of fishing landing berths will be estimated.

5.3.3.1 Wave Tranquillity Model

The study on wave tranquillity in the area between existing Vizhinjam fishing harbour and the proposed north breakwater has been done using ARTEMIS model, which is part of the TELEMAC finite element hydraulic modelling systems. The model employs finite element technique to compute the wave heights throughout the area being modelled for each set of incident wave conditions. The model includes wave diffraction by surface piercing structures as well as due to features of the seabed, refraction and shoaling effect due to varying depths, and partial or complete reflection from the harbour boundaries. The energy dissipation process of wave breaking and seabed friction are also included in the model.

ARTEMIS is based on the resolution, through the finite element method, of the mild slope equation (or Berkhoff's equation), which is given by

$$\nabla\left[CC_g\nabla\phi\right]+\omega^2\frac{C_g}{C}\phi=0$$

Where C and C_g are the phase and group velocities respectively defined by

$$C=\frac{\omega}{k} \quad and \quad C_g=\frac{1}{2}\left[1+\frac{2kh}{\sinh(2kh)}\right]C$$

Where ω is the angular frequency, h is the still water depth, k is the wave number defined by $2\pi/L$ and L is the wavelength.

There are certain conditions that can be applied along the boundaries, depending on the type of boundary. This includes incident wave boundary condition, which can also absorb the reflected waves (specified in terms of an incident wave height, period and direction), partially or fully absorbing boundary conditions (specified in terms of a reflection coefficient, phase change and assumed wave direction). Depending on the type of obstruction, different reflection coefficients can be specified to simulate desired effect.

5.3.3.2 Methodology

The methodology adopted for the tranquillity study is summarized as follows:

- Model domain will be set up using the bathymetry is shown in Figure 5-32: Model bathymetry with the proposed structure.
- Wave parameters were extracted at 25 m contour from the SWAN model and will be used to estimate the wave conditions inside the domain.
- Simulations will be carried out for all predominant wave directions (S, SSW, SW, WSW and W) within the range of time periods 4 to 25s. Proper reflection coefficients will be applied to the structures present in the domain of study.
- Relative wave height of 1.0 m will be provided as boundary condition, to get the diffraction co-efficient (RAOs) within the domain. The co-efficient will then be used to get the significant wave heights by using the input significant wave heights extracted at 25 m water depth (SWAN model). The wave heights thus obtained will be used to estimate the downtime for limiting wave height as per standards.

5.3.3.3 Model Bathymetry and Boundary Condition

As seen from wave propagation, the waves are mainly from S to W directions. Therefore, the domain was chosen such that waves from these directions are simulated properly. The effect of the wave reflection from breakwaters of existing harbour and proposed port and other features (like rock cliff, artificial structures etc.) are also simulated. Triangular mesh elements of size 3.0 m were chosen so that the wave phase, bathymetry and the geometric features of the breakwater are accurately resolved.

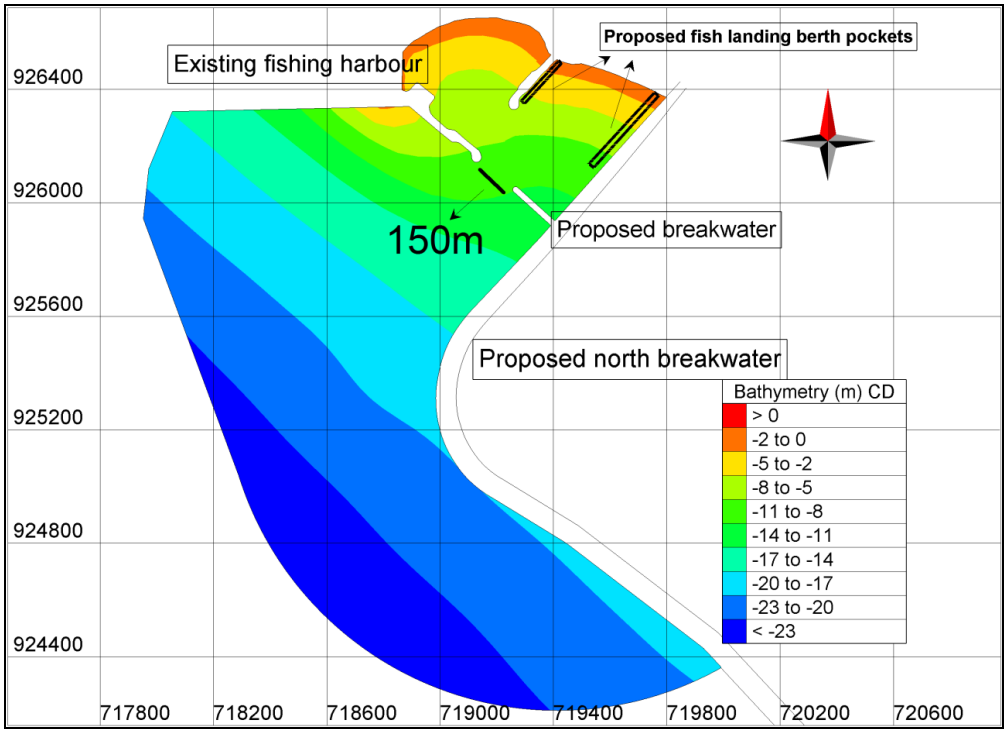


Figure 5-32: Model bathymetry with the proposed structure

5.3.3.4 Simulation and Results

ARTEMIS model was set up to study the wave tranquillity for the proposed fish landing facility. Wave disturbance pattern inside the proposed fish landing facility was simulated for monochromatic waves approaching from predominant directions (S to W) for a series of wave periods ranging from 4 to 25 seconds with input relative wave height given as 1 m as boundary condition. The simulations were carried out by giving various reflection co-efficient at the boundaries considering the reflections from the natural and man-made structures. A total of 110 simulations were carried out for each of the layout configurations. The reflection co-efficient considered for the study is given in **Table 5-9**

Table 5-9: Reflection Co-Efficient Considered

Type of Boundary	Range of Reflection Co-Efficient, Cr
Beaches	Cr=0.10
Large rock	Cr=0.35
Rock bund	Cr=0.38
Rubble mound/rock armour (2 layer)	Cr=0.40
Rubble mound/rock armour (1 layer)	Cr=0.45
Caissons/vertical faced structures	Cr=0.90

The first study was carried out for the breakwater configuration as provided by VISL (Layout-1) as shown in **Figure 5-32.** The length of the proposed breakwater is about 185 m. The minimum entrance width for the fish landing centre is considered as 150 m. For the initial study, two set of simulations were carried out considering both the fish landing berths as vertical wall (Cr=0.90 for Layout-1A) and as rock slope (Cr=0.40 for Layout-1B). The proposed breakwater, proposed port breakwater and existing fishing harbour breakwater were considered as rubble structure with reflection co-efficient given as (Cr=0.40) for both the simulations. The results for the Layout-1A (vertical wall for berthing structure) and for the Layout-1B (rock slope for vertical wall for berthing structure) are shown in **Figure 5-33** to **Figure 5-42**

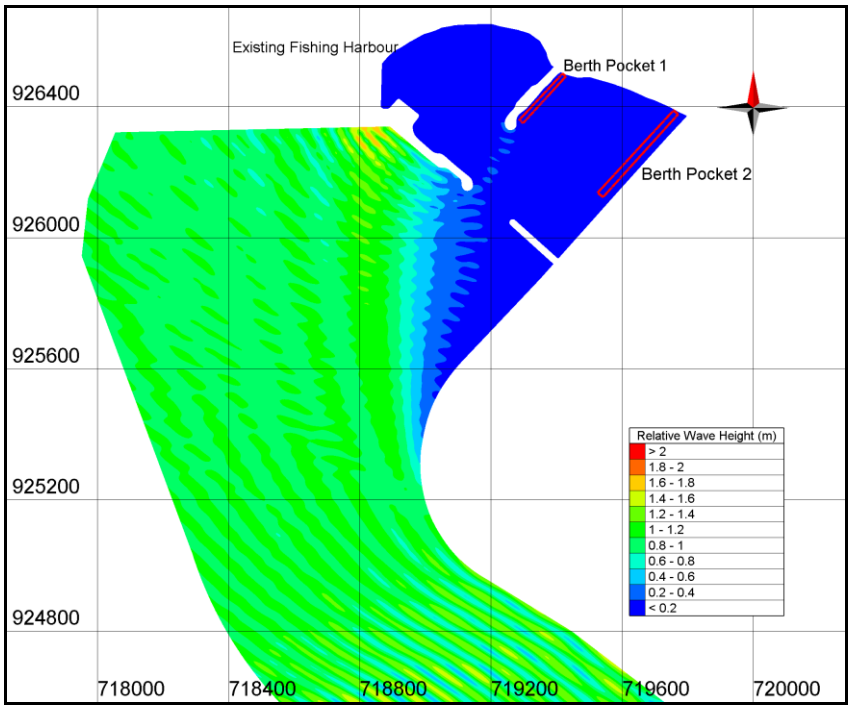


Figure 5-33: Relative Wave Height Distribution (Inputs: H = 1 m, Direction - S, T = 8 sec) for Layout-1A

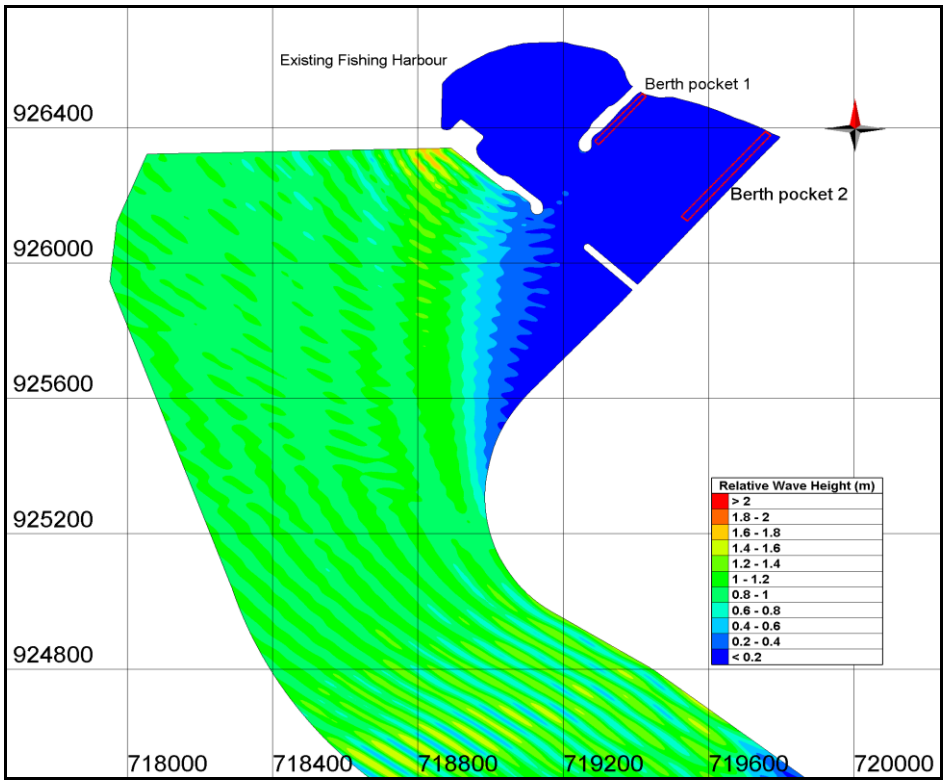


Figure 5-34: Relative Wave Height Distribution (Inputs: H = 1 m, Direction - S, T = 8 sec) for Layout-1B

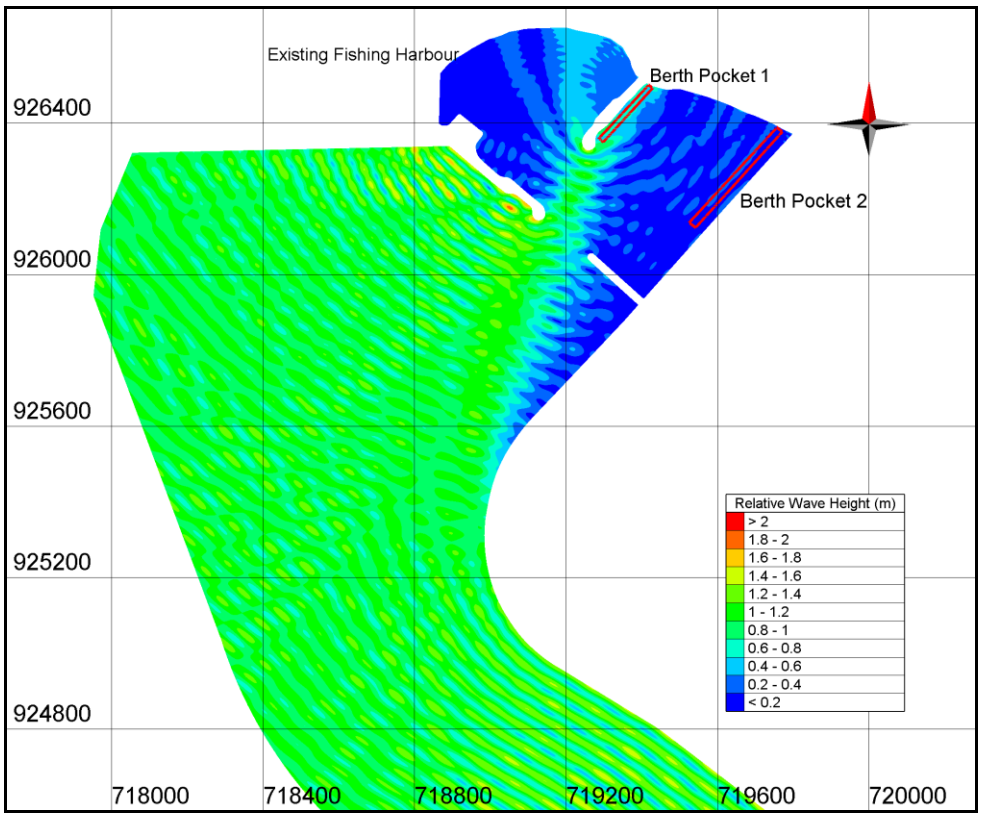


Figure 5-35: Relative wave height distribution (Inputs: H = 1 m, Direction - SSW, T = 8 sec) for Layout-1A

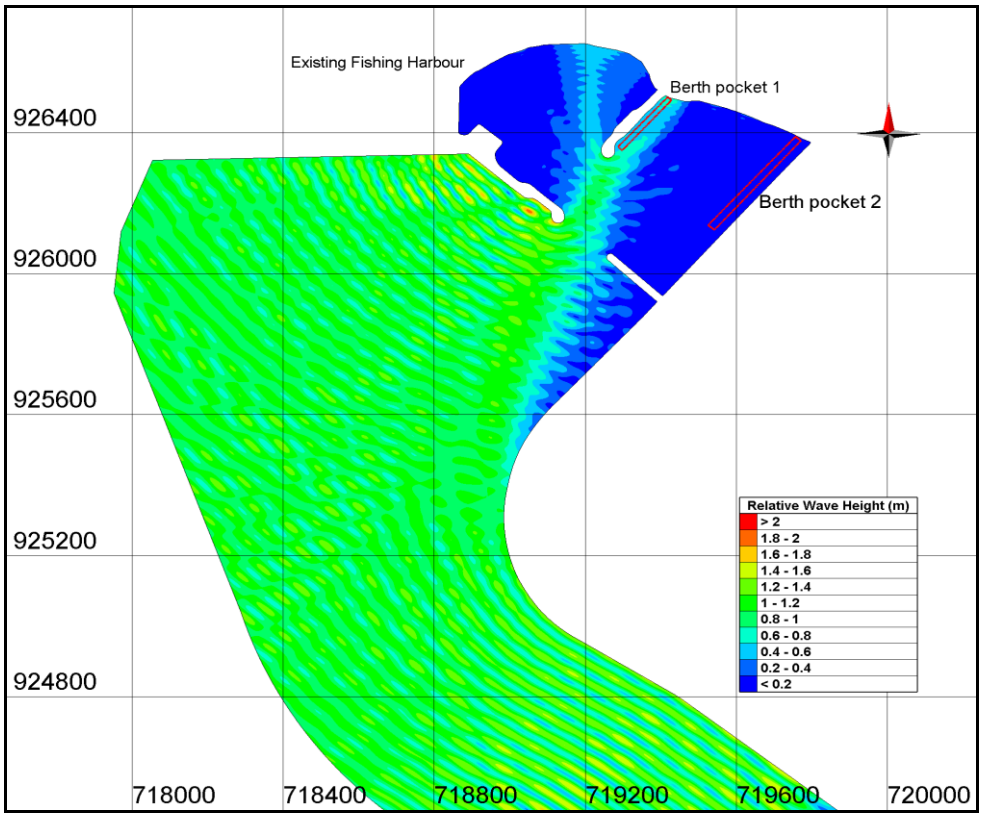


Figure 5-36: Relative wave height distribution (Inputs: H = 1 m, Direction - SSW, T = 8 sec) for Layout-1B

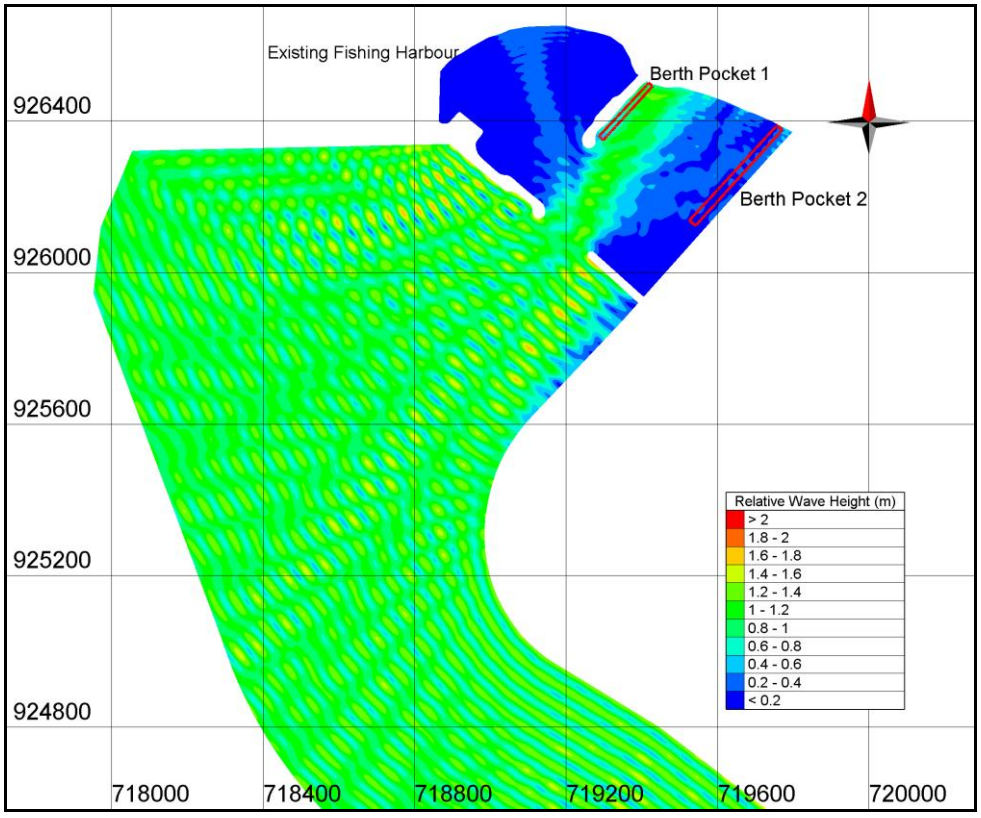


Figure 5-37: Relative wave height distribution (Inputs: H = 1 m, Direction - SW, T = 8 sec) for Layout-1A

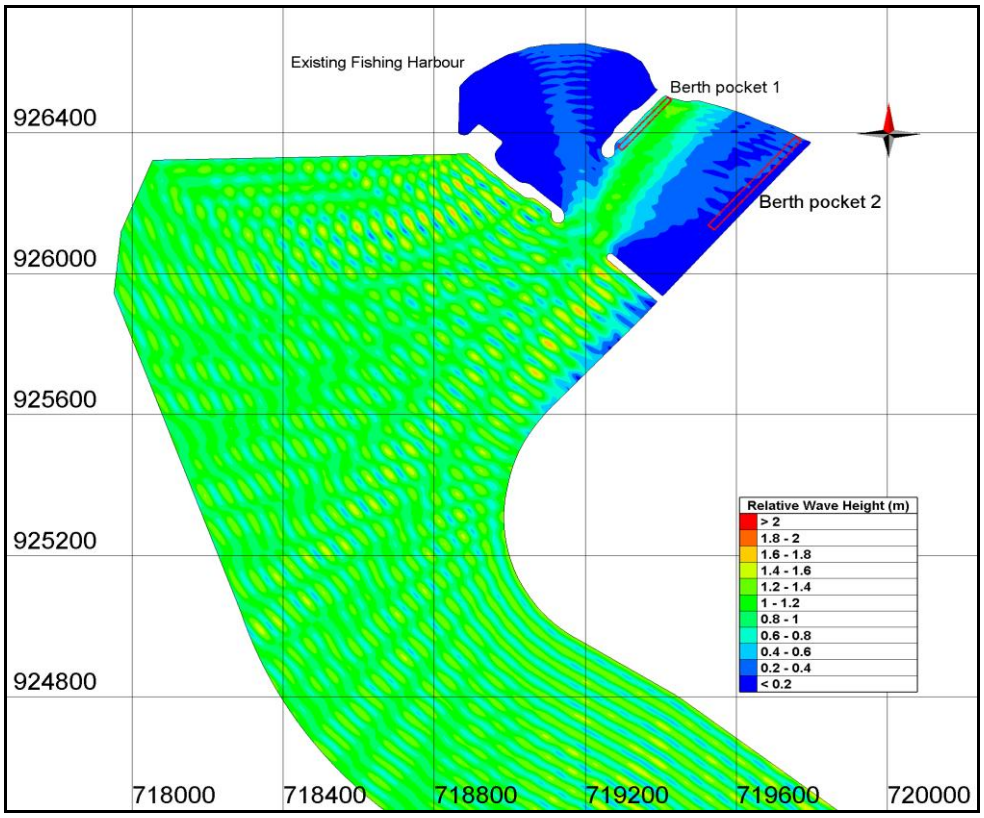


Figure 5-38: Relative Wave Height Distribution (Inputs: H = 1 m, Direction - SW, T = 8 sec) for Layout-1B

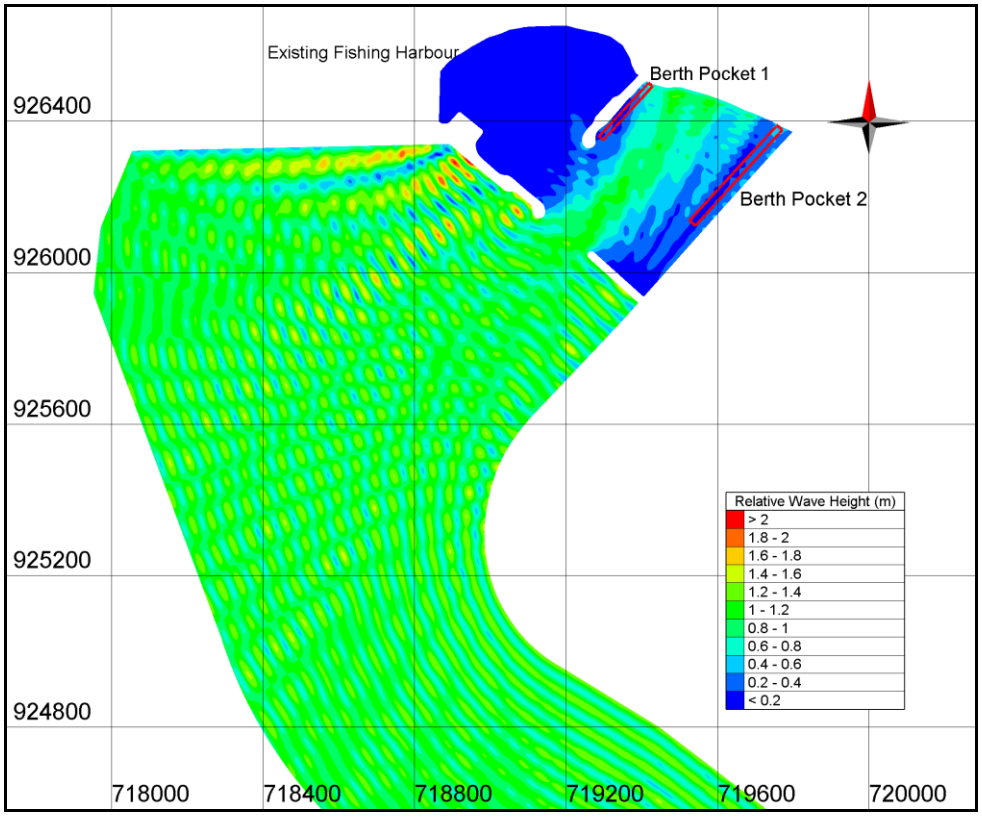


Figure 5-39: Relative Wave Height Distribution (Inputs: H = 1 m, Direction - WSW, T = 8 sec) for Layout-1A

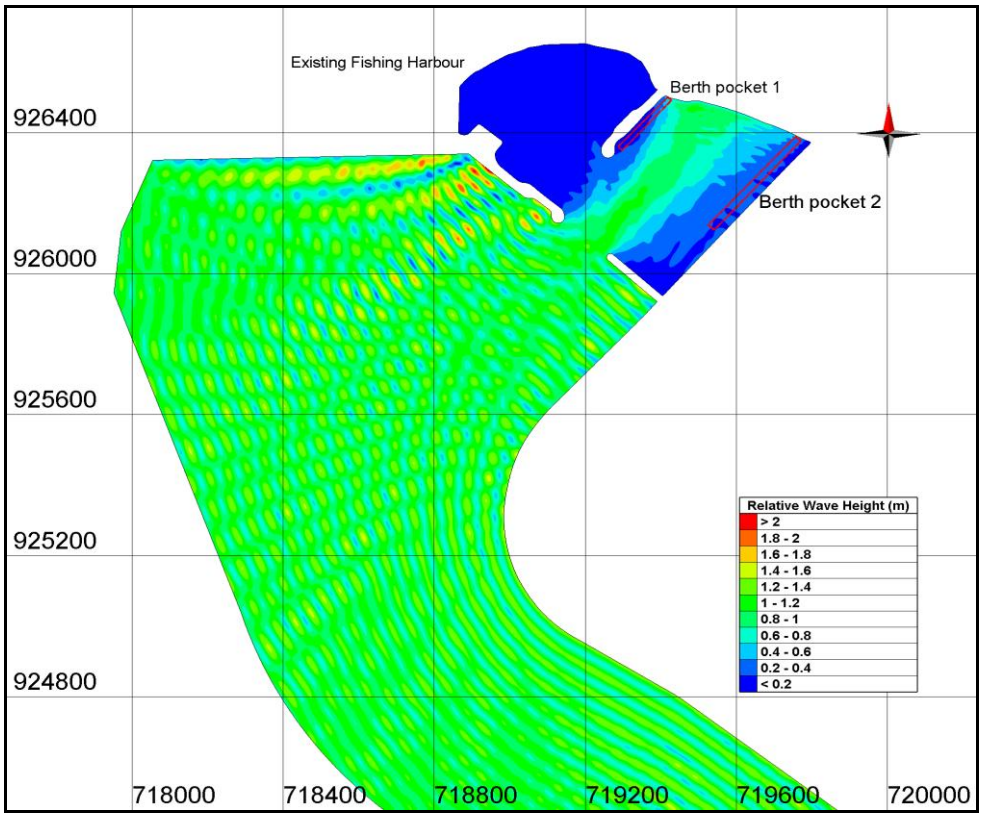


Figure 5-40: Relative wave height distribution (Inputs: H = 1 m, Direction - WSW, T = 8 sec) for Layout-1B

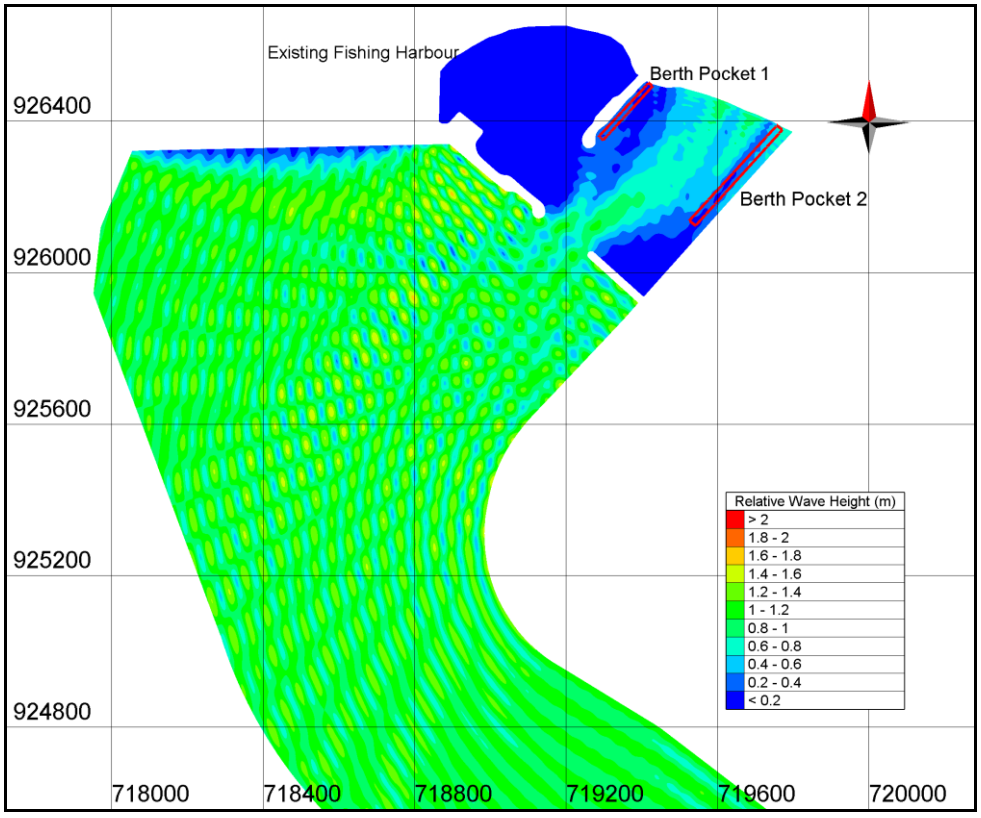


Figure 5-41: Relative wave height distribution (Inputs: H = 1 m, Direction - W, T = 8 sec) for Layout-1A

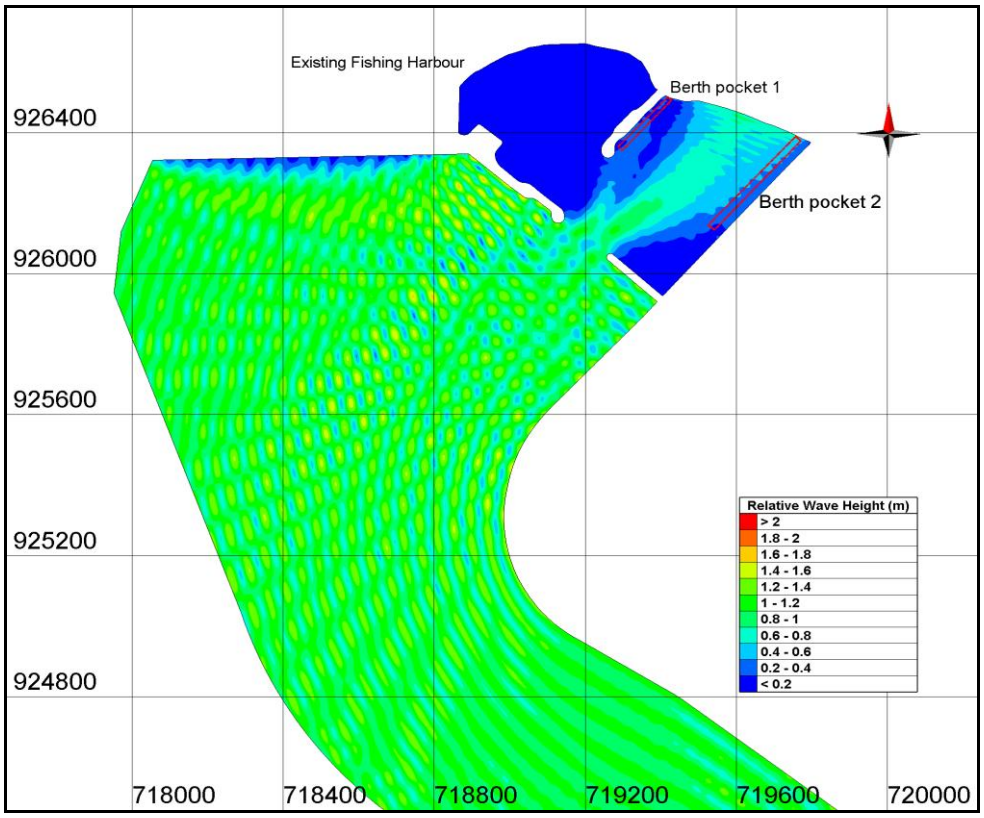


Figure 5-42: Relative wave height distribution (Inputs: H = 1 m, Direction - W, T = 8 sec) for Layout-1B

It can be seen from the results for Layout-1A & 1B shown from **Figure 5-33 t**o Figure 5-42 that waves from S are blocked by the north breakwater of the proposed port and no disturbance is expected within the existing fishing harbour and proposed fish landing centre for waves from this direction even without any additional breakwater. However, waves from SSW and SW can cause significant disturbance within the existing fishing harbour and along the berth pocket-1 of the proposed fish landing facility. The disturbance on berth pocket-2 for both of these directions was found to be less. For the waves from WSW, the berth pocket-1 along the south breakwater of the existing fishing harbour will be affected. The berth pocket-2 and the region within existing fishing harbour will have fewer disturbances. The existing fishing harbour and the berth pocket-1 are expected to be less influenced by waves from west. The estimated diffraction co-efficient (RAOs) from the results were then used to get the significant wave heights inside the harbour by using the significant wave heights extracted at 25 m water depth from the nearshore wave transformation model.

The downtime was then estimated by calculating exceedance over a specified limiting wave height. The limiting wave height considered for the fish landing berths was taken as 0.5 m (IS: 4651 stipulates 0.6-0.9 m as the limiting wave height for trawler and fishing boats). Annual downtime for the proposed berths of Layout-1A and Layout-1B are given in **Table 5-10, Figure 5-43** and **Figure 5-44**.

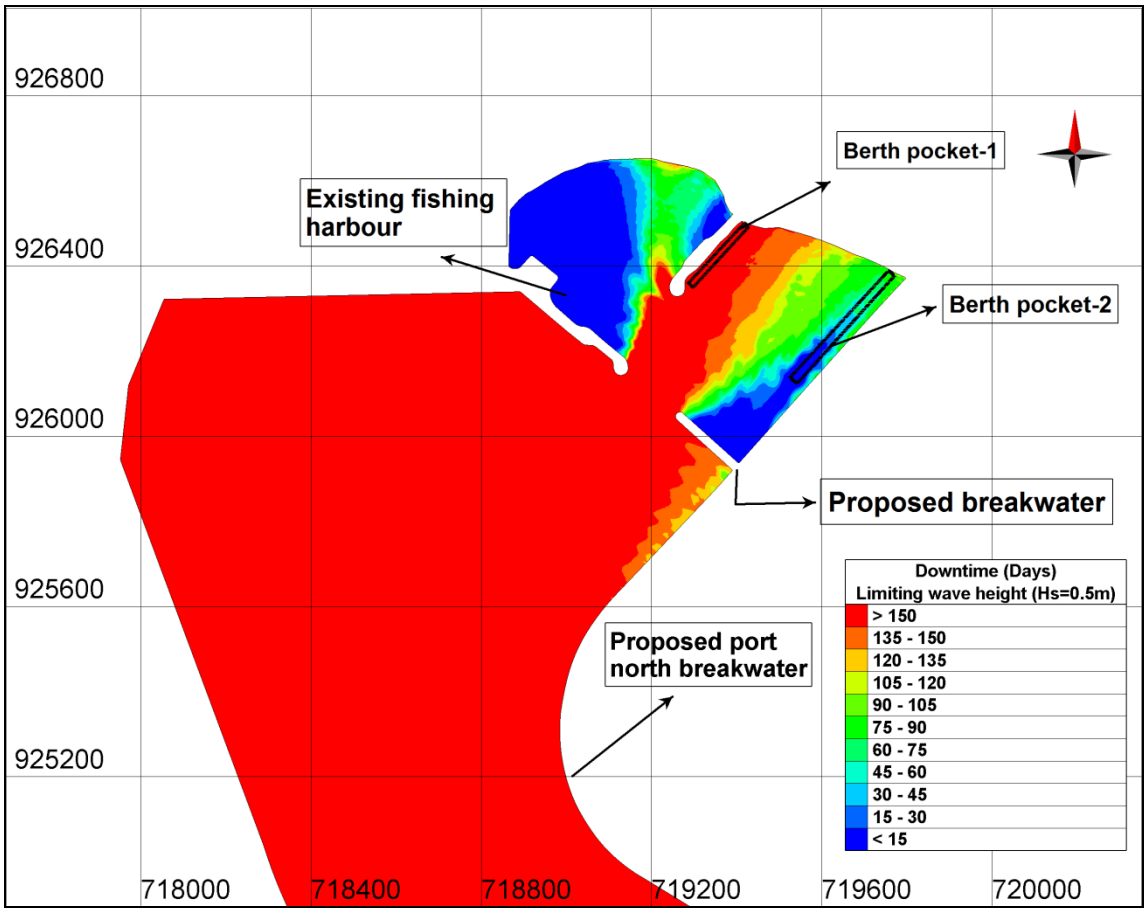


Figure 5-43: Annual Downtime (days) for the Layout-1A (Vertical wall)

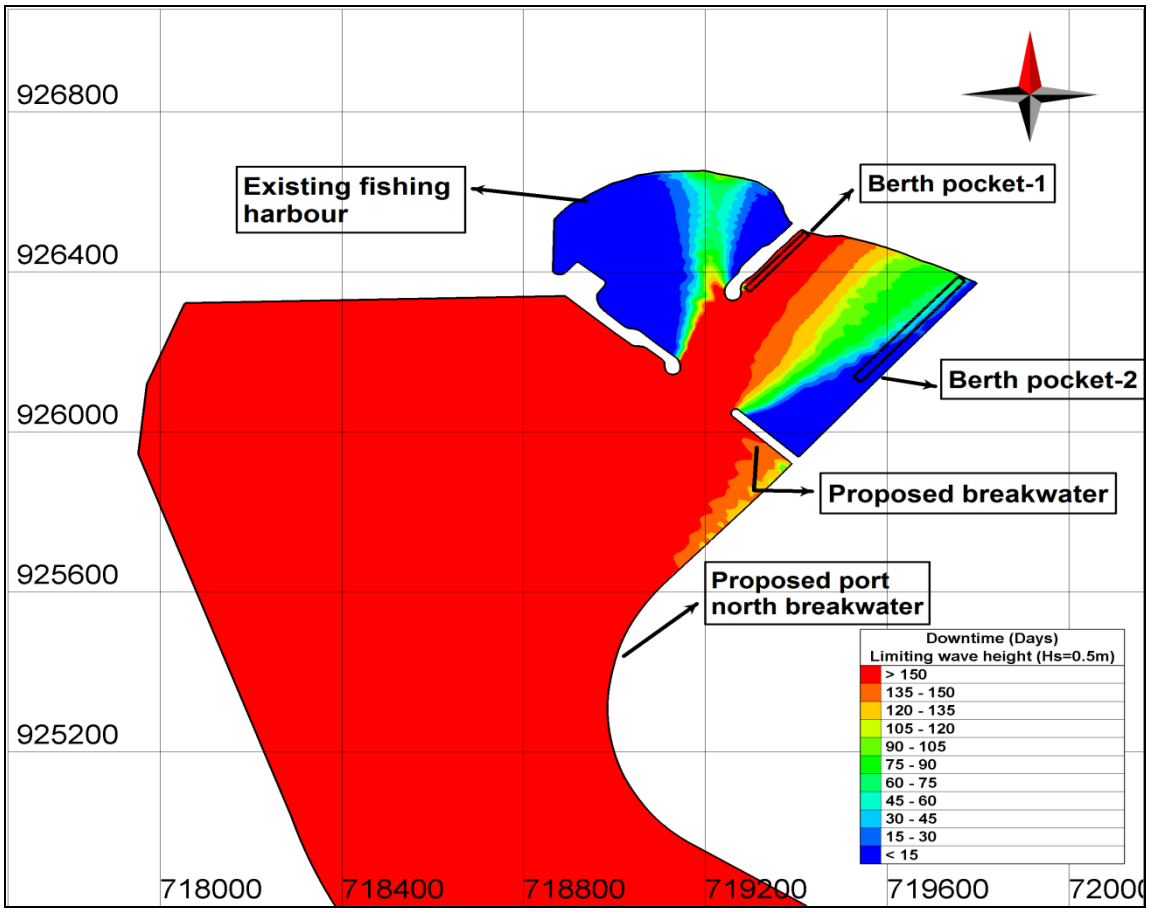


Figure 5-44: Annual Downtime (days) for the Layout-1B (Rock Slope)

Table 5-10: Annual Downtime (days) for the Proposed Fish Landing Facility

Layouts considered for the study	Downtime for the Proposed fish landing Berths (Limiting wave height Hs=0.5 m)	
	Berth pocket-1 (190 m)	Berth pocket-2 (345 m)
Layout-1A (Vertical)	275	99
Layout-1B (Rock slope)	272	81
Berth pocket length considered for calculating the downtime is as follows; Berth pocket-1 length = 190 m; Berth pocket -2 length = 345 m.		

It was found that the downtime for the proposed fish landing berths of Layout-1A and Layout-1B has a scope for further reduction. Therefore, it was decided to carry out the study with various layouts. These configurations include extension of the existing north break water, projection on either side of the new entrance, placing the proposed breakwater at slightly deepwater and increasing its length. Various layouts considered for the study are shown in to and **Figure 5-47** described in **Table 5-11.**

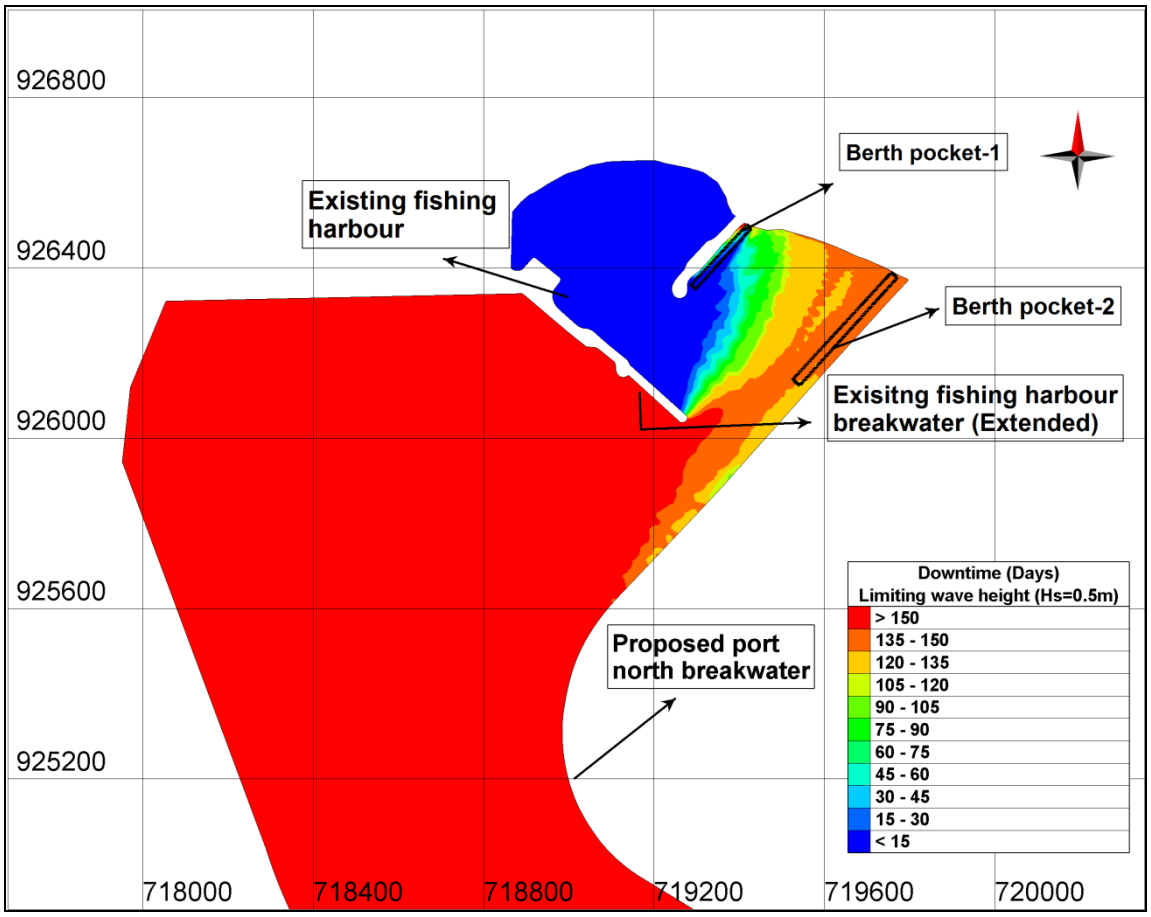


Figure 5-45: Layout-2 - Existing Fishing Harbour Breakwater extended by 170 m

The study was carried out by extending the north breakwater (Layout-2) of the existing fishing harbour by 170 m (extending upto 11 m depth). The region inside the existing fishing harbour was found to have complete tranquillity but optimum tranquillity for the proposed fish landing facility was not achieved.

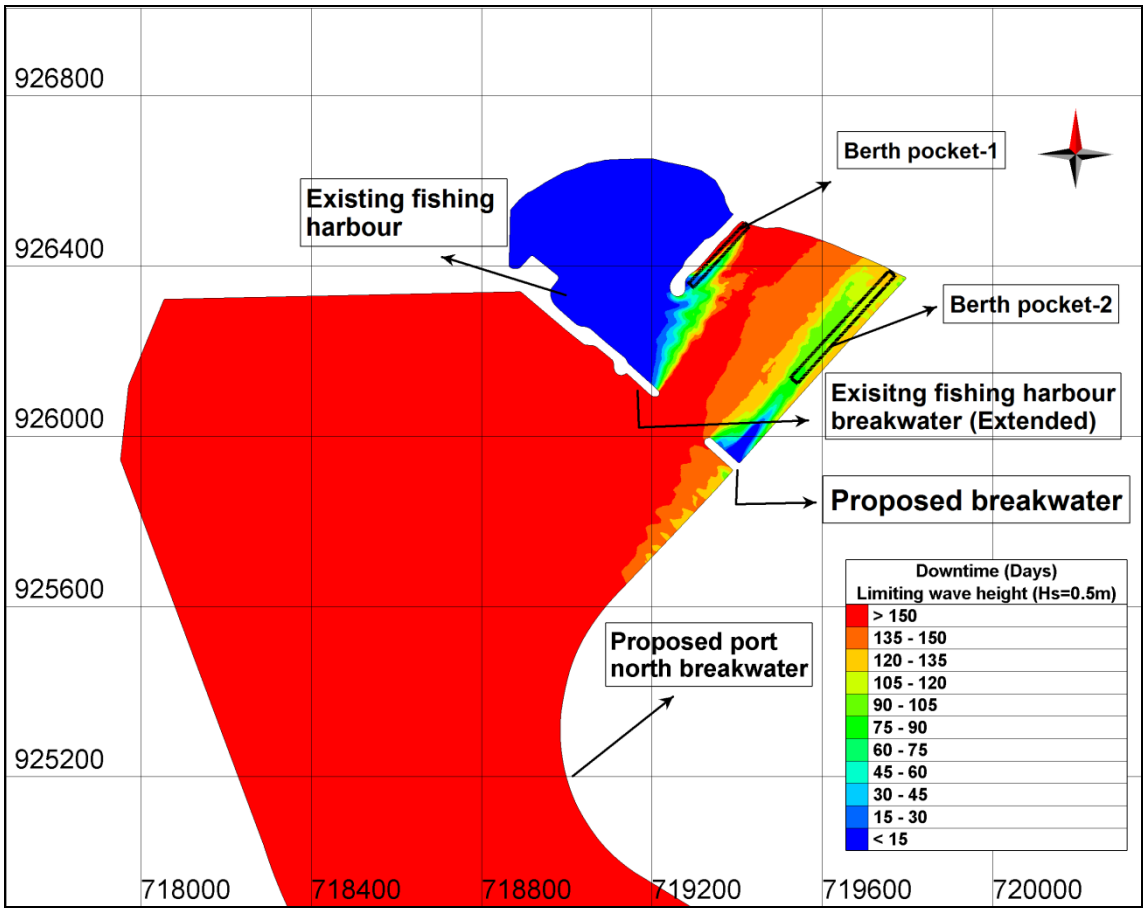


Figure 5-46: Layout-3 - Existing Fishing Harbour Breakwater and the Proposed Breakwater Extended by 90 m

Since Layout-2 was not providing optimum tranquillity, the existing fishing harbour breakwater and the proposed breakwater was extended by 90 m (Layout-3). It was found that, only the area within existing fishing harbour will achieve maximum tranquillity.

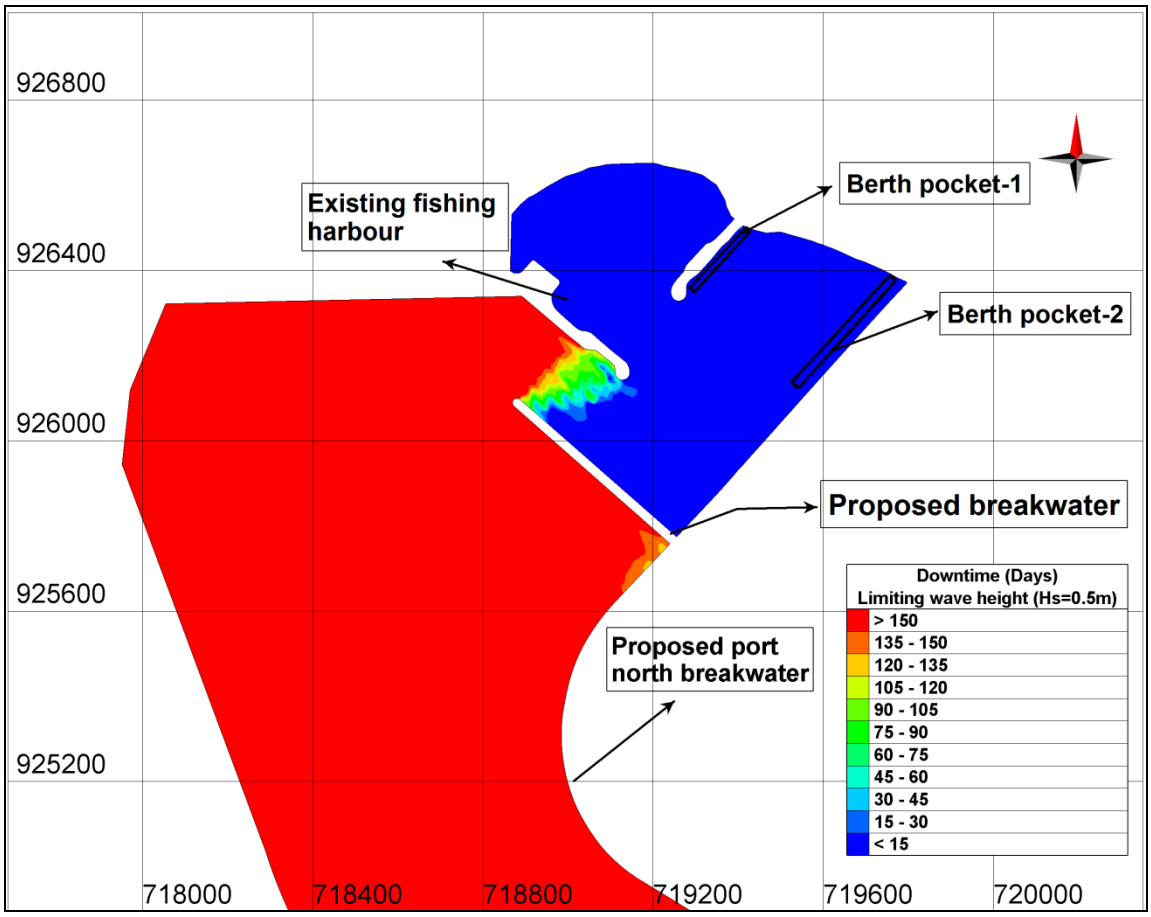


Figure 5-47: Layout-4 - Proposed Breakwater for Fish Landing Centre extended by 500 m

Since, Layout-2&3 do not provide desirable tranquillity for the proposed fish landing centre, it was decided to move the proposed breakwater (layout-4) to slightly deepwater to a depth of about 12 m. It was found that with this configuration, complete tranquillity will be achieved within the existing fishing harbour and the proposed fish landing facility as well.

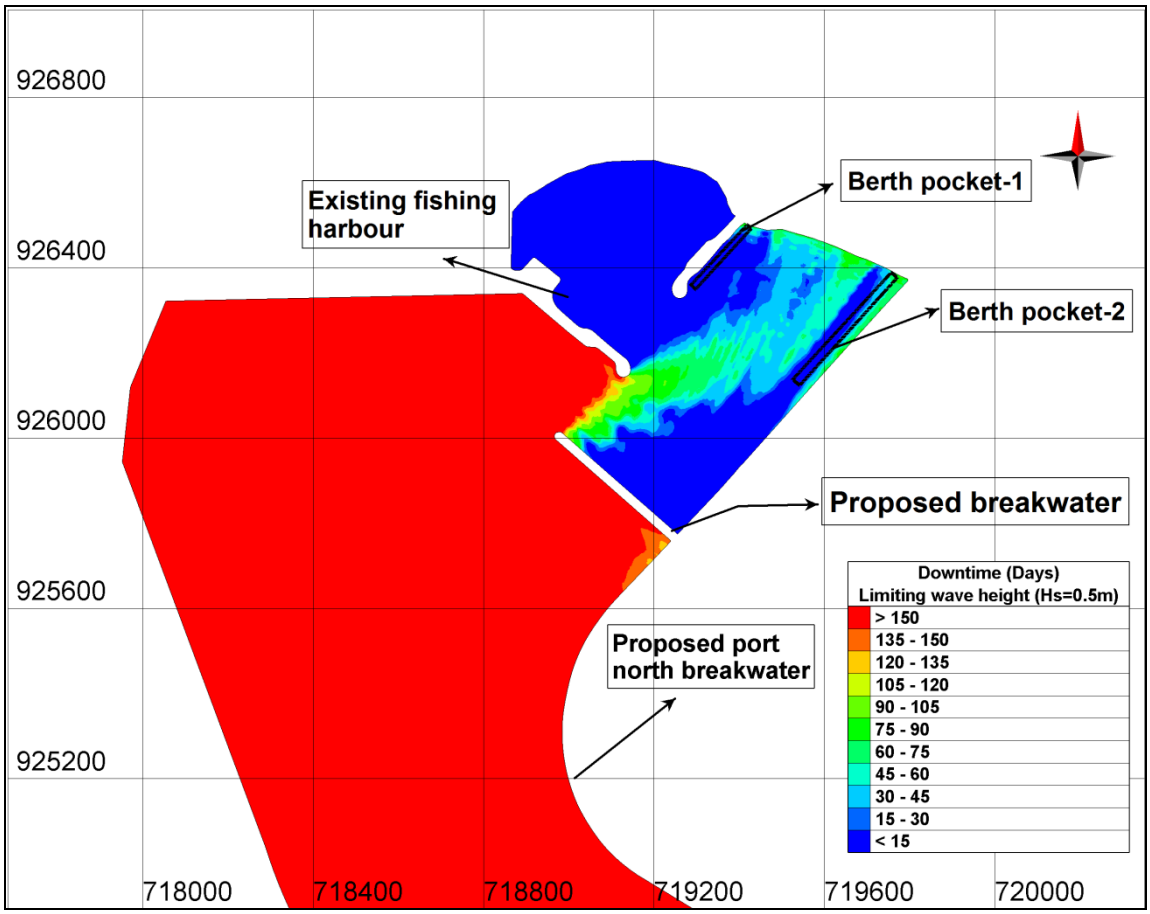


Figure 5-48: Layout-5 - Proposed Breakwater for Fish Landing Centre extended by 370 m

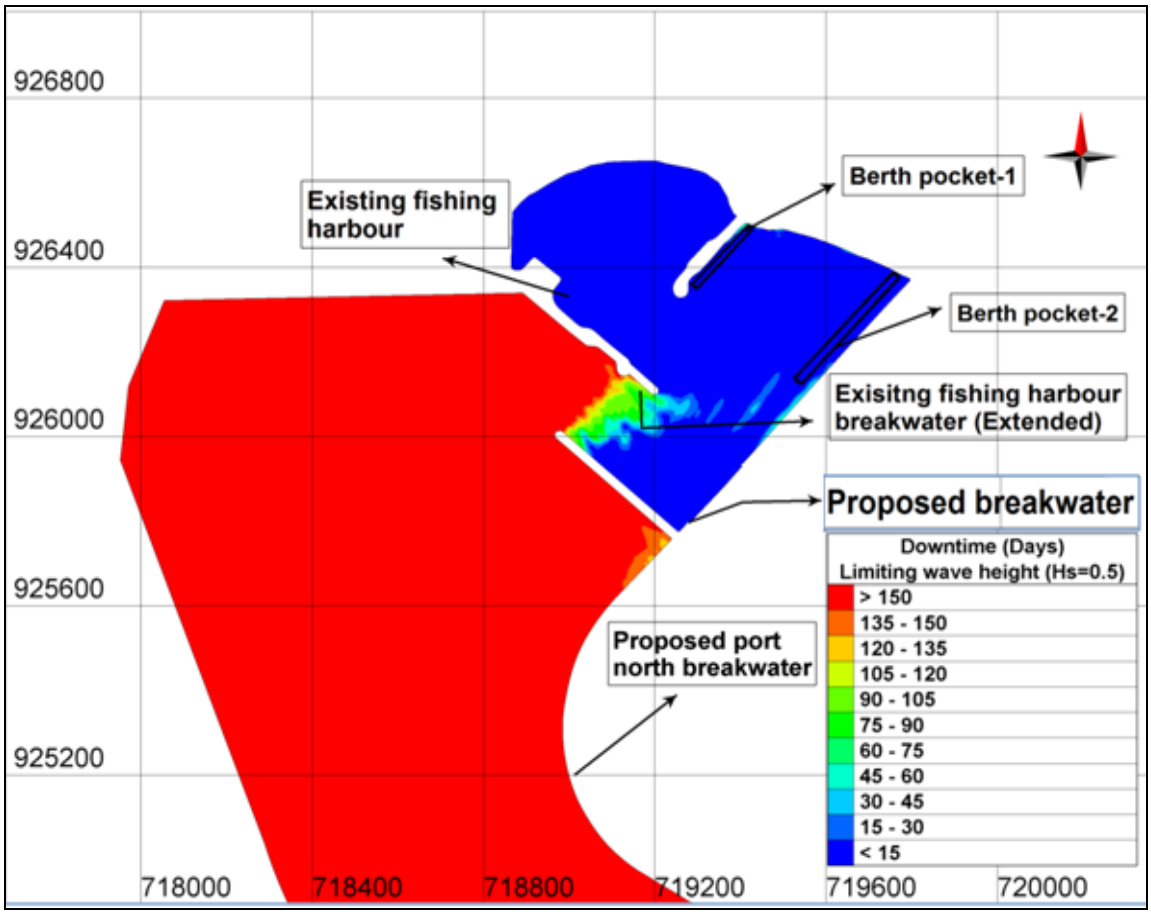


Figure 5-49: Layout-6 - Proposed breakwater for Fish Landing Centre extended by 370 m and Existing Fishing Harbour by 75 m

Keeping in consideration the cost for construction, two additional layouts i.e. Layout 5&6 were studied in order to achieve desirable tranquillity as well as to reduce the cost of construction. Layout-5 was created by reducing the length of proposed breakwater used in Layout-4 and Layout-6 was similar to layout-5 with an additional projection on the breakwater of the existing fishing harbour. It was found that Layout-6 was providing downtime less than 20 days and will be economical. The configuration of all the layouts considered for the study is given in **Table 5-11** and the estimated downtimes for all the layouts are give in**Table 5-12.**

Table 5-11: Configuration of Various Layout Considered for the Study

Layouts considered for the study	Reflection co-efficient considered for the proposed fish landing facility		Breakwater length (m)		Total BW Length (m)	Mean Depth (m)	
	BS1	BS2	From BW of proposed port	Extension of existing fishing harbour BW		From BW of proposed port	Extension of existing fishing harbour BW
Layout-2	0.90	0.90	--	170	170	--	11
Layout-3	0.90	0.90	90	90	180	11	10
Layout-4	0.90	0.90	500	--	500	12	--
Layout-5	0.90	0.90	370	--	370	12	--
Layout-6	0.90	0.90	370	75	445	12	10
BW-Breakwater; BS1- Berthing structure along Berth pocket-1; BS2- Berthing structure along							

Layouts considered for the study	Reflection co-efficient considered for the proposed fish landing facility		Breakwater length (m)		Total BW Length (m)	Mean Depth (m)	
	BS1	BS2	From BW of proposed port	Extension of existing fishing harbour BW		From BW of proposed port	Extension of existing fishing harbour BW
Berth pocket-2							

Table 5-12: Downtime (Days) various layout considered for the study

Layouts considered for the study	Downtime for Proposed fish landing Berths (Limiting wave height Hs=0.5 m)	
	Berth pocket-1 (190 m)	Berth pocket-2 (345 m)
Layout-2	140	151
Layout-3	270	134
Layout-4	5	1
Layout-5	84	91
Layout-6	17	14
The minimum entrance for the fishing harbour kept in all the layout is 150 m. Berth pocket length considered for calculating the downtime is as follows; Berth pocket-1 length = 190 m ; Berth pocket -2 length = 345 m. (About 700 m for layouts 4,5 and 6); All layouts except Layout -1, provides complete tranquillity within existing fishing harbour.		

By comparing all the layouts, it was found that Layout-6 provides optimum tranquillity for the proposed fish landing facility and is relatively economical.

The suggestions and recommendations given by LTR were analysed by VISL and found that Layout-1 was suitable after considering all aspects (navigation, construction, practical aspects) with few modifications on the berthing structures.

With this background VISL had requested LTR to study the suitability of Layout-1 with the modification suggested by them. Further, VISL requested to increase the length of the fish landing berth-2 by 150 m upto the proposed fishing breakwater instead of providing fish landing berth-1. Based on the above request, It was decided to carry out the study for three layouts i.e. Layout-7, 8&9. Layout-7 configuration was same Layout-1 as provided by the client. Layout-8 was created by reducing the length of the proposed fishing harbour breakwater used in Layout-7 to 140 m and similarly Layout-9 by 100 m. The fish landing berth along the proposed port breakwater was considered as vertical wall with full reflection Cr=0.90 and the berthing area increased until the proposed fishing harbour breakwater (i.e., 150 m). The existing fishing harbour breakwaters and other proposed structures were considered as rubble mound with Cr=0.40.

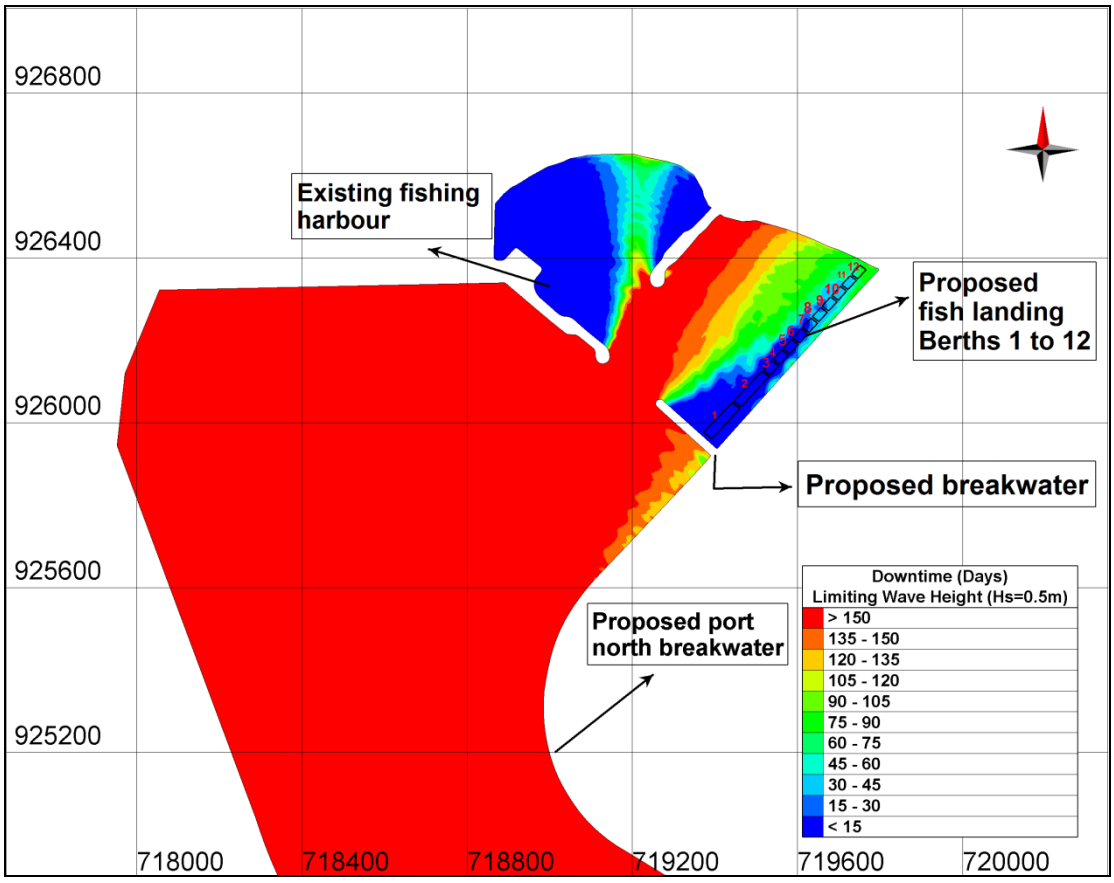


Figure 5-50: Layout-7 – As Provided by Client

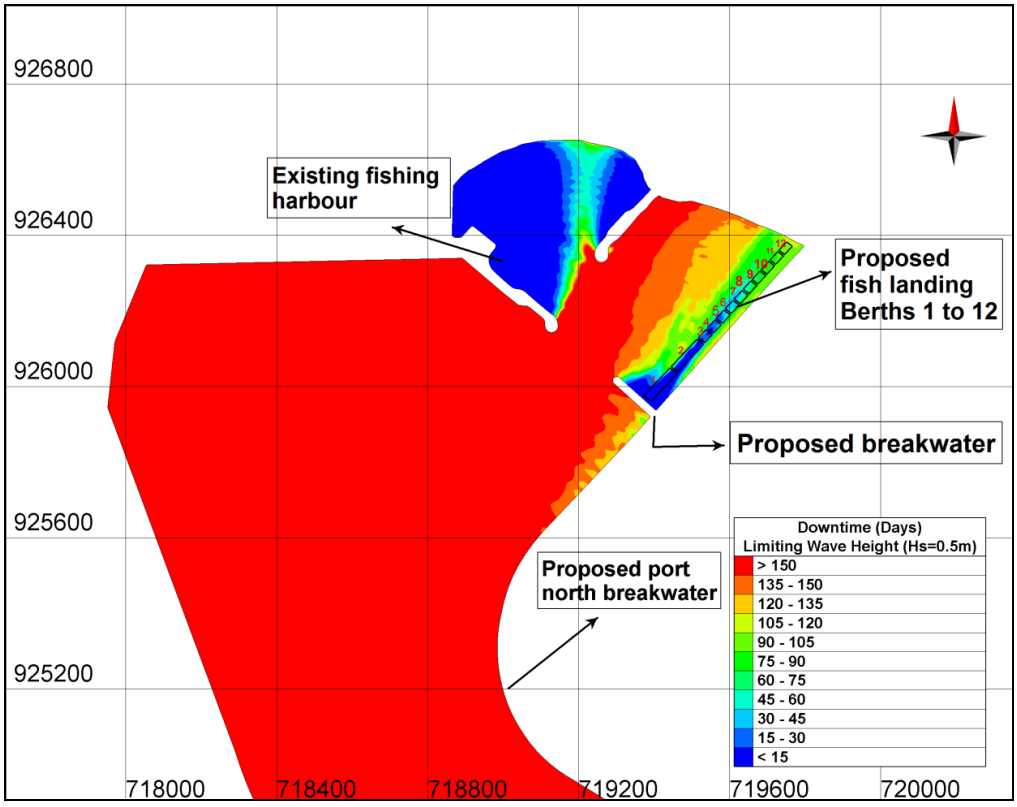


Figure 5-51: Layout-8 – Proposed Fish Landing Breakwater Reduced to 140 m

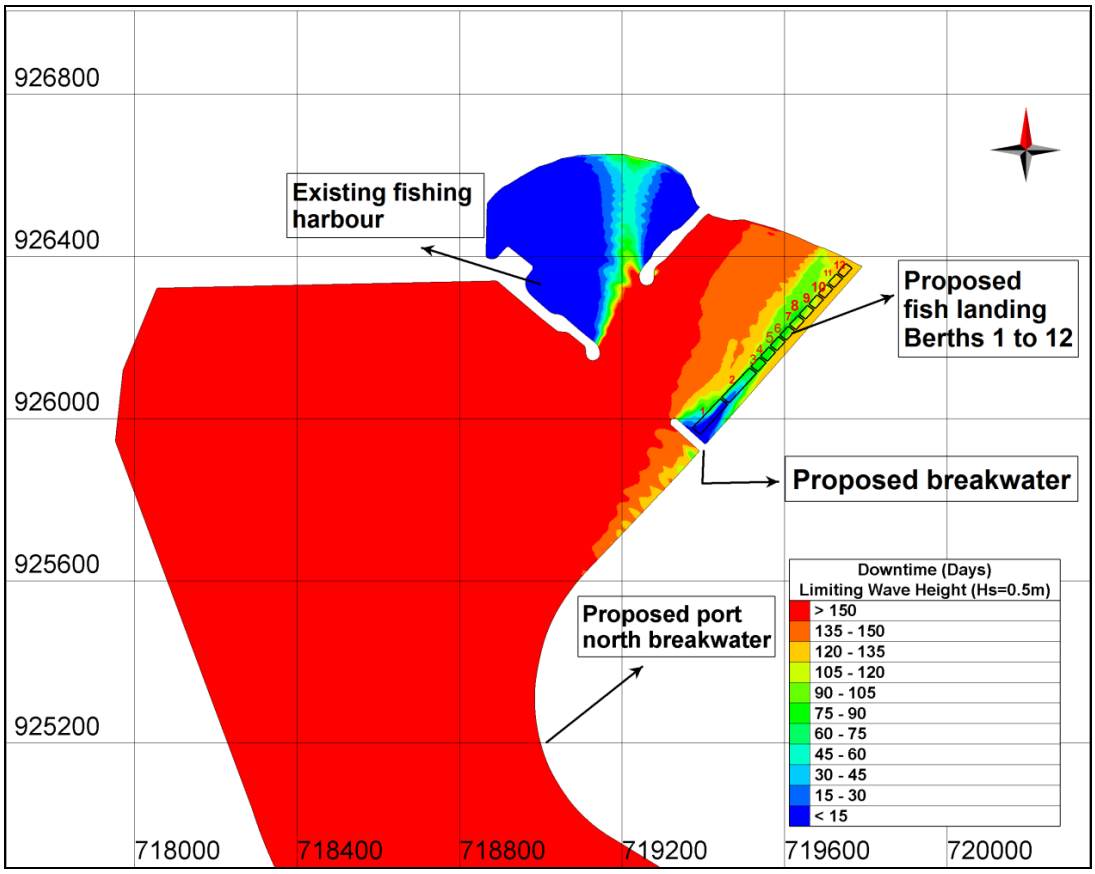


Figure 5-52: Layout-9 – Proposed Fish Landing Breakwater Reduced to 100 m

The annual downtime (days) for Layout-7,8 & 9 was shown in **Figure 5-50** and the estimated downtime for each of the berths as provided by client are given in **Table 5-13** and **Table 5-14.**

Table 5-13: Downtime (Days) for limiting wave height (Hs=0.5 m) for Layout-7&8

Layouts	Downtime (Days) Limiting wave height (Hs=0.5 m)											
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
Layout - 7	<1	<2	<2	<7	14	19	37	39	45	47	60	85
Layout - 8	80	101	70	57	63	74	84	88	92	92	95	115
Layout - 9	83	105	106	112	116	119	124	125	126	126	126	132

Table 5-14: Downtime (Days) for limiting wave height (Hs=0.9 m) for Layout-7&8

Layouts	Downtime (Days) Limiting wave height (Hs=0.9 m)											
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
Layout - 7	0	0	0	0	0	<1	<1	<2	<4	<5	<8	31
Layout - 8	0	0	<1	<1	<2	<2	<4	<7	<14	<14	26	49
Layout - 9	<2	<12	27	34	41	48	61	61	72	72	81	91

By comparing all the results, Layout-7 was found to provide optimum tranquillity and less downtime compared to Layout–8&9. Hence, we suggest Layout-7 with new berthing alignments as suitable.

5.3.3.5 Summary and Conclusion

VISL is planning to expand the existing fishing harbour at Vizhinjam by developing a fish landing facility in the area between existing fishing harbour and north breakwater of the proposed port. In order to provide tranquillity for the proposed fish landing facility, VISL is planning to construct a breakwater between the breakwaters of the existing fishing harbour and north breakwater of the proposed port.

Tranquillity study was carried out for the area between existing fishing harbour and proposed port breakwater which is proposed to be developed as fish landing facility for various layout configurations to find out the most suitable length and orientation of the required breakwater.

The initial study was carried out for the layout-1 considering the berthing structure as a piled structure with rock slope and as vertical wall with initial berthing alignment as provided by client. It was found that the estimated downtime for initial arrangement of berthing alignment was not desirable. Hence it was decided to study various layout configurations by increasing by increasing/reducing the length of the proposed fishing harbour breakwater and by placing the proposed fishing harbour breakwater at slightly deeper depths. A total five layout configurations were studied apart from client provided layout. Based on the estimated downtime for all the layouts LTR suggested that Layout-6 was found to provide optimum tranquillity and also economical.

The recommendations provided by LTR were analysed by VISL and suggested that Layout-1 can be suitable with few modification in berthing alignment after considering all aspects (navigation, construction and cost). VISL suggested that fish landing berth-2 along the proposed port can be extended to 150 m upto the proposed fishing breakwater and the fish landing berth-1 is not required. Moreover, VISL suggested that 10 berth of 30 m each and two berths of 100 m each is planned to be developed and requested LTR to study the tranquillity and estimate the downtime for the same. Based on the VISL request, the study was carried out by LTR for Layout-7 (same as Layout-1) with the modification suggested by VISL. And two additional studies were carried out with the proposed fishing breakwater reduced to 140 m (Layout-8) and to 100 m (Layout-9).

By comparing the results, Layout-7 was found to provide optimum tranquillity and lesser downtime for the berths B1-B8 for limiting wave height 0.5 m and for all the berths for limiting wave height 0.9 m.

5.3.3.6 Comparative study on tranquillity in the fishing harbour

The diffraction coefficients obtained from ARTEMIS simulations were used for transforming each of the near-shore wave events within the domain, reflecting the effect of the breakwaters and other entities of the harbour complex like the wharves, natural beach and rock bund. Thus, average annual wave climate was created within the harbour and at the mouth, which was used for the comparative study between with and without layout conditions.

Points at the entrance to the fishing harbour and near the two wharves in the fishing harbour were considered to assess the impact of the breakwater of the proposed port. **Figure 5-53** shows the location of the chosen points and the likely navigational paths the fishing vessels can take. **Figure 5-54** to **Figure 5-63** show the wave heights occurring at the selected points (three points near the

mouth of the fishing harbour and two points near the berths and four points outside mouth in open sea) in existing condition and with breakwater of the proposed port.

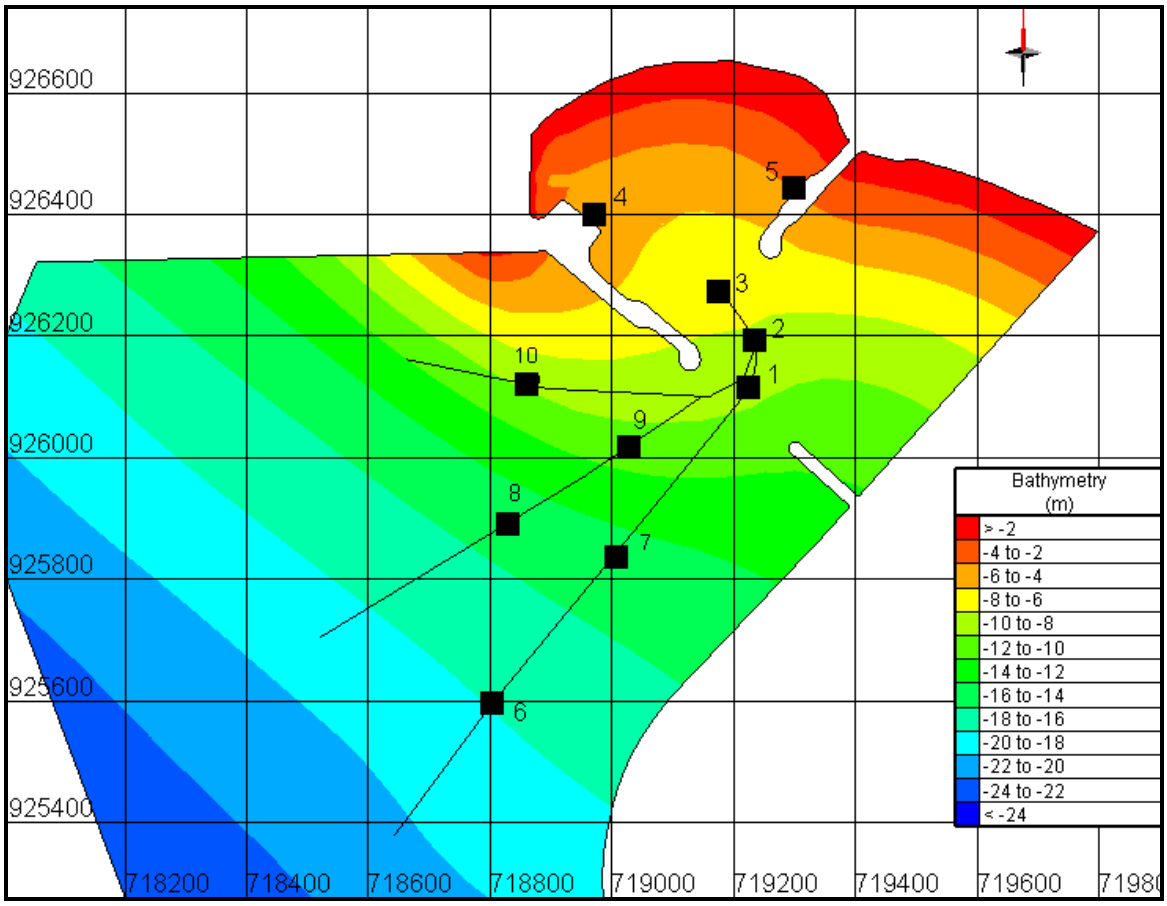


Figure 5-53: Location of the selected points

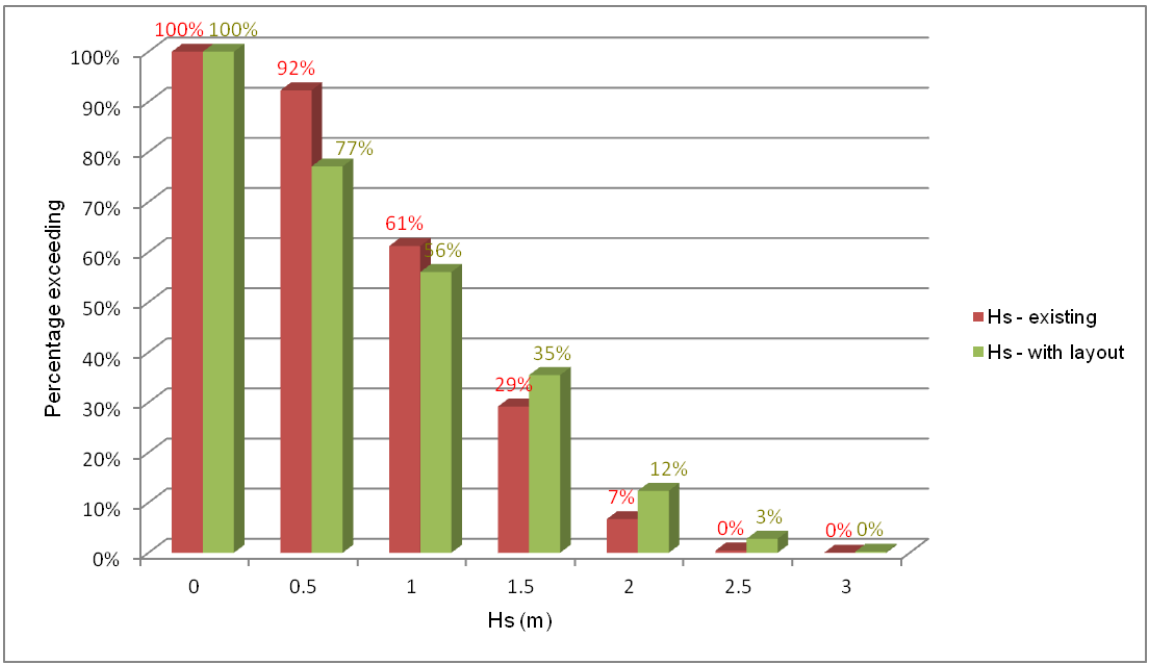


Figure 5-54: Percentage of exceedance of wave heights with and without layout at point 1

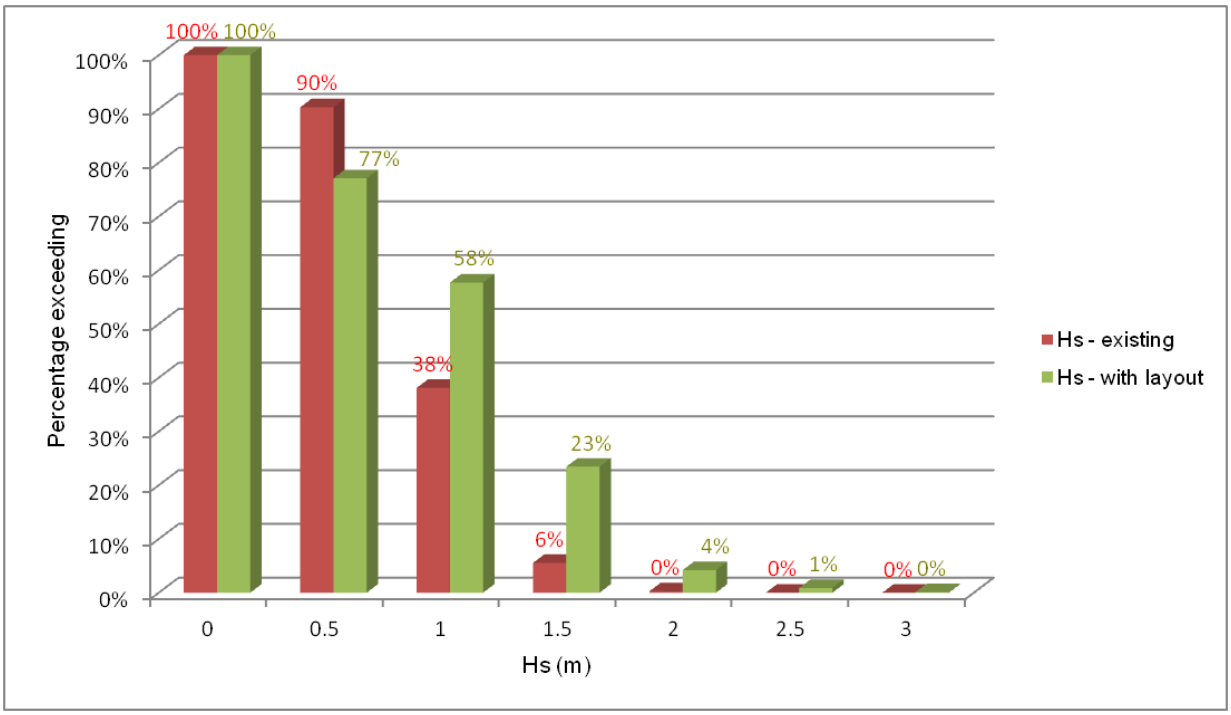


Figure 5-55: Percentage of exceedance of wave heights with and without layout at point 2

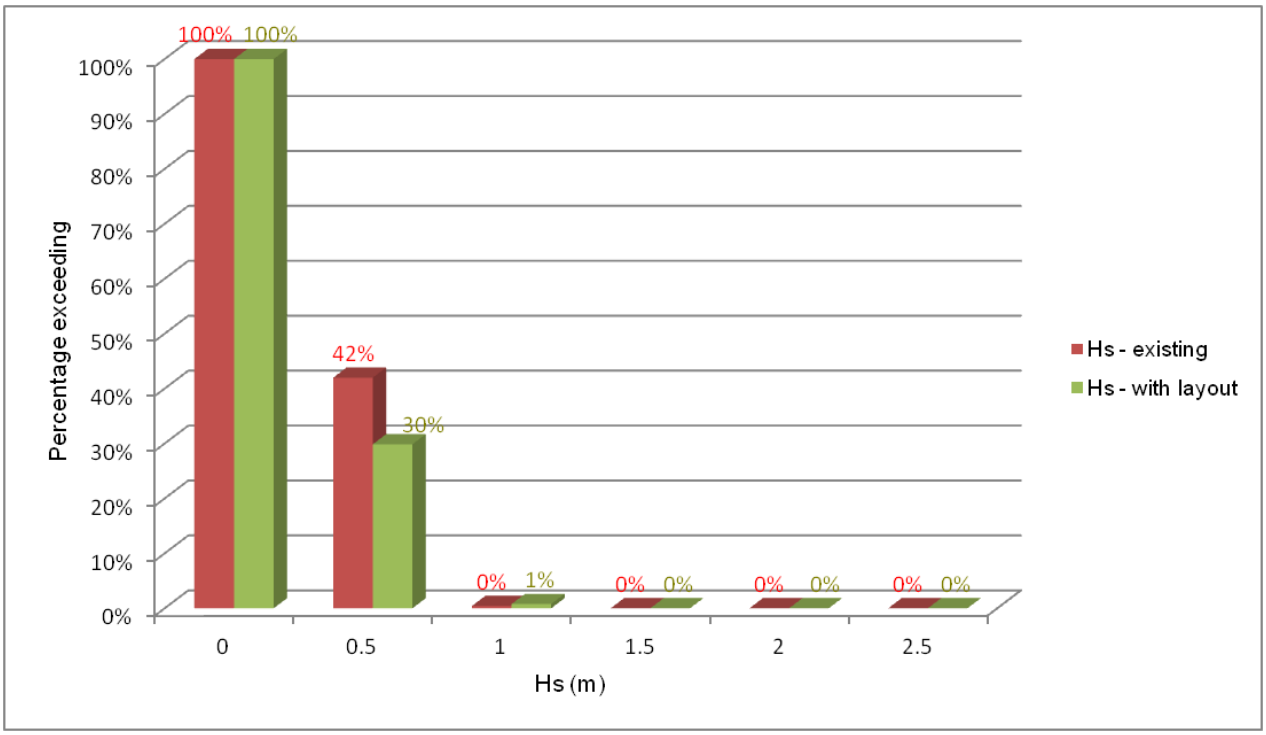


Figure 5-56: Percentage of exceedance of wave heights with and without layout at point 3

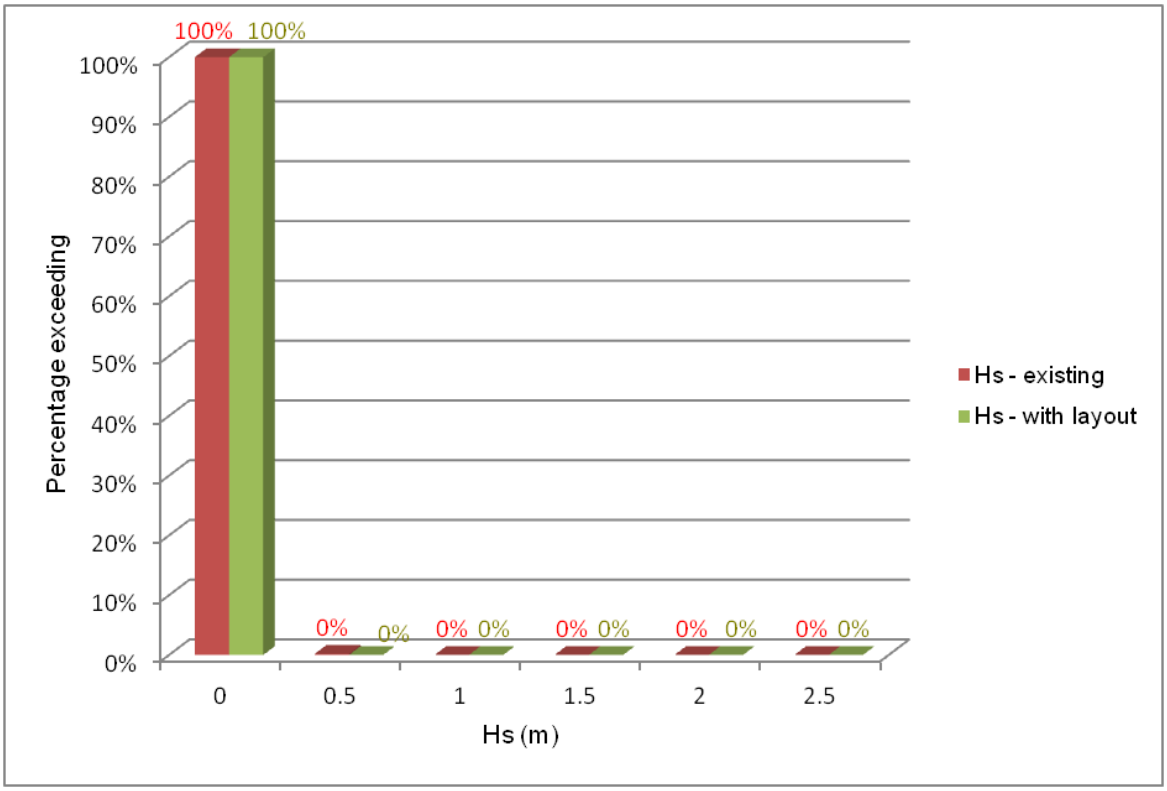


Figure 5-57: Percentage of exceedance of wave heights with and without layout at point 4

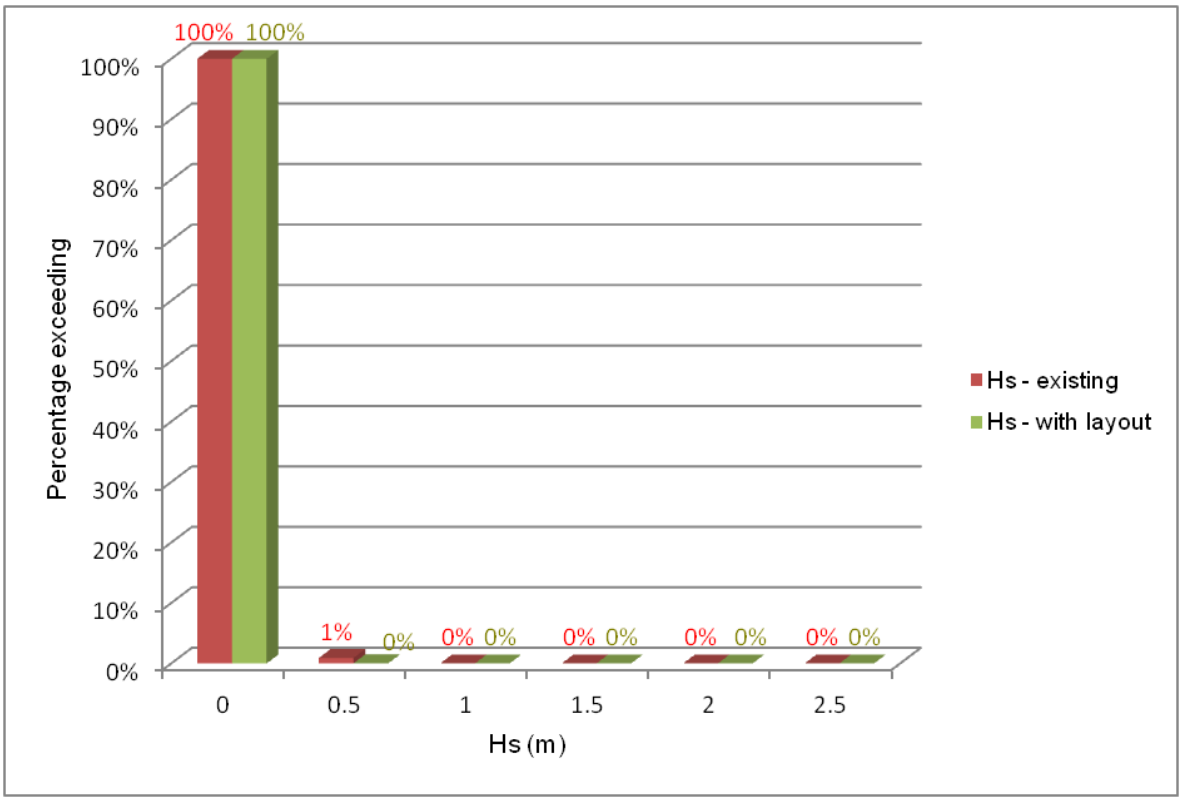


Figure 5-58: Percentage of exceedance of wave heights with and without layout at point 5

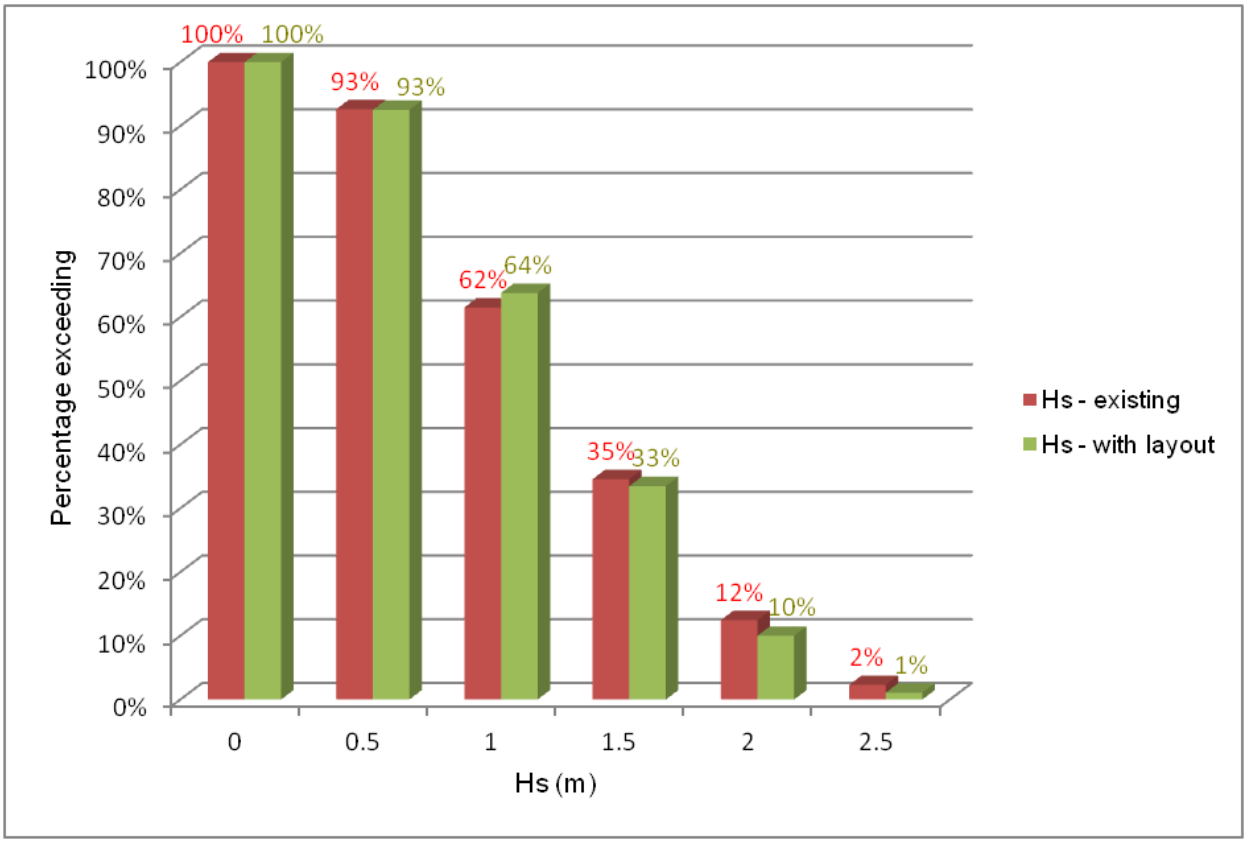


Figure 5-59: Percentage of exceedance of wave heights with and without layout at point 6

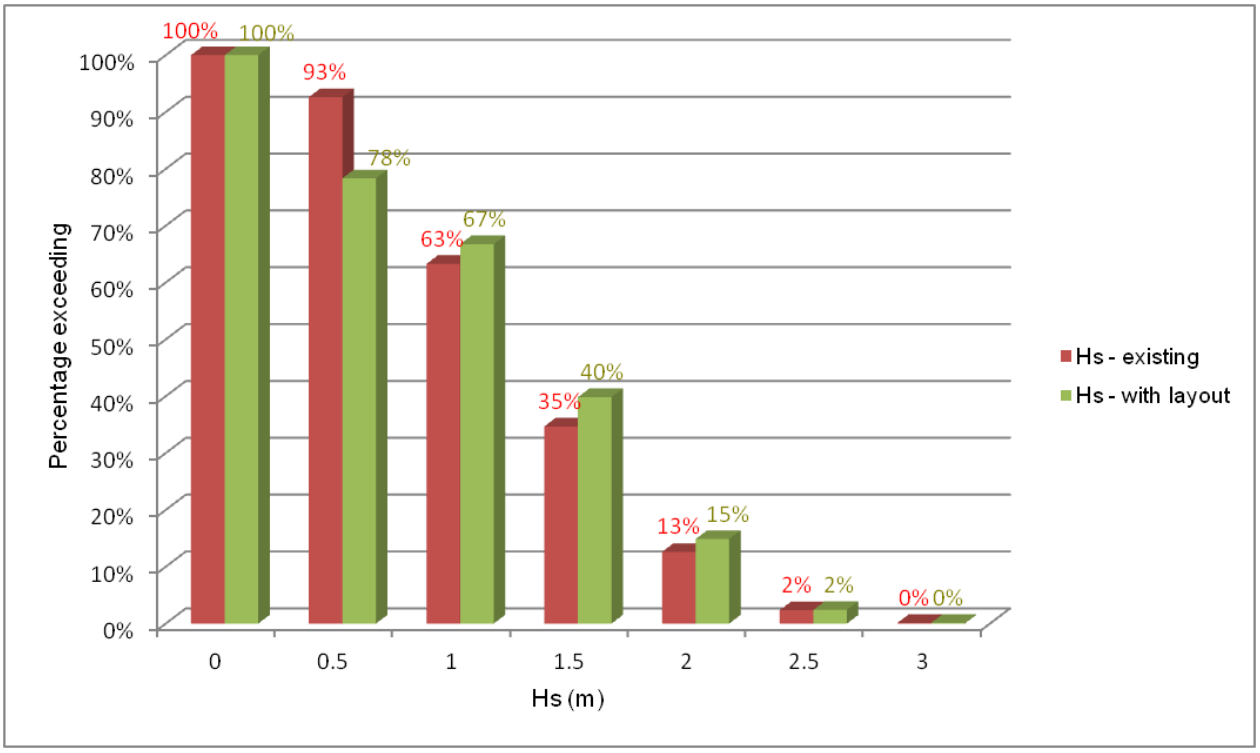


Figure 5-60: Percentage of exceedance of wave heights with and without layout at point 7

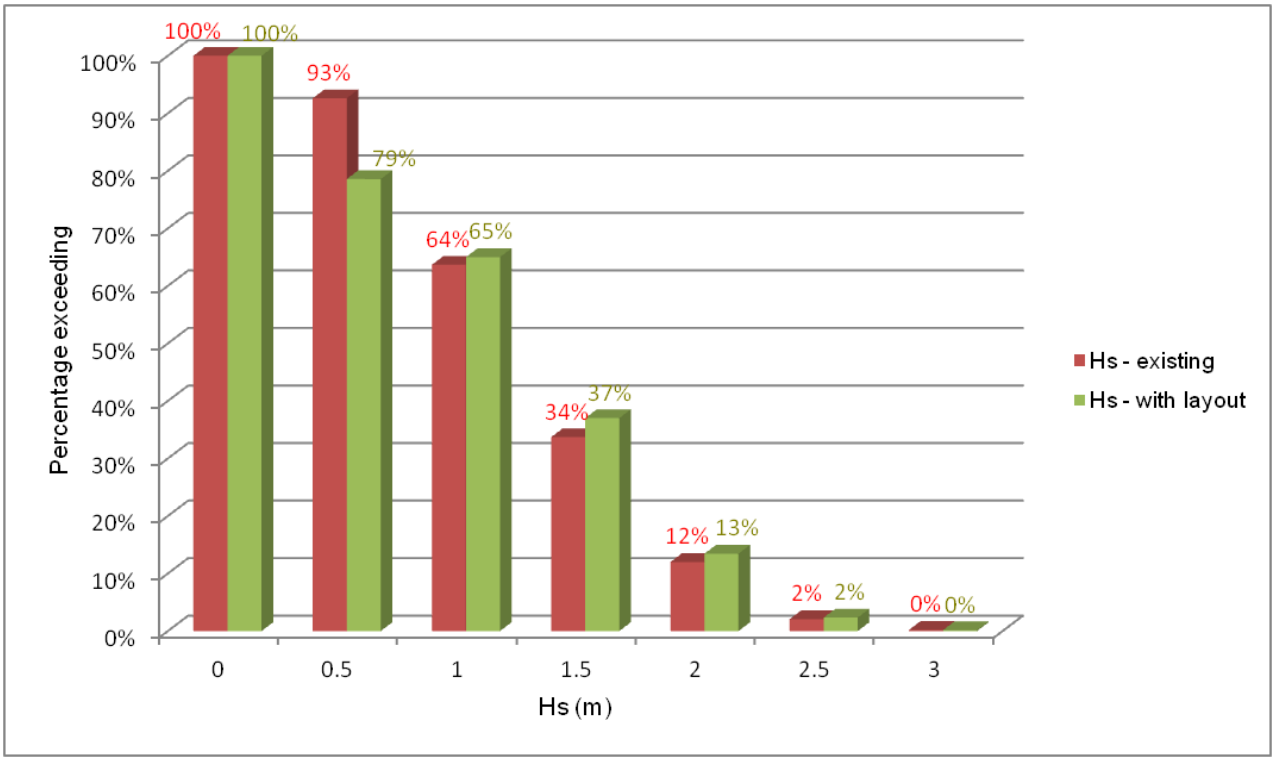


Figure 5-61: Percentage of exceedance of wave heights with and without layout at point 8

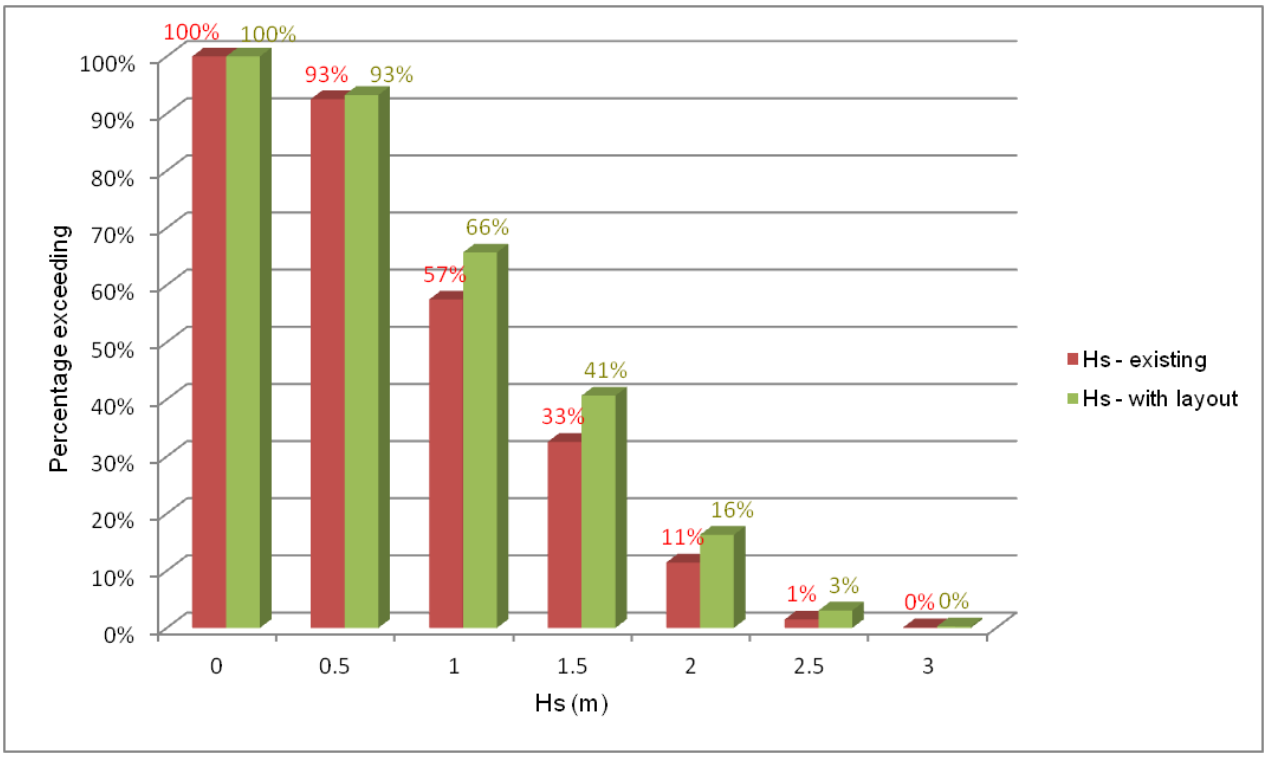


Figure 5-62: Percentage of exceedance of wave heights with and without layout at point 9

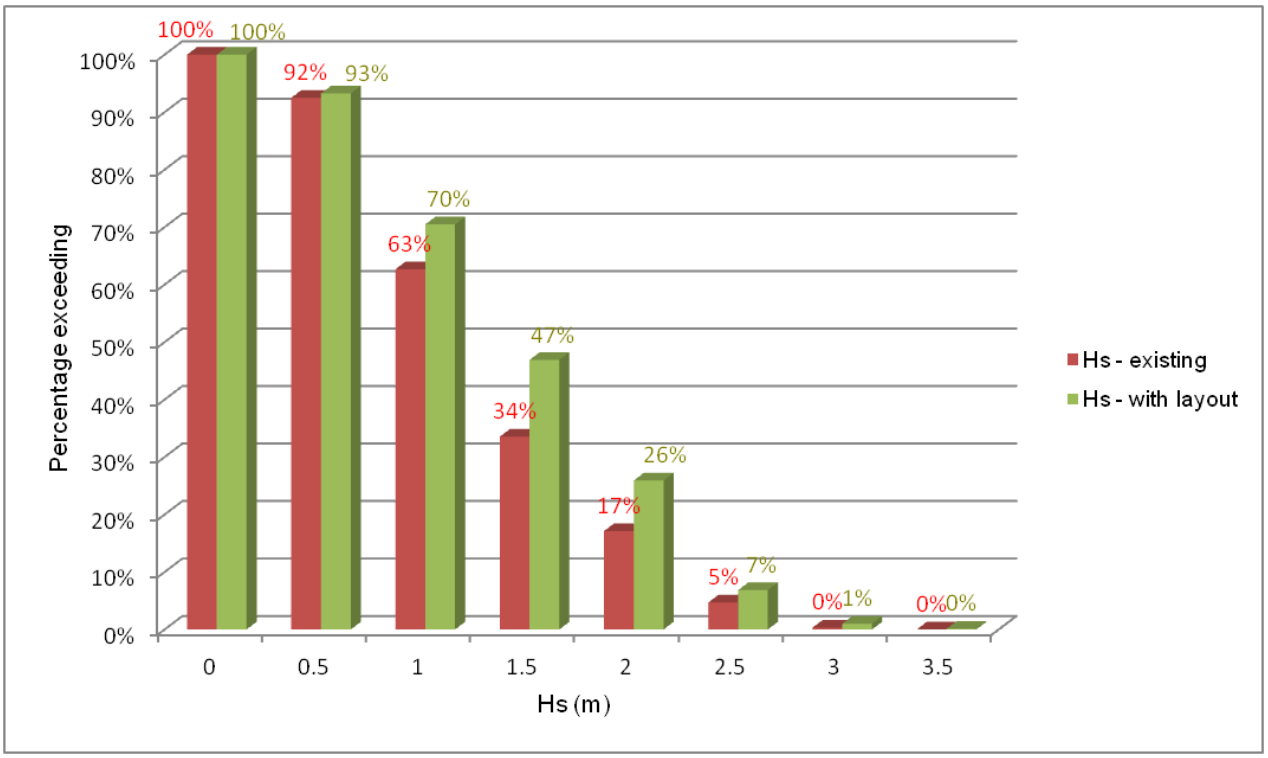


Figure 5-63: Percentage of exceedance of wave heights with and without layout at point 10

5.3.3.7 Potential impact on the bed sedimentation pattern in the Fishing Harbour

All the geotechnical bore holes in the sea bottom where the propsed port will be built showed that the surface of bottom sediments is predominantly coarse or fine grained sand intermixed with shell fragments. LTR also observed that the same sand intermixed with shell fragments is also seen along the beaches and in the fishing harbour areas. From this it can be strongly concluded the source of sediments at beaches are the sea bottom sediments. Neverthless Kerala State being an area of 3000 mm (AAR) with 41 rivers discharges sediment laden water in to the sea. The finer material of this discharge some time lead to a phenomenon called ‘mudbanks’ often the source huge quality fish especially prawans. Such formation is also due to the nutrients contain in the Mud banks suspended material in the water. In this case it may be noted that there are no major discharging rivers up to Neyyar river up to 10 km south and Karmana river at 9 km. Therefore the source of beach sands is the bottom sediments and the process happen in a cycle during monsoon and non monsoon seasons.

5.3.3.8 Impact on Marine Water Quality

Marine water quality will be impacted due to dredging and disposal and also during construction of breakwaters and cargo berths during construction phase. Direct impact of these activities on marine water quality would be an increased turbidity due to suspended sediment and will be predominant during dredging.

Turbidity due to dredging operation varies with depth and lateral distance from the dredger location. During dredging, transport of sediment depends on velocity and fine material concentration. Very fine cohesive material will remain in suspension for a long time and is independent of hydrodynamic conditions. Due to above factors, there will be an increase in turbidity due to suspended sediment in water column. Thus, it can be inferred that dredging can cause a short-term and localised impact on marine water quality.

Apart from turbidity, the marine water quality could be affected due to aqueous discharge (oily wastes, sanitary wastes, etc.) from the dredgers, barges and workboats involved in the activities.

5.3.3.9 Impact on Marine Ecology

Capital dredging and construction of approach channel, breakwaters and cargo berths will result in disturbance to marine ecology.

Turbulence – Changes in Dissolved Oxygen (DO) Levels: During dredging, oxygen-demanding compounds, nutrients and sediments from the sea bed enter into water column. Since concentrations of oxygen-demanding compounds are normally much higher in pore water than in water column it will cause a drop (depletion) in oxygen concentration. Nutrients may stimulate primary production when light and temperatures are sufficient and may cause eutrophication problems when released in favourable conditions. DO levels in bottom sediments, which are usually low would increase during dredging period. Changes in DO levels and noise are likely to result in localised and short-term impacts on marine ecology

Removal of Benthic Communities associated with Bottom Sediments: Dredging would result in removal of benthic communities associated with bottom sediments. During dredging, sessile forms are removed along with sediments and mobile species tend to move away and are likely to increase species diversity in areas adjoining dredging site. Further, it is observed that due to movement of mobile species and transfer of nutrients during dredging, there will be an increase in species diversity and density in areas adjoining dredging site.

Mitigation Measures: To mitigate impacts on marine ecology, measures such as selection of equipment and dredgers, environmental monitoring and regulating activities based on monitoring results will be adopted.

Smothering Effect Due to Settling of Sediment: Settlement of the suspended sediments can result in the smothering or blanketing of sub-tidal communities and / or adjacent inter-tidal communities. Presently, the marine biota in Indian Coast is already subjected to considerable changes in turbidity due to large-scale littoral movement, which is a recurring regular natural phenomenon. Therefore, it would be able to withstand localised turbidity induced during the dredging.

5.3.3.10 Changes in Seabed Profile

Generally construction of marine structures may alter the seabed profile. In the proposed development, marine structures include cargo berths, breakwaters etc. which in turn involve lowering of piles into the seabed. The changes in the seabed could be in terms of disturbance to the strata and localised sediment dispersion. The dispersed sediment tends to increase the turbidity of the seawater resulting in an impact on the food chain of the marine biota. The details of littoral drift and sediment transport which leads to changes in seabed profile are discussed.

5.3.3.11 Mitigation Measures

No discharge from the dredgers or work boats shall be allowed into marine waters. The dredging activity will be confined within the project site and the impact due to dredging will cease upon completion. The impact due to dredging can be minimised with the implementation of a dredge management programme.

Prior to commencement of dredging, a Drede Management Plan will be prepared and implemented, which will include the following details.

- A schedule for dredging shall be prepared and list of DO(s) and DO NOT(s) shall be circulated among the people involved in construction activities
- It is proposed to check turbidity levels with baseline turbidity levels as a reference during dredging
- Less intrusive dredging techniques shall be adopted to minimise turbidity
- It will be ensured that suitable dredging equipment is deployed to minimise the suspension of fine sediments at the dredge site
- Dredging activity will be regulated during rough sea conditions
- It will be ensured that barges/workboats have slop tanks for collection of liquid/solid waste generated on board. Discharge of wastes into sea will be prohibited.
- Spill control measures will be adopted while fuelling dredgers, barges, workboats, etc.
- Post dredging monitoring program will be carried out to assess effect of dredging and disposal on marine ecology
- Environmental Monitoring Programme comprising of monitoring of marine water quality, marine sediment quality and marine ecology will be initiated one week prior to commencement of dredging and will be carried out throughout dredging period
- Dredging and dredged material disposal will be monitored for compliance with proposed mitigation measures.

Being a tourist area, this project requires contaractors EMP that includes Dedge/ Reclamation mangement plan based on his actual implementation plan. This has to be approved by VISL or VISL and appointed consultant.

5.3.4 Potential Impact during Operation

5.3.4.1 Impact on Marine Water Quality and Ecology in Harbour Basin

Due to Aqueous Discharges: During the operation phase there will be continuous movement of cargo vessels and port crafts round the clock. There is a possibility of aqueous discharges from the cargo vessels such as dumping of ship wastes (sullage) / sewage, bilge water, solid wastes, etc. if not regulated.

Ships/vessels calling at Vizhinjam port will not be permitted to dump the wastes /bilge water during the berthing period. However, during emergency, sufficient reception facilities will be provided to receive the residues and oily mixtures generated from ship operations according to provisions of the International Convention for the Prevention of Pollution from Ships, 1973/78 (MARPOL). In addition, reception facilities for garbage, waste oil and bilge water from the ships shall also be provided. The bilge water will be collected by authorised waste recyclers and taken for further treatment.

In addition, land-based sources of pollution such as runoff from the cargo berths, waste water, sewage and effluents from the port operations would also affect the marine water and sediment qualities in the harbour basin, if disposed without proper treatment. To avoid impacts on the marine water quality it is proposed to prevent discharges from certain areas and regulate the discharges from other areas. Accordingly, storm water runoff will be directed into open concrete lined channels. The runoff from uncontaminated areas will be discharged directly into the sea. The runoff from berths and cargo storage areas will be intercepted and directed to collection ponds where the water quality will be tested and then discharged in to sea if the water quality meets the Marine water discharge standards. Only increase in oil and grease content may be expected in the water from these area. Hence, the oil and

grease content exceeds marine discharge standards (10mg/l), it will be routed through Oil- Water Separator to bring down the Oil and Grease content

Due to Cargo Spills during Handling: Spills are not anticipated to occur during normal operations, as the cargo will be handled by specialised ship-loaders/un loaders. In the event of accidental spills of cargo during transfer from / to the ships, the marine water quality, sediment quality and ecology in the harbour basin will be impacted.

Due to Oil Spills during Fuelling: Oil spills are not anticipated to occur during normal operations. In the event of accidental oil spills during fuelling of port crafts and accidental spillage of oil from ships visiting the port, the marine water quality in the harbour basin will be impacted. To minimise the impacts on marine water quality, the spills will be recovered.

5.3.4.2 Mitigation Measures

Ships visiting the port will comply with MARPOL convention and avoid discharges into the harbour basin.
To provide waste reception facilities at port in emergency, standard format of the advance notification form for waste delivery to port reception facilities and standard format for the waste delivery receipt following a ship's use of port reception facilities as recommended by Marine Environment Protection Committee, IMO will be maintained.
Collection ponds will be provided for containment/treatment of runoff from cargo storage areas and other areas liable for oil & grease pollution. When the oil and grease content exceeds marine discharge standards (10mg/l), it will be routed through Oil- Water Separator to bring down the Oil and Grease content.
It will be ensured that the dumping of the maintenance dredge spoil would be uniform.
Along with the operational phase environmental monitoring, an additional Environmental Monitoring Programme comprising of monitoring of marine water quality, marine sediment quality and marine ecology will be initiated one week prior to commencement of maintenance dredging and will be carried out during the dredging period.
In case of any cargo spillage during transfer from/to ships, it will be attempted to recover the spill
Oil spill control equipment such as booms / barriers will be provided for containment and skimmers will be provided for recovery.
As the accidental spills will be in harboured waters, it would not spread spatially and the response time for shutting down the fuelling, containment and recovery will be quicker.

5.4 Biological Environment (Terrestrial and Marine Ecology)

5.4.1 Potential Impact Due to Port Location

5.4.1.1 Impact on Mangroves and other sensitive Ecosystems

Land area for the proposed VISL port is predominantly reclaimed land. The portion of available land does not have any mangroves. Hence, proposed port development will not have any impacts on mangroves.

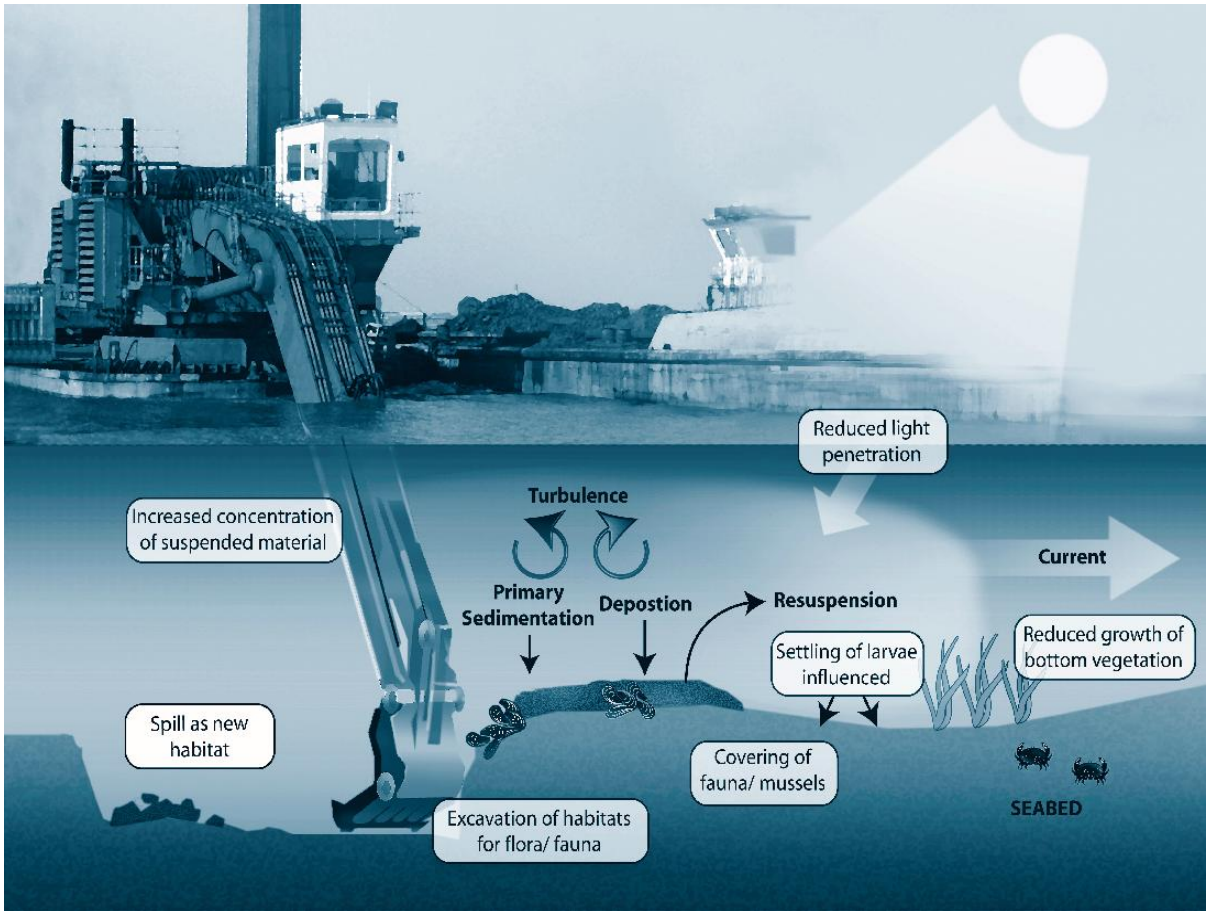
The International transhipment route is 10 nautical mile away. There is no wadge bank or any sensitive marine ecosystems in this 10 nautical mile stretch. Therefore there will not be any impact to wadge bank (located 40 km away) due to the construction and operation of the Vizhinjam deep water

port. Once Vizhinjam port traffic enters in to international transhipment route it is an existing traffic roué.

5.4.2 Potential Impact Due to Construction

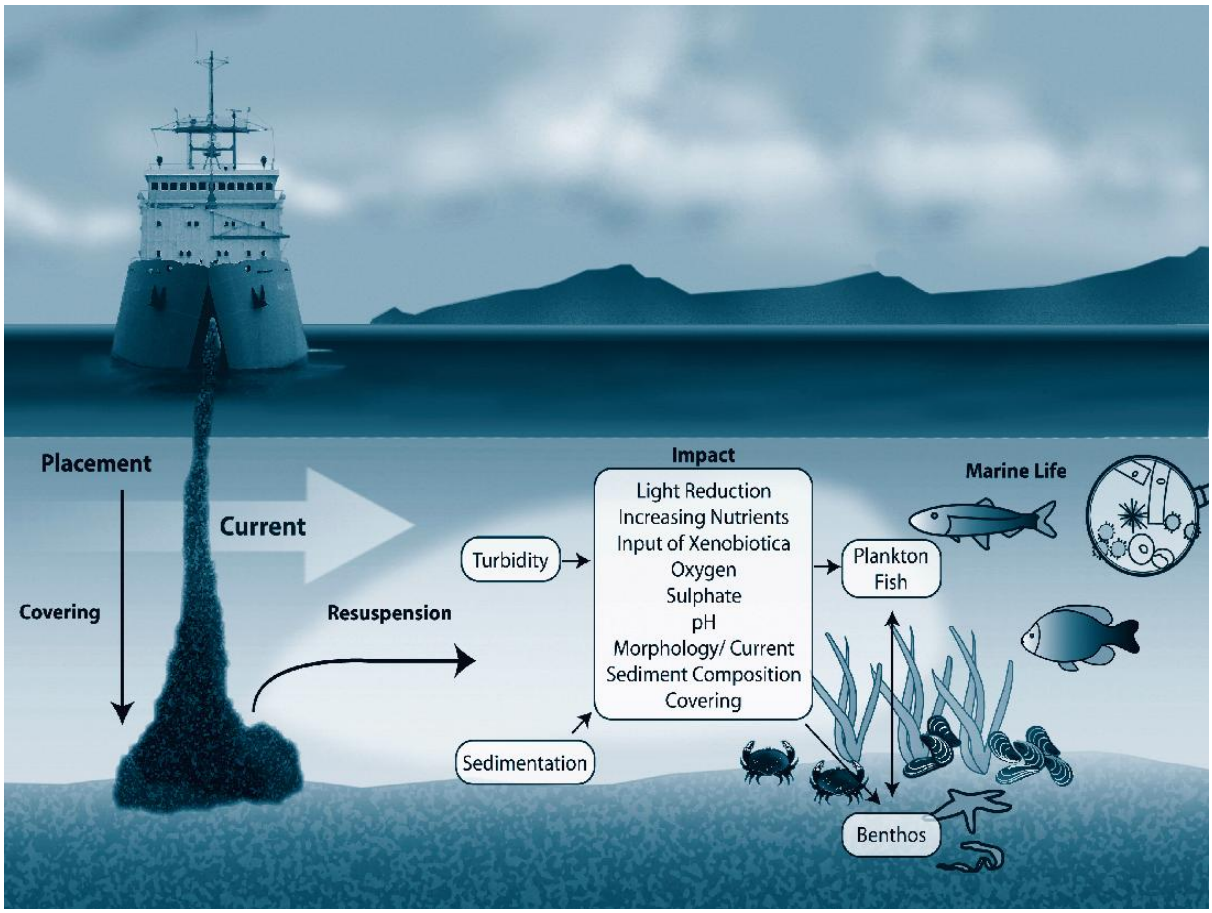
5.4.2.1 Impact due to Capital Dredging and Disposal

Capital dredging is required to create inner navigation channel, outer navigation channel, turning circle and berthing areas which may cause temporary disturbance to biological environment. Dredging removes bottom biota and dumping of dredged material covers bottom habitat. Piles, rubble mounds and concrete surfaces will form new habitat. During the construction phase there will be impact on fashinmg activity/ fisharies in the project region



(Source: Axel and Christine, Terra et Aqua, No. 114, March 2009)

Figure 5-64: Impacts due to Dredging



(Source: Axel and Christine, Terra et Aqua, No. 114, March 2009)

Figure 5-65: Impacts due to Dredged Material Disposal or Reclamation Identification of Dredge Material Disposal Site

5.4.2.2 Mitigation Measures

- Appropriate selection of equipment for pile driving and dredging
- Providing silr scrrens to avoid movement suspended solid for a longer distance
- Uniform disposal of dredged material at identified disposal location
- A well planned mplementation programme based on contractors dredge management plan

5.4.2.3 Impact on Ecology due to Reclamation

The proposed port is to be developed on reclaimed land. Around 66.00 Ha of land is planned to reclaim for port operation. For this area reclamation, about 6.9 MCM dredge material is being used. To meet 6.9 MCM materials it is envisaged to dredge 7.6 MCM. Whereas from port design, approximately 5.04 MCM dredge material will be getting. Hence additional 2.56 MCM will be dredged additionally in approach channel.

5.4.2.4 Mitigation Measures during Reclamation

While reclaiming the area, bunds will be provided with a suitable overflow facilities so that only clear water will be returned to the sea. Ecology in the vicinity of the port is not anticipated to be disturbed during reclamation. The Chapter 10 EMP provides the detailed methodology of actual implementation of dredging and reclamation (Dredge & reclamation Management Plan) without impacting the nearby waters.

5.4.2.5 Road & Rail connectivity

This is one of the most important impacts due to construction and operation of the road/rail connectivity to the Vizhinjam port. Both for the road as well as the rail alignments the entire alignment is new causing potential impacts to flora of the region. The entire impacts is portrayed in the environmental strip plans prepared for both road and rail connectivity as provided in **Appendix 5.1** and **Appendix 5.2** respectively. Most of these strip plans were prepared by using high resolution Google imagery available for the both alignment supplemented by other data available from various sources coupled with ground truth verifications. The entire land use along the alignment will be converted to Transportation land.

5.4.2.6 Impacts and Avoidance Measures

5.4.2.6.1 During Construction Phase

***Flora and Fauna*:** During the construction stage due to the felling of trees, noise and smoke from the construction activities shall force the native animals and birds to migrate from the place.

Forest Area: No forest area or forest land has been identified along the proposed road and rail alignment. Therefore no such impacts are anticipated.

Tree Cutting: The proposed road and railway alignment are new links, in such cases trees along the corridor need to be felled and agricultural land will be converted in to transportation land. However the road and railway alignment constructions are limited within the proposed Right of way. Details of the trees impacted are given in the **Table 5-15**.

Table 5-15: Biological Impact Potential of Road and Rail Alignment

S. No.	Road Alignment			Rail Alignment			Growth of the Trees along Proposed Road/Rail Corridors
	Impacted Trees	Total Nos.	Area in Hectares	Impacted Trees	Total Nos.	Area in Hectares	
1	Coconut trees	1062	3.44	Coconut trees	6898	27.59	Fully grown and yielding
2	Plantain (Indigenous banana)	7140	2.55	Plantain (Indigenous banana)	13356	4.77	Seasonal Two times a year
3	Tapioca crop	1140	0.57	Tapioca crop	4600	2.30	Seasonal two times a year
4	Paddy	-	1.05	Paddy	-	9.63	Two times a year
5	Other trees Mango, Jack fruit, Tamarind,	100	0.50	Other trees Mango, Jack fruit, Tamarind,	1000	3.00	Perennial crop
		Total	**8.11**		**Total**	**47.29**	

Cattle Grazing: There are no cattle grazing along the proposed road and rail alignment. Therefore no impacts are anticipated.

Wild Life: No Wild life is observed along the proposed road and rail alignment.

5.4.2.7 Mitigation and Enhancement Measures

5.4.2.7.1 During Construction Phase

A tree plantation along the Right of way is one of the important planned mitigation measures. Uprooting the big trees and planting the trees in the suitable place is also one of the options. Proper care should be taken during construction to avoid contaminated runoff in to the nearby agricultural land or coconut farms.

A **comprehensive tree plantation plan** covering all phases (preconstruction, construction and operation) of the project needs to be prepared by Environmental Management Unit of Vizhinjam port. Preliminary discussions have been carried out with concerned officials of the Forest department (Ref: ***Ms. Shobana K. S. Rao, CCF***, ***Special aforestation & Nodal officer and special officer for Sabarimala***). As a part of totall loss of green cover VISL is commited to plan about 25 Ha based on the foot print impact of Vegetaion cover along the acquired land. The discussion includes tree cutting, tree plantation schemes, available nurseries, cost of transportation and planting scheme and timings. The EMP unit of Vizhinjam port need to prepare an operational EMP(this is not part Contractors EMP as it is not part of Civil construction contract) covering all elements of compensatory and enhancement tree plantation programme. In addition the land owners have been compensated from the loss of income from these plants considering the income from plants. For example, 200 coconuts from a fully grown tree per year will be compensated for the next 15 years or so. These people are also expected to plant an equal number of trees (not double) in their new rehabilitated area wherever they are rehabilitated depending up on the area available. But the horticultural crop loss is hardly compensated due to the prevailing socio economic conditions.

In order to cut the high beam light from opposite vehicles on the other side of the median a creeper planting scheme has been proposed to address the biodiversity issues. This project will try planting creepers along the median with the use of two parallel metallic wire fencing separated by 0.5 m (**Exhibit 5-7** and **Exhibit 5-8**). Alternatively barbed wire fencing roles with 0.5 m diameter can be used for growing creepers. These plants shown are representative and the actual species selection needs to carry out with care. For example plants shall not be vegetable (e.g. Kovakka) or it shall not be fruit bearing like grape. The selected creeper species shall be unpalatable and flowering in nature. This has been planned to showcase the cause of biodiversity issues that even forest department neglect. In the name of forest fires all over the world, creepers are being systematically destroyed especially those that have no direct economic value. People in their gardens are selectively felling and destroying all such creeper plants. In Kerala State traditionally sacred groves (mini or micro forest especially by the Nair communities in Kerala) which always include creepers are also being slowly eliminated over a period of time. The project will also protect and enhance the quality of one sacred grove located along the project road (Chainage km 1.800) and also one along the railway line. These protective measures will be documented for future use and showcase the activity planned and implemented by VISL.



Exhibit 5-7: Sample Fencing for Creeper Planting



Exhibit 5-8: Sample Creeper Planting for Median

In addition to this both road and railway connectivity will have a strip plantation to prevent induced developments. While the plants for 2.0 km long road will have very selective flowering plants the rail alignment will be planted with plants which are always discarded by public because of very low economic value. This is also to show case the Biodiversity for this international port Infrastructure project. There will be a 10 m multipurpose strip plantation on both sides of the rail way alignment. The growth of the trees shall not create large scale canopy with suitable spacing to the neighbouring agricultural areas. Extreme ends on the 45.00 m wide RoW can be protected with barbed wire fencing on both sides with all required access for the building and properties intact.

In addition to the median flowering creepers, the trees on either side of the project road also need to be flowering on account of the Cruise terminal facility. The recommended trees for this strip planting are an inner layer of Kanni konna ie Cassia Fistula (yellow flower in April) a middle layer of Alary (Red flower in May-June) and outer layer of Ashoka. The outer layer Ashoka is necessary to avoid large scale canopy to the neighbouring agricultural areas. All these things together form a 10 m wide strip plantation on either side of the road. With barbed wire fencing on outer part of the road all ribbon developments can be avoided. This is also an effective green barrier for noise attenuation.

All specific details for contracting and operational purpose can be included in the Operational Environmental Management Plan (EMP) to be prepared by the Vizhinjam port EMP Cell. Preparation of Operational EMP and Contractors EMP shall be complted just prior to construction phase when the EPC Contractor is appointed and preliminary discussions are completed. In the case of rail alignment also except the median planting the 10 m strip plantation on either side can be developed with the same tree species described for road section.

5.4.3 Potential Impact Due to Port Operation

5.4.3.1 Impact due to Aqueous Discharges and Mitigation Measures

During the operation phase there will be movement of cargo vessels and port crafts round the clock. There is a possibility of aqueous discharges from the cargo vessels such as dumping of ship wastes (sullage)/sewage, bilge water, solid wastes, etc. if not regulated. It will affect on marine life & production due to mixing of oil & grease, heavy metal, Pesticide, nutrients in sea.

5.4.3.2 Mitigation Measures

Sewage/ effluent coming out from port premises and surrounding areas and joining the should be treated and treated water will be discharged into sea after meeting the discharge norms of MoEF.

5.4.3.3 Potential Impact due to Cargo Operations

Due to Cargo Spills during Handling: Spills are not envisaged to occur during normal operations, as the cargo will be handled by specialised loaders/unloaders, mutli purpose cranes, etc. In the event of accidental spills of cargo during transfer from/to the ships, the marine water quality, sediment quality and ecology in the harbour basin can be impacted.

5.4.3.4 Mitigation Measures

Spill contingency plan as a part of Disaster Management Plan will be prepared in accordance to the cargo to be handled Spill recovery/immediate response measures will be displayed at cargo handling areas, Material Safety Data Sheet (MSDS) of cargo (if applicable) being handled will be displayed. Mock drills will be conducted at periodic intervals

5.4.3.5 During Operation Phase of road& rail corridor

During operational phase, no potential floral and faunal impacts are anticipated for both road and rail alignment. Maintenance of tree plantation including the compensatory plantation of 10,000 trees is the main activity for the first five years of operational phase of the project. VISL will plant the trees in consultation with the forest department in degraded forest area as recommended by the forest department. The EMP cell of the Vizhinjam port need to document all such planting, maintenance and survived plants/trees.

- Proper maintenance of the sapling planted along the RoW
- Frequent examination of the sapling survival
- Watering of the sapling in regular interval

Impacts to domestic and stray animals like dogs is also largely mitigated by the raised median and proposed creeper planting as discussed above. This structure will remain as a barrier for their fast movements

5.5 Air Environment

5.5.1 Potential Impact during Construction

5.5.1.1 Impact due to Transportation of Construction and Cargo Material

Some of the project activities (site clearance, dredging and reclamation, construction of breakwaters, construction of port infrastructure, traffic during construction and use of heavy machinery construction of road and rail) will generate air pollutants like NO_2, SO_2, HC, CO, PM, VOCs, etc. This has the potential to cause temporary impacts on the air quality.

The baseline concentrations of Particulate Matter (PM_{10} and $PM_{2.5}$), SO_2, NO_2 and CO are within the limits of NAAQS stipulated by MoEF/CPCB. With the present background concentrations of air quality

parameters, it is expected that there will only be a mild build-up of air pollutants. Further, because of the prevailing strong winds along the coastal region and the resulting dispersion the impact on air quality from pollutants would be reduced. Towards land ward side all is green with complete coverage of coconut and other trees (green barrier) will also nullify any air pollution impacts. In addition, adoption of suitable mitigation measures will ensure that these impacts are rendered insignificant

The following activities may cause air pollution during construction phase

- Material sourcing at Quarry
- Material transport
- Equipment transport
- Stone crushing operations in the crushers;
- Handling and storage of construction material;
- Concrete batching plants;
- Asphalt mix plants due to mixing of aggregates with bitumen; and
- Construction and allied activities.

5.5.1.1.1 Mitigation Measures

The following measures could mitigate the anticipated negative impacts on the ambient air quality

- To reduce the impact on air quality, quarry material is planned to transport from respective quarries from nearby harbous to vizhinjam harbour. This material transportation through sea will reduce dust as well gaseous emissions drastically. Material transport route from quarry to vizhinjam is shown in chapter 4.
- Transportation vehicles to be properly and timely maintained and serviced regularly to control the emission of air pollutants in order to maintain the emissions of NO_X and SO_X within the limits established by international regulations;
- All static and mobile diesel-powered plant / generator sets should be used only during power cuts;
- Use of good quality fuel and lubricants will be promoted. Moreover, low sulphur content diesel shall be used as fuel for generator sets to control emission of SO_2;
- Generators, machineries and vehicles are to be serviced and maintained regularly to avoid generation of dust and other air pollutants;
- Regular verification of Pollution Under Control (PUC) certificates of all the vehicles entering into the port area;
- Vehicles older than 15 years will not allowed to operate during construction phase
- Storage facilities shall be equipped with leak detection systems.
- Include vegetation screens alongside the port access roads and apply of speed restrictions in order to the dispersion of pollutants from roads
- Minimize idling time for vehicles
- Water sprinkling will be carried out to suppress fugitive dust during earthworks and along unpaved sections of access roads.
- Environmental awareness program/training will be organised to the personnel involved in developmental works
- Adequately sized construction yard will be provided at the site for storage of construction materials, equipment tools, earthmoving equipment, etc. In addition, temporary field offices and worker amenities will be provided at site. Appropriate spill control measures and labelling / handling procedures will be maintained.

5.5.1.2 Impact due to Quarrying

Quarrying needs blasting, drilling, digging, road transport, use of heavy machinery for hauling and loading, storage and handling of fuels, etc. This will generate dust and other air pollutants like NO_2, SO_2, HC, CO, PM. This will affect the ambient air quality. It will be contractor's choice to choose the quarry site but avoiding nuisance for the public is required. Prior to commencing the works the contractor should establish the environmental baseline conditions in the specific area around the selected quarry. Monitoring right from the beginning of the production should indicate whether standards are exceeded and early action is required.

Kadavila Quarry: This quarry site is surrounded by human settlements within 500 m distance. On the way to the Muthalapozhy harbor from the quarry site, from where the quarry is proposed to be transported to the Project site through barges, human settlements are evident.

Theviyodu Quarry: Only few mud houses of workers/labours working in the quarry are present near the quarry area. There is no residential area established in the immediate vicinity of the quarry site.

Of the two mentioned quarries the proximity of the human settlements should be taken in consideration regarding air (among others) impacts.

Particulate Matter (PM), including respirable suspended particulate matter (RSPM) is generated during all phases of exploitation and processing from fugitive sources (e.g. shovelling, drilling, blasting, transport, crushing, or stockpiling). The main sources of PM emissions include crushing–grinding, drilling, blasting, and transport. Impacts from PM emissions are related to its size (e.g. whether it is less than 2.5 microns in diameter), its main components (e.g. silica, silicates, carbonates), as well as to rock impurities and trace components. During the quarrying activities it is expected that PM will be generated constantly and hence potentially impact the local air quality. Climatologic circumstances such as wind will determine the dispersion patterns. Rock impurities and components need to be checked and monitored by the contractor.

Furthermore, the ambient air quality is affected by the combustion by-products that are emitted by vehicles and other combustion sources installed in the quarrying sites. Toxic and nontoxic gases are normal by-products generated by blasting activities, regardless of the explosive materials used.

5.5.1.2.1 Mitigation Measures

Management of air quality at quarry site is important at all stages of the quarry cycle. The following measures are proposed:

- Blasting for quarrying shall only be carried out during calm wind conditions;
- A good blasting practice (like optimal blasting hole, suitable blasting methods) shall be adopted;
- Automated sprinkler system to be installed at quarry site to minimise the dust emissions;
- Quarry and construction materials shall be covered with sheets/enclosed during transportation and storage to avoid dust generation;
- Dust suppression techniques (e.g. wetting down, use of all-weather surfaces, use of agglomeration additives) for roads and work areas, optimisation of traffic patterns, and reduction of travel speeds;
- Exposed soils and other erodible materials should be re-vegetated or covered promptly;
- New areas should be cleared and opened-up only when absolutely necessary;
- Loading, transfer, and discharge of materials should take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems;

- Hardened roads should be laid in the area to avoid dust generation due to vehicular movement;
- Solid wood barriers or wind screen fabric should be used around the perimeter of construction site to avoid impact on neighbouring communities due to dust generated from construction activities;
- Dust suppression techniques (e.g. wetting down, use of agglomeration additives) for roads and work areas should be applied;
- Good maintenance of vehicles and equipment according to a periodical repair/revision programme;
- Use of good quality fuel and lubricants;
- Daily cleaning of access ways in the neighbourhood of work sites (removal of earth and sand) to prevent dust;
- Collection and temporary storage of sanitary and cleaning wastes, as well as garbage, in containers;
- Only Vehicles having Government license and Pollution Under Control (PUC) certificate for transportation of construction and quarry materials should be used;
- Older than 15 year vehicles wll not be allowed to operate
- Transportation vehicles shall be properly and timely maintained and serviced regularly to control the emission of air pollutants in order to maintain the emissions of NOx and SOx within the limits established by international regulations;
- Energy conservation measures can enhance efficient energy consumption patterns and consequently affect the GHG emissions impacts in a positive manner.

5.5.1.3 Impact due to Road/Rail Corridor Development

Due to the small nature of the road (less than 2.0 km) and rail (15.0 km) project, there will be some air quality impacts along the project corridor. Construction stage impacts will be of short term but have adverse impacts on the construction workers as well as the settlements adjacent to the road and rail alignment, especially those in the down wind direction.

5.5.1.4 ***Dust Generation****:* Generation of dust is the most likely impact during this stage due to:

- Site clearance and use of heavy vehicles and machinery, etc.
- Procurement and transport of raw materials and quarries to construction sites
- Dust/ air pollution is likely to be generated due to the various construction activities including:
  - Stone crushing operations in the crushers
  - Handling and storage of aggregates in the asphalt plants
  - Concrete batching plants
  - Asphalt mix plants due to mixing of aggregates with bitumen; and
  - Construction and allied activities

Generation of dust is generally a critical issue in road /rail projects and is likely to have adverse impact on health of workers in quarries, borrow areas and stone crushing units. Normally all these could be located away from the alignment. This is a direct adverse impact, which will last almost throughout the construction period. The Environmental Action Plan (contract documents) to be prepared by VISL should lay emphasis on enforcement of measures such as provision of pollution masks, regular sprinkling of water to suppress dust along haul roads at quarries, crushers and borrow areas to mitigate this impact.

Exhaust gases Generation: Generation of exhaust gases is likely during the preconstruction stage during movement of heavy machinery, oil tankers, etc. This impact is envisaged to be insignificant during the preconstruction stage.

High levels of SO_2, HCs are likely from hot mix plant operations. Volatile toxic gases are released through the heating process during bitumen production. Although the impact is much localised, it can spread downwind depending on the wind speeds. The Environment Management Action Plan (EMAP) needs to ensure adequate measures especially for health and safety of workers such as providing them with pollution masks during working hours. Also, the contractor will be ensured that hot mix plants, stockyards, etc. are away from residential areas and residential quarters of all workers. Contractors also should be asked to provide regularly Pollution under Control (PUC) Certificate for their vehicle mounted equipments and machinery as per prevalent norms. If adequate measures are taken, then impacts from generated gases can be negligible.

5.5.1.4.1 Mitigation Measures

Dust Generation: If adequate measures such as sprinkling of water on haul roads around sites where clearance activities are on, covering material trucks especially those carrying sand and borrow materials etc, then the impacts can be reduced to a great extent. The main source of dust generation is due to site clearance activities, removal of trees and loading/unloading of construction material. To mitigate the dust generation, following suitable mitigation measures shall be applied:

- Sprinkling of water shall be carried out at construction sites
- Asphalt plants, crushers will be sited at least 1.0 km in the down wind direction of human settlement and other sensitive receptors along the project corridor
- During and after compaction of the sub grade/sub base water will be sprayed at regular interval in order to avoid fugitive dust generation
- Vehicles carrying fine and coarse aggregate should be covered with tarpaulin in order to avoid the spills on the existing road.

Exhaust Gas Generation: Emissions are anticipated from construction plants, vehicles, etc. So in order to mitigate the exhaust gases, all the vehicles should be warranted with PUC Certificate proper maintenance of the vehicles shall be followed.

5.5.2 Potential Impact due to Operation

Operation of the port (container terminal, multi-purpose cargo, cruise) does not include bulk or uncovered materials exported from or imported to the terminal or stored on site.

The sources of air pollutants from port operations include combustion emissions from ships' propulsion and auxiliary engines and boilers, mainly consisting of sulphur dioxide (SO_2), nitrogen oxides (NO_X), greenhouse gases (e.g. carbon dioxide [CO_2] and carbon monoxide [CO]), fine particulate matter [PM], and volatile organic compounds [VOC]), followed by combustion source emissions from vehicles, port equipment and land-based engines and boilers contributing similar pollutants. Volatile organic compounds (VOC) may also be emitted fuel storage and transfer.

However increased traffic on the access road has the potential to cause an impact on the air quality experienced by the residents along the access road; specifically an increase in pollutants such as oxides of nitrogen and particulates. Concentrations of primary pollutants generated by road traffic decrease exponentially with increasing distance from the road. This means that 50 m from the road centre the concentrations of carbon monoxide, oxides of nitrogen, particulates and non-methane hydrocarbons (benzene and related compounds) are considerably less than half the levels at the central median.

5.5.2.1.1 Mitigation Measures

Operation of the port (container terminal, multi-purpose cargo, cruise) itself is not anticipated to result in any significant air quality impacts.

The following measures could mitigate the anticipated negative impacts on the ambient air quality during O&M phase

- Project will implement **"Cold ironing"** to reduce pollution and also to reduce the diesel generated power consumption from the ship. Cold Ironing is basically using electrical supply from the port main to the ship for all purposes for the entire period of stay in the Vizhinjam port.
- Similarly most of the Cranes in the port will also use electric power.
- Transportation vehicles to be properly and timely maintained and serviced regularly to control the emission of air pollutants in order to maintain the emissions of PM, CO, NOx and SOx within the limits established by international regulations.
- All static and mobile diesel-powered plant / generator sets to be used only during power cut;
- Use of good quality fuel and lubricants to be promoted. Moreover, low sulphur content diesel to be used as fuel for generator sets to control emission of SO_2.
- Generators, machineries and vehicles are to be serviced and maintained regularly to avoid generation of dust and other air pollutants.
- Regular verification of Pollution under Control (PUC) certificates of all the vehicles entering into the port area.
- Prohibition of use of more than 15 Year old vehicles for construction and operational phase
- Use of electric cars inside the port area for all transport requirements
- Developing air quality management procedures for ship operators, such as navigation of port access areas at partial power, achieving full power only after leaving the port area, limiting the practice of blowing soot from tubes or flues on steam boilers.
- Include vegetation screens alongside the port access roads and apply of speed restrictions in order to the dispersion of pollutants from roads.
- If the annual nitrogen dioxide concentrations (expected outcome of the air quality modelling) exceed internationally accepted standards for protection of human health port operator have to consider resettlement of the residents living adjacent to the port access road.
- Although entire land area of port side is a green belt wherever possible thick greenbelt in port and its associated facilities will be provided.

5.5.2.2 Impact due to Ship Emissions

During the operational phase, there will be an increase in the movement of traffic and hence, emissions from the moving vehicles will also increase. The exhaust from the DG set at the port, the tugs, launches, diesel operated small boats, dredgers etc will enhance a pollution load during operational phase. With the increase in the number of ships and boats, their operation and movement of cargo to and fro will also increase. These activities will increase the pollution load in the atmosphere.

The Annex VI of MARPOL Convention deals with the "*Regulations for the Prevention of Air Pollution from Ships".* It sets limits on NOx and SOx emissions from ship exhausts, and prohibits deliberate emissions of ozone depleting substances. It also prohibits the incineration on board ships of certain products, such as contaminated packaging materials and polychlorinated biphenyls (PCBs). The vessels are required to comply with the regulations and should have the "*International Air Pollution Prevention Certificate*". Vizhinjam port will take all appropriate measures to comply exhaust emission from vessels in accordance with MARPOL regulations and Euro Emission standard norms so as to reduce pollution load in the air environment.

5.5.2.2.1 Mitigation Measures

- Ambient air quality monitoring will be carried out regularly at selected locations in the predicted maximum impact zone in order to check and compare the predicted concentrations with the measured concentrations.
- Although Natural green belt exist, the Greenbelt of adequate width will be developed in all possible areas including Cargo storage areas and long the boundary of expansion project area to minimise the likely impacts due to air pollution.

5.5.2.3 Impact due to Cargo Handling and Storage

Since its a container terminal, and no dust cargo will be handled at port, no significant direct impact on air quality is anticipated while handling and storage. Storage and handling of dry bulk cargo, as well as from onshore operation activities and vehicle traffic on unpaved roads, may also contribute to particulate matter emissions.

5.5.2.3.1 Mitigation Measures

- All static and mobile diesel-powered plant / generator sets to be used only during power cut;
- Regular verification of Pollution Under Control (PUC) certificates of all the vehicles entering into the port area
- Project will implement “Cold ironing” to reduce pollution and also to reduce power consumption
- Similarly most of the Cranes in the port will also use electric power.
- Prohibition of use of more than 15 Year old vehicles for construction and operational phase
- Use of electric cars inside the port area for all transport requirements

5.5.2.4 Impact due to Road/Rail Corridor Development

This will not be as severe; as the construction stage impacts will be confined to receptors close to the road and rail. Both the construction and operation stage impacts can be effectively mitigated if the impacts have been assessed with reasonable accuracy in the design stage itself.

Dust Generation: The negative impacts on air quality during operation stage shall not be significant as that of construction stage. This is due to the reduction of dust particles. No dust generation is envisaged during the operation stage as the entire road shoulders are proposed to be paved or compacted and all slopes and embankments shall be turned as per best engineering practices. During the operation of rail there is no dust generation expected. The air quality shall also improve due to the plantation activity carried out in the RoW during the end of construction phase.

Exhaust Gases Generation: The major impact on air quality will be due to plying of vehicles. The impacts on air quality at any given time depend upon traffic volume/rate of vehicular emission within a given stretch and prevailing meteorological conditions. Air pollution impacts arise from two sources: **(i) inadequate vehicle maintenance**; and **(ii) use of adulterated fuel in vehicles**. Enforcement standards to meet better vehicle performance in emissions and the improvement of fuel constituents can assist in improving regional air quality.

In this ESIA report Modified “***Gaussian Plume model for line source****”* is used for calculating the dispersion of emission from the transportation of cargoes through proposed road connectivity. For modelling always worst case scenarios are taken in to consideration so that it can cover all other scenarios with lesser effect.

In this calculation it is assumed that emission is continuous and unlimited, direction of the wind is perpendicular to the road and considering worst case scenario of very stable condition (Pasquill stability class = A)

General Finite Line Source Model (GFLS) for Vehicular Pollution Prediction.

$$C\ (X,Y,Z) = \frac{Q}{2\sqrt{(2\pi)}\sigma z(USin\theta+U_o)}\left(E^{\frac{-(Z-H)^2}{2\sigma z^2}}\right)+\left(E^{\frac{-(Z+H)^2}{2\sigma z^2}}\right)Erf$$

$$\left(\frac{Sin\theta\left(\frac{L}{2}-Y\right)-XCos\theta}{\sqrt{2\pi}\,\sigma y}\right)+Erf\left(\frac{Sin\theta\left(\frac{L}{2}+Y\right)+XCos\theta}{\sqrt{2\pi}\,\sigma y}\right)$$

Where Q = Mass Emission rate (g/s)
U = mean wind speed (m/s)
U_0= Wind Correction factor
Z= Height of the receptor relative to the ground
L= length of the line source
H = effective stack height (m)
Θ = Angle between wind and Surface of the line source
σy = Cross wind dispersion coefficient = X /(A + B SinΘ)
σz =vertical dispersion coefficient = (a + b X /Sin) c
Erf= Error function

Table 5-16: Vehicular Emission Rate

Attributes	Vehicular Emission Rate (g/km)	
	Heavy Vehicle	Light Vehicle
PM	1.24	0.30
NO_2	9.30	6.53
SO_2	0.14	0.09
CO	6.00	3.92

Table 5-17: Cumulative Emission (g/sec) Calculation

Attributes	Total Number of Vehicles = 2000/Day		Total Emission (g/m/s)
	Heavy Vehicle (80%)	Light vehicle (20%)	
Number of Vehicles	**1600**	**400**	**2000**
PM	2.2963E-05	1.38889E-06	2.43519E-05
NO_2	0.000172222	3.02315E-05	0.000202454
SO_2	2.59259E-06	4.16667E-07	3.00926E-06
CO	0.000111111	1.81481E-05	0.000129259

Table 5-18: Calculation of Vertical Dispersion Coefficient

Receptor Location (X, in m)	GM Model for class A			σz (m)	σy (m)
	a	b	c		
100	1.14	0.03	1.33	8.55	129.37
200	1.14	0.03	1.33	18.32	258.73
300	1.14	0.03	1.33	29.64	388.10
400	1.14	0.03	1.33	42.17	517.46
500	1.14	0.03	1.33	55.71	646.83

Receptor Location (X, in m)	GM Model for class A			σz (m)	σy (m)
	a	b	c		
600	1.14	0.03	1.33	70.12	776.20
700	1.14	0.03	1.33	85.31	905.56
800	1.14	0.03	1.33	101.21	1034.93
900	1.14	0.03	1.33	117.76	1164.29
1000	1.14	0.03	1.33	134.90	1293.66
2000	1.14	0.03	1.33	332.72	2587.32
3000	1.14	0.03	1.33	566.88	3880.98
4000	1.14	0.03	1.33	828.44	5174.64
5000	1.14	0.03	1.33	1112.52	6468.31
6000	1.14	0.03	1.33	1415.97	7761.97
7000	1.14	0.03	1.33	1736.57	9055.63
8000	1.14	0.03	1.33	2072.62	10349.30
9000	1.14	0.03	1.33	2422.80	11642.90
10000	1.14	0.03	1.33	2786.04	12936.60
15000	1.14	0.03	1.33	4771.16	19404.90
20000	1.14	0.03	1.33	6990.53	25873.20

Table 5-19: Estimated Concentration Level for Different Receptor Locations - General Finite Line Source (GFLS) Model by Luhar and Patil

S. No.	Receptor Location	Particulate Matter	NO_x	SO_2	CO
	(m)	($\mu g/m^3$)			
1.	100	4.62	38.37	0.57	0.02
2.	200	1.10	9.17	0.14	0.01
3.	300	0.47	3.80	0.06	0.002
4.	400	0.24	2.01	0.03	0.001
5.	500	0.15	1.22	0.02	BDL
6.	600	0.09	0.81	0.02	
7.	700	0.07	0.57	0.01	
8.	800	0.05	0.42	BDL	
9.	900	0.04	0.32		
10.	1000	0.03	0.26		
11.	2000	0.02	0.05		
12.	3000	BDL*	0.02		
13.	4000		0.01		
14.	5000		BDL		
15.	6000				
16.	7000				
17.	8000				
18.	9000				
19.	10000				
20.	15000				
21.	20000				

*Where BDL is Below Detectable Level

Observation: From the **Table 5-19**, estimated concentration levels are found to be well within the National Ambient Air Quality Standards (NAAQS). It can be concluded that there is no significant increase over the baseline levels. Downwash and barriers are not considered for computations in practice, the actual concentrations are likely to be lower than indicated.

5.5.2.4.1 Air quality - Mitigation Measures

During the operation phase dust generation will be a minimum because most of surface will be covered by paved shoulder. Compensatory tree plantation along the Right of Way also will act as a major sink of pollutant due to the plying vehicle along through corridor.

A regular air quality monitoring programme should be defined and implemented for the port O&M phase.

5.6 Noise Pollution

5.6.1 Potential Impact due to Port Construction

5.6.1.1 Impact due to Port Construction Activities

Construction noise will result from operation of equipment including the dredger and associated tugs, piling equipment, tracked excavators, Lorries, dump trucks, and other earth-moving equipment, cranes, and generators / lighting equipment. The exact construction methods and plant utilised will depend on the EPC contractor. Noise nuisance during construction depends on the exact place of the receptor and of the source and the duration of the activity. However, in this touristic area it is considered high, especially as the ambient noise level for the settlements of Mulloor and Pulinkudi all through the study period were in the range of 38 to 50.1dB(A) Leq (day time)and between 39.4 to 51.1 dB(A) Leq (night time) which is below the IFC EHS General guidelines noise standard of 55 dB(A) Leq day time and 45 dB(A) for Leq night time.

The noise and vibration generated by piling in water if not controlled and monitored properly, can be transmitted considerable distances through the water and therefore have the potential to impact on marine mammals. There are no marine mammals present in the port foot print area and nearby premises.

Such noise pollution may cause nuisances to the population. Atmospheric conditions that may affect noise levels include humidity, wind direction, and wind speed.

Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. Underwater noise during the port construction will result from the equipment that are used for underwater activities, such as dredging, reclamation or the construction of the bund wall, piling and ship movements.

5.6.1.1.1 Mitigation Measures

The following measures could mitigate the negative impacts caused by noise emissions:

- Noise mitigation measures shall be in place prior to the commencement of any construction work.
- All contractors and subcontractors involved in the port construction phase should comply with the relevant international noise standards;
- Activities that take place near residential or sensitive receptors to be careful planned (restricted to daytime, taking into account weather conditions, etc.);
- Residents in the vicinity to be notified about construction schedules and activities;
- All plant and equipment to be fitted with silencers, mufflers, acoustic linings, or shields, as necessary.

- If necessary, measures to be taken to reduce noise emissions from the site shall include provision of screens or bunds to absorb noise and deflect it away from receptors;
- Before commencing any piling operations, the contractors shall be required to submit calculations to demonstrate that the appropriate standards will not be exceeded
- Timing and programming outside sensitive seasons (e.g. avoiding the migration seasons of marine mammals, etc.), especially concerning underwater noise;
- Apply a change management process to modify operations, if necessary to address noise issues;
- Vehicles and generator sets to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them;
- Employees working in noisy environment should be made to wear ear muffs/ear plugs to avoid any adverse impact of noise on them;
- Employees exposed to hand vibration while handling/operating of heavy machineries should compulsorily wear anti vibration gloves made up of visco elastic material;
- Shock absorbing techniques should be used to minimise the impact of vibration from heavy machineries;
- Heavy machineries and generators to be operated during day time only.
- A noise monitoring programme during construction should be implemented
- Vehicles older than 15 years will not be allowed to operate during construction and operational phase.
- Preferably battery operated very low noise generating vehicles will be used in the port premises during operational stage

5.6.1.2 Impact due to Quarrying

Noise pollution may result from the quarrying activities. The main noise sources are associated with drilling, breaking, crushing and handling, screening and transport. The blasting of rocks during quarrying (Kadavila/Theviyodu) will generate additional noise, besides the regular quarrying machinery. The most significant vibration emission will be associated with blasting activities. Minor vibrations will be associated with use of rock hammers.

Of the two mentioned quarries the Kadavila is most subject to noise (among others) impacts.

Contractor to make an Contractors EMP for all major aspects of pollution including for noise. Prior to commencing the works, the Contractor should establish the baseline conditions for noise in the specific area around the selected quarry.

Monitoring right from the beginning of the production should indicate whether standards are exceeded and early action is required.

5.6.1.2.1 Noise - Mitigation Measures

- All contractors should comply with the relevant international noise standards;
- Activities that take place near residential or sensitive receptors shall be planned (restricted to daytime, taking into account weather conditions, etc.);
- Residents in the vicinity to be notified about construction schedules and activities;
- Where necessary, noise emissions should be minimised and controlled through the application of techniques which may include installation of sound barriers and optimisation of internal-traffic routing.
- Proper maintenance of equipment to be conducted;
- All internal combustion equipment to have properly functioning silencers or mufflers;
- Adequate choice of equipment;

- Apply a change management process to modify operations, if necessary to address noise issues;
- Vehicles and generator sets to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them;
- Heavy machineries and generators to be operated during day time only;
- Blasting for quarrying shall only be carried out during calm wind conditions (November to May) to avoid extensive noise emissions to far stretched areas;
- A good blasting practice with specific blasting plans (like optimal blasting hole, suitable blasting methods) shall be adopted;
- Blasting in quarrying site (Kadavila/ Theviyodu) shall be carried out during day time only;
- Signage shall be kept in the blasting area (Kadavila/ Theviyodu) to cordon off the blasting area from general public;
- Labourers working near the blasting area shall be provided with ear muffs.

5.6.1.3 Impact due to Dredging and Reclamation - Noise

Dredging is likely to occur 24 hours a day, seven days per week. While dredging activities will generate noise from a variety of sources, the primary sources of equipment noise would include the cutter suction dredger itself, with its associated pumps and generators and the tugboats used to position the dredger. Other equipment such as the crew boats and survey boats would not contribute substantially to the noise associated with the dredging activities. Additionally, noise will be generated by onshore plant used to spread the dredged materials and to assemble and periodically relocate pipelines.

Generally speaking, a weighted noise intensity from working engines at the noise source shall not exceed a continuous level above approximately 120 dB(A).

Underwater noise

Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. Underwater noise during the Port construction will result from the equipment that are used for underwater activities, such as dredging, reclamation or the construction of the bund wall, piling and ship movements.. The noise and vibrations generated by the underwater activities can potentially be transmitted to considerable distances through the water and hence cause negative impacts on the marine mammals. Conditions that determine the transmission of noise emissions and vibrations are current pattern and strength and the hydrological/geomorphologic circumstances.

5.6.1.3.1 Noise - Mitigation Measures

- Where necessary, noise emissions should be minimised and controlled through the application of techniques which may include installation of sound barriers
- Optimising dredging activity and duration

5.6.1.4 Impact due to Road/Rail Corridor Development

Traffic both along the Rail and road will be primarily due to port development and in phase 1, one or two container trains run per day. Nevertheless there will be some level of Noise quality impacts along the project corridor in construction. Construction stage impacts will be of short term but have adverse impacts on the construction workers as well as the settlements adjacent to the road and rail alignment, especially those in the down wind direction.

Noise created during construction activities may force birds to temporarily migrate to others places. During the construction stage, crusher, DG sets and mixture machine and diversion of traffic will lead to rise in noise level, ultimately results in increase in the ambient noise quality. However, the impacts during construction are short-term in nature and will cease on completion of the construction

5.6.1.4.1 Noise - Mitigation Measures

The noise generated from construction activities of road and rail corridors is temporary and cease upon completion of construction phase. However the Contractor should adhere to good machineries and must take all precautions to control noise pollution. The Diesel Generator (DG) sets should be erected with approval of SPCB with good enclosures for controlling noise.

5.6.2 Impact due to Port Operation

Impacts during operations mainly will result from the port terminal activities such as vessel loading/unloading, container handling and access road/rail traffic that will result from container traffic arriving and departing through the port business day.

Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. The day to day terminal activities such as vessel loading / unloading, container handling etc. will cause additional underwater noise emissions. These are however not expected to be significant.

5.6.2.1.1 Noise Mitigation Measures

- Detailed consultations with the residents along the access road should reveal those potentially affected by terminal operations, specifically traffic. These might be offered relocation or compensation.
- Acoustic fencing might be installed along the edge of the access road should the traffic-generated noise levels be significant to warrant mitigation measures
- Apply a change management process to modify operations, if necessary to address noise issues when they occur.
- Vehicles and generator sets to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them.
- Employees working in noisy environment should be made to wear ear muffs/ear plugs to avoid any adverse impact of noise on them;
- A regular noise monitoring programme should be defined and implemented for the port O&M phase.

5.6.2.2 Impact due to Road/Rail Corridor Development

Road and rail noise depends on factors such as traffic intensity, the type and condition of the vehicles/trains plying on the road/railway line, acceleration/deceleration/gear changes by the vehicles depending on the level of congestion and smoothness of road surface (**IRC: 104-1988**). The baseline noise levels monitored at various locations along the candidate road indicate the baseline levels is exceeding the permissible limits for residential and rural areas and exceeds in some commercial areas. This is mainly because of the high density of road network and the traffic plying on them and towards sea the coastal wave actions also add up to the noise levels. Even the night, noise levels recorded at the various locations are close to or higher than the noise levels allowed during daytime.

This impact will be confined to receptors close to the road and rail. Both the construction and operation stage impacts can be effectively mitigated if the impacts have been assessed with reasonable accuracy in the design stage itself.

During operation stage rise in noise level may arise due to increase in traffic. During the operation stage noise pollution will very negligible by adopting proper Environmental Management Plan.

Road Noise: In this report Empirical noise modelling equations were considered to calculate generated sound pressure level due to the vehicles plying on the proposed road.

1) *Mathematical modelling of road traffic noise prediction- International Journal of Applied Mathematics and Mechanics 7(4) 21-28, 2011, IIT Roorkee, India*

$$L_{eq} = 19.92224 \log [Q (1+0.1 *VP)] + 12.59764$$

2) *A compact model for predicting the road traffic noise – Iran Journal of health science engineering, Vol 6, 2009, Tehran University.*

a) Calculation of Traffic flow and traffic speed

$$L_{traffic}\ dBA = 7.228 \text{ Log Nt} - 0.238 \log Vti + 0.208*P$$

Where Nt = Number of vehicles (V/hr)
Vti = Average mean speed (kmph)
P = Percent of heavy vehicles (%)

b) Calculation of road dimension effect

$$L_{dimension}\ dBA = (5.624 X10^{-4} L) - (8.13 X 10^{-2} W) - (3.71X10^{-2} H) - (7.65 X 10^{-2} S)$$

Where L = length of the road section (m)
W = Width of the road section (m)
H = Height of the building (m)
S = Gradient of road section (%)

c) Calculation of equivalent sound pressure level 3.0 meters near road surface

$$L_{eq}\ dBA = 48.48 + L_{traffic} + L_{dimension} - \Delta_e\ dBA$$

Where Δ_e = effect of distance. Foliage, air temperature, wind, humidity and Barriers (~4dBA)
General assumptions:
Q/Nt = 2000/day = 84/hr
Vti = 45 kmph
Percentage of heavy vehicle p = 80% = 0.8
Length of the Road = 2.0 km or 2000 m
Width of the Road = 45 m
Height of the building ~ 20 m (2.0 storey building)
Gradient = 1/4 = 0.25

3) *Calculation of Predicted Sound level – Great Britain Transportation model*

10 log Q+33 log (V+ 40 + 500/V) +10 log (1+5P/V)-30.6 dBA

Where Q = 2000/day = 84/hr
V = 45 kmph
Percentage of heavy vehicle p = 80% = 0.8

Table 5-20: Estimated Noise Value using Modelling Equations

S. No.	Different Noise Modelling Equations	Estimated Sound Pressure (dBA)
1.	L_{eq}= 19.92224 log (Q(1+0.1 *VP))+12.59764	56.02
2.	L_{eq} dba= 48.48+ $L_{traffic}$+ $L_{dimension}$ - Δ_e dBA	54.90
3.	10 log Q+33 log (V+ 40 + 500/V) +10 log (1+5P/V)-30.6 dBA	54.44

Geometrical Spreading: Assuming a source in a homogeneous non-dissipative atmosphere in the absence of a reflecting plane, the sound pressure varies inversely with distance from the source. The attenuation is A_s is therefore given by following equation.

$$\mathbf{A_s = C \log (R_o/R)}$$

Where R_0 is the reference distance (for line source ~7.5 m), R is the distance from the source centre in meters, C=10 for line source.

Table 5-21: Estimated Sound Pressure Level at Receptor from the Source

S. No.	Receptor Distance (m)	Geometrical spreading dBA	Estimated Sound Pressure Level at Receptor		
			Equation 1: 56.02 dBA	Equation 2: 54.90 dBA	Equation 3: 54.44 dBA
1.	10	-1.25	54.77	53.65	53.19
2.	15	-3.00	53.02	51.90	51.44
3.	20	-4.26	51.77	50.65	50.19
4.	25	-5.22	50.80	49.68	49.22
5.	30	-6.00	50.02	48.90	48.44
6.	35	-6.70	49.32	48.20	47.74
7.	40	-7.27	48.75	47.63	47.17
8.	45	-7.80	48.22	47.10	46.64
9.	50	-8.24	47.78	46.66	46.20

Rail Noise: In this report general noise modelling is considered due to the movement of the container loaded trains along the rail track. Calculation of rail noise (CRN) is based on the following equation: (Source: Predicting outdoor sound by Keith Attenborough, et.al, 2007[25])

Sound Exposure Level (SEL) or L_{eaq} = 31.2 + 20log (V) + 10 log (n)

Where V = Average speed of train in (km/hr)

N = Number of rail cars

- Distance correction (A_d)
  A_d = 10 log (D/25), where D is the distance between the source and receptor
- Air Absorption correction (A_s)
  A_s = -0.008D-.2, where D is the distance between the source and receptor
- Ground Effect Correction (A_{GC})
  A_{GC} = -0.61(6-H) Log (D/25), where D is the distance between the source and receptor & H is the mean propagation height

[25] Predicting outdoor sound by Keith Attenborough, Kaiming Li and Kirill Horoshenkov Taylor and Francis Published in 2007

Basic Assumption for calculating SEL

- Average speed of train V = 45 km/hr
- Number of trains along the rail alignment N = 54 (worst case scenario consideration)
- Height of exposure H = 4 m
- SEL or L_{Aeq} = 81.59 dBA

Table 5-22: Estimated Sound Exposure Level at Receptors

S. No. (1)	Receptor Distance (M) (2)	Distance Correction A_d dBA (3)	Air Absorption correction (A_s) dBA (4)	Ground Effect Correction (A_{GC}) dBA (5)	SEL= 81.59+Column (3+4+5) dBA (6)
1.	25	0.00	-0.40	0.00	81.2
2.	30	-0.79	-0.44	-0.10	80.26
3.	35	-1.46	-0.48	-0.18	79.47
4.	40	-2.04	-0.52	-0.25	78.78
5.	45	-2.55	-0.56	-0.31	78.17
6.	50	-3.01	-0.60	-0.37	77.61
7.	60	-3.80	-0.68	-0.46	76.65
8.	70	-4.50	-0.76	-0.55	75.78
9.	80	-5.10	-0.84	-0.62	75.03
10.	90	-5.60	-0.92	-0.68	74.39
11.	100	-6.02	-1.00	-0.74	73.83

Observations:

Road Noise: From the **Table 5-20** and **Table 5-21** estimated noise levels are found to be well within the CPCB standards for Commercial zone & Residential zone. Barriers and other noise attenuations are not considered for computations in practice, the actual noise levels are likely to be lower than indicated.

Rail Noise: From the **Table 5-22**, estimated sound exposure level due to the rail is exceeding the CPCB standards for industrial zone. Additionally cumulative road /rail noise level will increase the baseline noise level of the surrounding area. The number of rail movements expected during Phase 1 is one or two/day. Hence the impact due this will be limited to minimum time when it passes nearby habituated area.

5.6.2.2.1 Mitigation Measures

Considering the very low traffic growth scenario noise barriers are not required in any of the locations along the Road as well as the rail corridor. However in case after several years if this is found necessary then following are the mitigation measures suggested:

Requirement of noise barrier wall, minimum height of 2.0 to 3.0 m can be constructed on either side of the rail corridor where ever found necessary. During the design of elevated structures, wind load need to be considered for computing the height of noise barrier wall.
Proper maintenance of the rail track and rail wagon, by frequent lubrication to avoid frictional noise.
Allowing the rail to travel with an optimum speed.

Figure 5-66 shows a noise barrier for the road. This is only required where the settlements/ cluster of houses (or Silence zones) are present. No such areas are noticed so far along the entire alignment. No solid noise barriers are found necessary due to very low traffic expecting for the first fifteen years. During this period of low traffic, only strip plantations (also called Green noise barrier) of 10 m width. The specific details of the multipurpose strip plantations are provided in **Figure 5-67**. In a green noise barrier the individual leaves will act as noise attenuators. The smaller the size of the leaves, the better the attenuation. Similarly, the more the number of these small leaves, the better the noise attenuation.

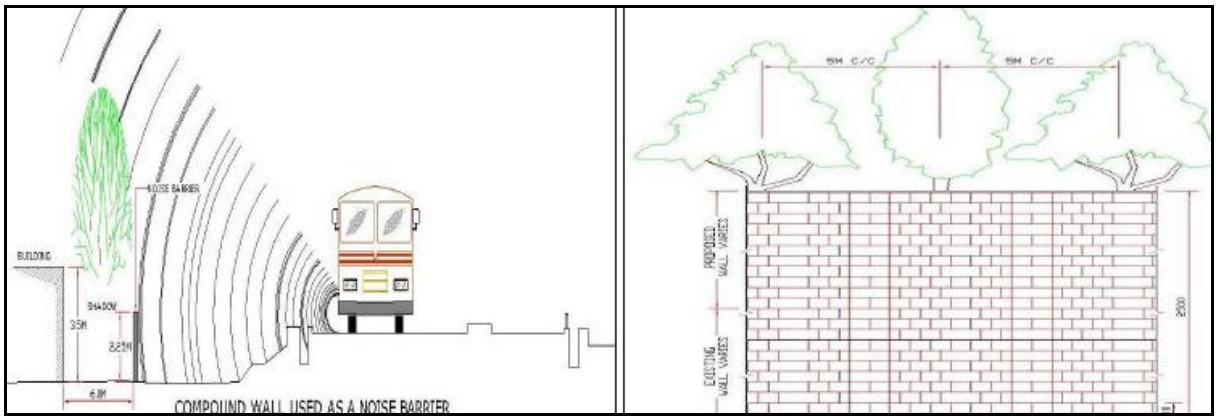


Figure 5-66: Noise Barriers for Road Connectivity

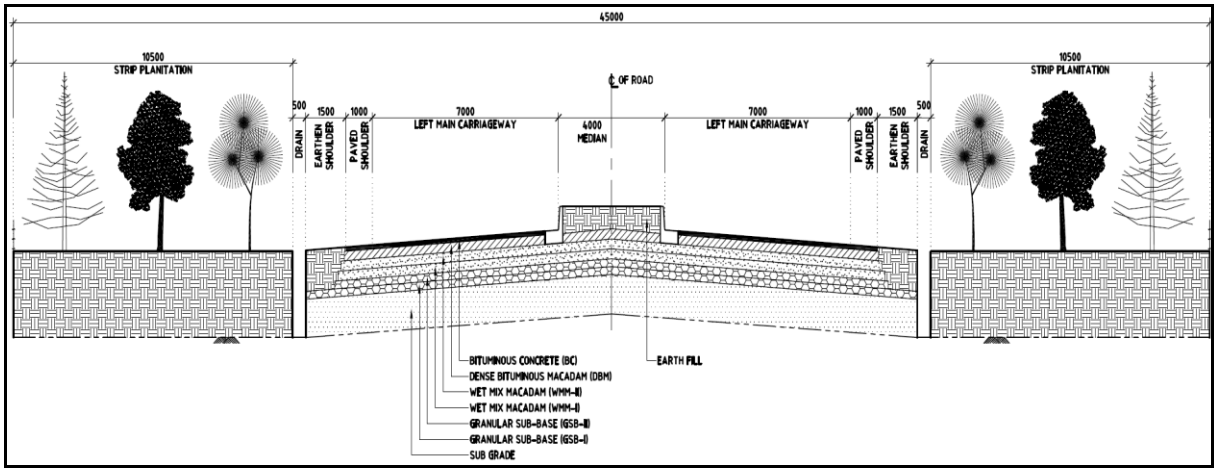


Figure 5-67: Green Noise Barrier for Road Connectivity

Underwater noise

Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. The day to day terminal activities such as vessel loading / unloading, container handling, etc. will cause additional underwater noise emissions. These are however not expected to be significant.

5.7 Solid Waste Management

5.7.1 Potential Impact due to Port Construction

5.7.1.1 Construction and Other Wastes

Construction will potentially generate the following wastes: green wastes from vegetation clearance, excess construction materials, including offcuts and packaging; hazardous wastes; oils, fuels and other chemicals generated by onsite maintenance and repair of construction equipment and machinery; Excavation materials; food wastes from construction personnel; site office wastes; and human waste; poor construction procedures that generate excessive wastes increase construction costs and results in disposal of otherwise valuable resources.

In the study area no sanitary landfill is foreseen. Therefore, there is a moderate risk to the soil quality, surface and groundwater and marine environment.

5.7.1.2 Hazardous Materials Management

Hazardous wastes (oil, chemicals, lubricants, paints, compressed gases, and varnishes, etc.) generated during the construction phase should be dealt with separately from non-hazardous waste.

5.7.1.3 Quarrying

Among others, solid waste will result from the clearing of trees and bush, from rock waste and removed topsoil. Other waste might originate from the destruction of structures, or from garbage dumped along the road and from household wastes from the construction workers. Rock impurities and trace components might cause hazardous wastes and should be managed appropriately.

5.7.1.4 Dredging and Reclamation

Most of the dredge spoil (80%) will be used for the reclamation, some spoil generated needs to be disposed-off, but sediment contamination at this point of time was not detected

5.7.1.5 Mitigation Measures/Solid Waste Management

The port Waste Management Plan for construction and operation phase should be developed defining adequate measures for SW collection, segregation, reuse and disposal.

The sewage/solid waste/hazardous wastes to be treated and disposed or sold to authorised recyclers as per the MoEF guidelines.

- Port operator should prepare a Waste Management Plan defining adequate measures for SW collection, segregation, reuse and disposal during construction.
- Proper sanitation bins to be installed in the port area for collection of sewage/solid waste/construction wastes on site.
- Solid waste generated during the construction process to be separated and recycled where possible / appropriate.
- Burning of waste on site should not be permitted. All waste, which cannot be recycled on site, should be collected and taken off site for recycling / reuse or disposal to an official/municipal waste disposal site after consultation with local authorities.
- A **'scavenging boat'** should be available at all times for collection of windblown rubbish within the harbour basin itself.
- All rubbish, waste materials and debris shall be systematically cleared from working areas as they accumulate; all such materials should be cleared at the end of each working day.
- If removal of waste materials at the end of the working day is not possible, the materials should be covered with tarpaulin or similar.
- Waste materials not removed directly from the site shall be temporarily stored at designated points and covered, pending removal from the site.
- All working areas and site roads to be kept clear of mud, water, silt and other materials at all times. If earth, mud, or other debris is deposited on roads, it shall be immediately removed.
- Hazardous waste should only be handled by legitimate enterprises and following good international practices and applicable local and international regulations (Bazel and Rotterdam Convention)

- For the purpose of an highly efficient EMP implementation pirticularily solid waste management the entire port and associated infra facilities have been divided in to 10 units (refer Chapter 10). The ultimate objective of the EMP is to create an awareness of '**Zero Tolerance'**.

5.7.1.6 Impacts due to Road/Rail Corridor Development

The issue of solid waste like water scarcity is a prevailing environmental issue of the Vizhinjam area.

Solid waste from the road and rail corridors during construction will be mainly domestic scraps and wastes from the construction camps and construction spoils from construction sites.

5.7.1.6.1 Solid waste Management - Mitigation Measures

The solid waste and garbage will be cleared at regular intervals and disposed of in pre-identified areas.

- Small amount of construction debris will be disposed of in suitable pre-identified dumping areas in tune with the local condition to avoid land degradation and water logging due to indiscriminate dumping.
- Dumping areas shall be covered with topsoil and subsequently plantation shall be done over the same.
- Regular inspection of haul roads, construction site shall be carried out to ensure regular and timely removal of construction debris to the dumping site.
- A locally employed and trained scavenger team is required for day long operations.
- The fishing Harbour need lot of improvement works. These improvements with a ten year life period could be a battery of toilets and bathing places, improved roads with proper covered drains with check points for solid waste removal, highly hygienic eating places, work area for fisherman to do petty jobs on the fishing nets, POL shops and repair support facility shops, health clinic, etc. This needs to be prepared in the form of a master plan and get approval from all stakeholders with or without changes and modifications.
- The conceptual plan includes four 'X' rows of toilets/bathing rooms for men and women. The maintenance will be planned in shifts. Only four rows of toilets will be operable in each month, so as to carryout maintenance at other four rows of toilets/bath rooms. This will help to maintain toilets clean and hence providing hygienic surrounding. To confirm a sustainable operation without fail. This block includes water harvesting and septic tanks.
- Operational EMP to be prepared by VISL need to address these issues holistically once after EPC contractor is in place.

5.7.2 Potential Impact during Port Operation

The amount of solid waste produced by the operational activities in the proposed port may be quite substantial. Wastes originating at the port may include inert solid waste from cargo packaging and from administrative offices, as well as hazardous or potentially hazardous waste associated with vehicle and equipment maintenance operations (e.g. used lubricating oils and engine degreasing solvents). Wastes originating from ships may include oily sludge, inert materials such as food packaging, and food waste. Among others, substantial amounts of solid waste will result from the terminals' daily and periodic activities, including the cleaning of storage tanks. The quantity of municipal solid waste generated from canteen and administrative areas is estimated at about 1000 Kg/Day, of which 60% will be bio-degradable and 40% non-biodegradable. These wastes will generate odour and health impacts and ground and surface water contamination, if not managed properly.

5.7.2.1 Solid Waste- Mitigation Measures

The port Waste Management Plan should be developed defining adequate measures for SW collection, segregation, reuse and disposal.

- Port operation activities solid waste shall be adequately collected and managed by Contractor (as one option) in accordance with the relevant Indian laws, IFC PSs and IFC EHS guidelines for Waste Management Facilities.
- In accordance with the requirements of MARPOL 73 /78 and its annexes IV and V, appropriate facilities shall be provided for the reception of all wastes arising from ships. These should include facilities for the following basic categories of ship-generated wastes:
  - ✓ Oily waste (usually oil mixed with larger quantities of seawater, also fuel residues and sludge).
  - ✓ Garbage (originating from crew and passengers, maintenance of the ship, cargo and fishing activities).

5.7.2.2 Solid Waste - Impacts due to Road/Rail Corridor Development

The solid waste mainly comes from the road users. They might throw all the unwanted materials present with them like plastic bags, water bottles and some other materials, etc., while passing through the road. Such materials get accumulated on the road or may lie along roadside which can obstruct the easy movement of vehicles sometimes.

No solid waste is expected / generated along the proposed rail alignment as this is specifically dedicated corridor for port container cargo only. No passenger traffic is expected along the alignment.

5.7.2.2.1 Solid Waste - Mitigation and Enhancement Measures

The solid waste generated during operation phase is not significant as the proposed road and rail corridors are dedicated to Vizhinjam port. However dustbins shall be provided along roadside so that the road users can use them for disposal of waste materials if any. Signboards can be installed at desired locations along the roadside propagating people about the environment to keep neat and clean.

Maintenance of the quality of the fishing harbour is very important. This cannot be achieved without adopting the fishing harbour by VISL. Therefore to address all issues especially solid waste management issues consultants has strongly recommended adopting the old fishing harbour and later integration of old /new fishing harbour with the rest of the port infrastructure.

The operational EMP need to address the prevailing solid waste issue holistically.

5.8 Socio-Cultural Impact

The activities will take place during the construction phase of the proposed project:	• Transportation of quarry materials. The impact will be caused by quarrying and transportation of quarry materials. • Dredging and Reclamation. • Construction of the breakwater and terminals. • Road & rail construction. • Establishment of labour camps.
Activities will take place during the operations	• Operation of terminals and the Port itself. • Changes in marine traffic.

phase of the proposed project:	• Maintenance dredging. • Changes in traffic due to Port operations (loading/uploading of cargo, etc.).

5.8.1 Project Activities in shadow area of the port

The Project shadow area has isolated fishermen dwellings. Unlike fishing village the families are not fully in to fishing occupation. Mostly these people are dependent on the Vizhinjam fishing harbour. Potential adverse impact is also anticipated on tourism which is dependent on Ayurvedic beach resorts along the coastal stretch of the Project site. Such Ayurvedic beach resorts represent another economic activity in the area. These potential impacts are anticipated during the construction and operation phases. The **Ayurvedic centres** are also not much affected as they can continue to do the business and it is independent of the beaches.

Workers camps might also have adverse impacts in terms of labour influx in the area, which might further increase the pressure on the existing resources/infrastructure.

At the same time, the positive impacts of the Project are expected to create more employment opportunities where fishermen might have a chance to acquire new skills, and increase commercial activity during the construction and operation of the Port

5.8.2 Potential Impacts on the Socio-Economic Environment

5.8.2.1.1 Land Use

Table 5-23: Impacts on Land Use during Construction and Operation Phases

Type of Impact	Project Affected People	Project Activity	Extent and Nature of Impact
Loss of land	Land owners (including resort owners) and land users	Reclamation, ancillary facilities, road and rail connectivity	Coastal landuse from Nellikunnu to Mulloor will change to Phase-I Port area. As a result of the Project development, this part of the sea coast and beaches will be permanently lost during the construction and operation of the Project. Land owners (including resorts owners in that area) and land users will be affected by the loss of land and their livelihood might, if these are dependent on land, e.g agricultural activities. Details of land loss and losers etc in these areas are given in chapter 7.

5.8.2.1.2 Land Details

Table 5-24: Details of land for the proposed port

S. No.	Port Infrastructure	Location	Breakup (Ha)	Total	
				Ha	Acres
1.	Backup Areas	Backup Area-1	11.42	23.35	57.70
		Backup Area-2	6.54		

S. No.	Port Infrastructure	Location	Breakup (Ha)	Total	
				Ha	Acres
		Backup Area-3	1.45		
		Backup Area-4	3.94		
2.	Road Connectivity		9.97	9.97	24.62
3.	PAF Zone	Port Operators Colony (Land Parcel-1), Truck Terminal (Land Parcel-2) & 220 KV Substation (Land Parcel-3)	19.87	19.87	49.10
4.					
5.					
6.	Warehouse		41.53	41.53	102.58
7.	Railway Connectivity		45.68	45.68	112.83
			Total	**140.41**	**346.83**

5.8.2.1.3 Land acquisition and project effected people

The details of land acquisition and project affected people in the study area are given in **Table 5-25.**

Table 5-25: Details of Land acquisition and project Affected people

S. No	Components	PAPs	PDPs	Squatters	Encroachers	Total
1	Back up area	80	29	0	0	129
2	Road	149	7	0	1	157
3	Rail	300	216	15	7	538
4	Port operators colony	NA	NA	NA	NA	0
5	Truck terminal	59	9	0	1	69
6	Ware house	601	13	0	0	614
	Total	1189	274	15	9	1507

5.8.2.1.4 Resettlement Action Plan (RAP)

As a part of compensation/mitigation work for the project VISL has already prepared an Re-settlement Action Plan (RAP). **Table 5-26** indicates the entitlement matrix for PAP as per VISL/GoK policy for the proposed project. The local communities are highly satisfied with the framework and steps taken for proper compensation of the PAPs.

Table 5-26: Entitlement Matrix for PAPs as per VISL/GoK policy for Vizhinjam Project

S. No.	Impact Category	Type of Loss	Unit Considered for Entitlement	Entitlement
1	Title holders of	Loss of land	Project affected/ displaced families	• Land value through negotiated direct purchase

S. No.	Impact Category	Type of Loss	Unit Considered for Entitlement	Entitlement
	private property			• Value of structures (compound wall/shed/basement/well/latrine/tank, etc.) in the property, as fixed by the District level Purchase Committee (DLPC) • Income restoration as per RAP • Income tax deducted at source will be exempted/born by Govt.
2	Title holders of private property	Loss of residential buildings	Project displaced family	• Land value through negotiated direct purchase • Replacement value of the displaced residential structure as per enhanced PWD schedule of rates (minimum value fixed as ₹ 3 lakhs) • 5 cents of land (resettlement site) free of cost to the owners who surrender land with building, in nearby areas • Hardship allowances which includes livelihood allowance (one time) and rent for 6 months, as fixed by DLPC • Tax exemption for source deduction (for land and structure value)
3	Title holder of Private Property	Loss of commercial building	PDP	• Land value through negotiated direct purchase • Replacement value of the displaced structure as per enhanced PWD schedule of rates • Hardship allowance as fixed by DLPC • Tax exemption for source deduction (for land and structure value)
4	Titleholder Trust/ cooperative /NGO, etc.	Loss of Cultural property/ common property	PDP	• Land value through negotiated direct purchase • Replacement value of the displaced structure
5	Property/ residence/ building, etc. partially affected	Loss of portion of land/ property (partially affected)	Project Affected Person	• Value of the land acquired through negotiated direct purchase • Compensation for the portion of the structure impacted as per valuation
6	Partially impacted common property resource	Private/ public ownership	Community	• Enhancement supports to reconstruct and recreate the lost/impacted portion • Provision of approach roads etc • Replacement/reconstruction at project cost in case of religious/cultural properties.
7	Non titleholder	Loss of land/ residence without pattas/ documents	Encroacher	• No compensation amount for land • Replacement value of the displaced structure as per enhanced PWD schedule of rates (minimum value fixed as ₹ 3 lakhs) • 5 cents of land free of cost, for rehabilitation • Hardship allowance as fixed by DLPC
8	Non titleholder	Loss of livelihood	Squatter	• Hardship allowance • Skill training if required

S. No.	Impact Category	Type of Loss	Unit Considered for Entitlement	Entitlement
9	Non titleholder	Loss of Livelihood	Employees of displaced shops	• Hardship allowance to employees as fixed by the committee proposed in RAP • Skill training if required
10	Non title holders	Loss of livelihood	Project Affected Persons	• Hardship allowances as fixed by the committee proposed in RAP • Income restoration programs as per RAP • Skill training if required

5.8.2.1.5 Impacts due to Road/ Rail Allignment

The following are the impacts due to rail alignment on socio economic and cultural activities:

- Partially affects the religious rituals
- Effect on water bodies such as wells, ponds, streams and canals
- Loosing of access roads, property, land, buildings etc..
- Possibilites of disturbance on supply of water, power and communication

5.8.2.1.6 Mitigation Measures

- Relocate all religious rituals with VISL/ consultant participation
- Religious properties need to get proper access.
- Provide alternate drinking water supply system
- Waste water drains need to be avoided by providing treatment or to provide underground piped connection to sea with filtering of solid waste to avoid clogging of channels
- Retain all access road with safer improvements
- During construction stage if any damage occurs to any distribution system, those will be rehabilitated.

5.8.2.1.7 Employment

Table 5-27: Impacts on Employment during Construction and Operation Phases

Type of Impact	Project Affected People	Project Activity	Extent and Nature of Impact
Increase in direct and indirect employment opportunities	People living around the Project	All construction activities and operations of the terminals	• Approximately 2,300 workers are needed for the construction in Phase 1 (20% skilled and the rest unskilled); This will create a significant number of short-term job opportunities and will improve the quality of life of the people employed. Both unskilled and skilled are residing in the local area, may be employed during the construction phase. • Approximately 650 skilled employees will be required during the operations period of Phase 1 of the Port Project (administrative, operation & maintenance). • Port will open new employment opportunities for this region for both skilled and unskilled local residents. • Operation of the terminals will bring along indirect employment opportunities. These opportunities will for example relate to loading and unloading of goods, local shops having more customers and able to expand their businesses, etc.

5.8.2.1.8 Livelihood

Potential Impacts during Construction

b. Loss of Access to the beaches

Fishermen using the seashore between Nellikunnu to Mulloor, which falls in the shadow area of Phase I will have to restrict access to the pocket beaches, as this part of the sea coast and beaches will be permanently lost due to reclamation and will be inaccessible for fishermen. Loss of these beaches during reclamation works will affect around 597 fishermen who are engaged in shore seine (at Valiakadappuram/ Nellikkunu beach), mussel (mulloor beach) and lobster collection. Movement of fishing vessels along this coastal stretch (Nellikunnu to Adimalathura) will also be hampered. Fishermen using these beaches shall have to either depend on the nearby Vizhinjam fishing harbour or have to move to other beaches.

c. Loss of fishing ground in the marine area for breakwater, approach channel and exclusion zone

Loss of fishing grounds occur for fisher folks using the area between the existing shore line and up to the breakwater and the exclusion and impacted fishing grounds in the approach channel. Social survey established that 597 fishermen from the southern villages were actively involved in fishing in the Project stretch including mussel, lobster and shore seine fishing. Breakwater will be at a distance of roughly 1500 meters from the shoreline and its length is around 1.7 km. Therefore, marine fishing ground of about 2.6 km^2 area will be lost during phase-I on account of breakwater alone. In addition to the 2.6 km^2 area fishing ground lost to the breakwater, fishing grounds in the approach may be affected (due to fishing exclusion zone) although not physically separated from the rest of the sea.

Fishing ground present in the project stretch enclosed by the breakwater where at present fishing catching activity for lobster, mussel collection, shore seine will be stopped. Fishing population, at present dependent on this patch of sea will lose their fishing ground and have to shift to some other part of coast and fishing ground in the sea beyond the Port area. This might not be feasible for some people and will result in the loss of their livelihood.
In addition to the active port area, the fishing activity will be hampered in the 1.6 km long and 400 m wide stretch of approach channel approx. 1.2 km away from the coast line. Because of this approach channel the ‘to and fro’ movement of boats from the shore adjacent to the approach channel will be occassionally hampered during the movement of ships, which is estimated to be a maximum movement of three ships per day in Phase I.

d. Obstructed access to the existing fishing harbour leading to an increase expenditure on fuel

During monsoon season, the fishermen from the northern and southern (about 10-15 Km) side of the Vizhinjam fishing harbour venture into the sea from the Vizhinjam fishing harbour, since they cannot embark into the sea directly from their beaches due the rough sea. At the onset on monsoon, they bring their boats (through sea or by road through trucks) and dock the same in the Vizhinjam fishing harbour, for a period of 2-3 months (monsoon) and will take back to their respective places after the monsoon. Due to the tranquil nature of the fishing harbour, fishermen could venture into the sea (and later land their fish), even if the sea is rough (in monsoon).
Survey data revealed that out of 877 fishermen households (those who responded to the questionnaire) from these southern villages only 37 people (3.23%) use the fishing harbour in pre monsoon season, while 498 (41%) and 342 (28%) fishermen use the Vizhinjam fishing harbour in monsoon and post monsoon season, respectively. So as to reach the Vizhinjam harbour for docking their boats, prior to monsoon (and to take it back after monsoon), the fishermen on the southern side

of the proposed port currently traverse through the proposed reclamation/dredging & port area. In future they might have to circumvent this area during construction and operation, by an additional distance of 3 Km, (once while taking their boats to Vizhinjam and then while taking back). This will have additional expenses on fuel, but will be limited to two trips per year per boat.

e. Reduction in catch/ yield

During disposal of dredged material, turbidity might increase in the nearby marine area leading to decrease in fish catch, which in turn will reduce the income of the fishermen living along the coast in these regions. This is a short term impact. Disposal will be in marine disposal borrow area

f. Loss of Income

Loss of fishing ground in the active Port area including approach channel area will reduce the income of many fishermen, who at present operate in this part of sea.

Potential Impacts during Operation

a. Permanent loss of fishing ground between Nellikunnu and Mulloor

Operation of terminals will reduce the effective fishing zone between Nellikunnu to Mulloor in phase -I, created by the BW area and will have adverse impact on the total fish catch from that region. This will have significant adverse impact on the income generation of local fishermen active in this stretch. Fishing activity at the active Port area will be permanently lost.

Fishing ground present in the Project stretch enclosed by the BW where at present fishing activity like lobster, mussel collection, shore seine and fishing in open sea take place will be stopped. Fishing population, at present dependent on this patch of sea will lose their fishing ground and have to shift to some other part of coast & fishing ground in the sea beyond the Port area. This might not be feasible for some people and will result in the loss of their livelihood.

In addition to the active Port area, the fishing activity will be hampered in the 1600 m long and 400 m wide stretch of approach channel approx. 1.2 Km away from the coast line. Because of this approach channel the ‘to and fro’ movement of boats from the shore adjacent to the approach channel will be occasionally hampered during the movement of ships, which is estimated to be a maximum movement of three ships per day in Phase 1.

b. Access to the existing fishing harbour

Fishermen residing in the villages located at the southern side of the proposed breakwater will be affected as their route to Vizhinjam fishing harbour passes through the proposed Port area. To approach the harbour they will need to take a longer route encircling the Port area atleast 1250 m away from the present coastline, at present their route is through a distance of 300-500 m from the coastline. But this is needed only twice in a year-once during their journey to Vizhinjam harbour before monsoon and later back after the monsoon.

c. Loss of income

Only those families, which use the beach in Chowara and Adimalathura will experience some loss of income as dredging activities for approach channel will affect the availability of fish and affect the

shore sein fishing in this part of sea in near shore waters. Number of such fishermen is expected to be small and this is a temporary activity till the completion of dredging.

d. Increased mussel collection

At the construction stage as well as initial stage of operation, the Port will have negative impact on the mussel production there by impacting the livelihood of the fishing population engaged in mussel collection. But after about 3 years from Port operation it is expected that the breakwater surface will act as substratum for the growth of mussels where (on the outer side) they can be picked. The lost mussel fisheries will be re-established (roughly after 7 years from commencement of Port construction) and provide livelihood for many.

e. Increased risk of accidents

Although movement of a maximum of three ships are only anticipated in Phase I of the project, the crossing of fishing boats at this time has got the risk of accidents, if the marine traffic lanes are not clearly marked.

Mitigation Measures

- Additional fish landing space to ease the congestion at the existing fishing harbour during monsoon and to promote fish landings in harbour (fish landing in beaches are considered unhygienic as per EU standards, which in turn has an impact on export oriented fisheries)
- Improve the living conditions of those economically displaced by the Project;
- Aim to maintain or restore catch per unit of effort or catch per unit of cost;
- Design and implement, in a timely manner, culturally sensitive and economically sustainable income restoration measures;
- Provide measures and support for livelihood diversification;
- Identify and provide special assistance to people who are especially vulnerable to economic displacement impacts;
- Conduct consultation processes that achieve free, prior, and informed participation; and
- Monitor and evaluate to ensure that livelihood restoration measures are meeting the needs of affected people and to identify the need for, and implement corrective measures.

The first terminal of the port is expected to start operations in 2017 - 2018. The operational phase of the port will include terminal operations and maintenance dredging. The likely impacts of these activities are more or less similar to the impact of construction phase on fishery based livelihoods, which includes the following:

(i) Permanent loss of beaches and fishing ground
(ii) Loss of income
(iii) An increased risk of accidents.

Impacts on beaches and resorts

Predicted impacts on beaches and resorts are presented in **Table 5-28** and **Table 5-29** respectively.

Table 5-28: Predicted Project Impact on Beaches/Fisheries

Phase (Construction period)	Development		Beaches (*Stretch*)	Marine Area Covered (Approx. km^2)	Remark
	Major(Beaches /stretch)	Sequential			
Phase I (2014 to 2024)	Breakwater (BW) Construction (Nellikunnu, Mulloor)	Development of Strip of land along the shoreline for Phase –I	Nellikunnu, Mulloor, (*complete Nellikunnu to Mulloor stretch*)	157	At least around 549 shore seiners, (Valiakadappuram and Adimalathura) 158 Mussel (Nellikunnu and Mulloor) Collectors, were active in this stretch*
		Land Reclamation Phase–I Terminals	No New beach (*Nellikunnu)*		

Out of 2111 number fishermen households among 3167 surveyed households (i.e. 15% of the total households present in Zone 1).

Table 5-29: Predicted Project Impacts on Beaches/Resorts

Phase	Construction period	Loss of Seashore	Resorts which will Lose their Seafront[#]
Phase I	2014 to 2024	Nellikunnu - Mulloor	**Nellikunnu;** Thapovan Heritage Home/Medicos Ayur Bay/ Kadaltheeram/Sea Park **Mulloor :** Coconut Bay Resort

[#] ***Rest of the resorts is not on the sea front (neither on beaches nor on Cliff)***

5.8.2.2 Mitigation Measures for Potential Impacts

5.8.2.2.1 Employment and Labour Camp

The employment and labour camp details are provided in **Table 5-30**.

Table 5-30: Predicted Project Impacts on Employment Opportunities

Anticipated Impact	Mitigation Measures	
	Construction	Operation
Increased opportunities for direct and indirect employment	Project developer has proposed to recruit 50%* of its workforce during construction, based on availability and skills, locally.	During operations, more skilled and technical manpower will be required and therefore, the project developer shall endeavour to recruit as much of its work force locally as possibly, if skills exist.
	Project developer shall require all its contractors and subcontractors to hire workforce locally. This requirement shall be included in the contractual agreements.	NA
	Project developer shall prepare a Local Hiring and Purchase Plan (LHPP). Plan shall include procedures & practices to maximise opportunities for hiring local	Local Hiring and Purchase Plan (LHPP) should be updated prior to commencement of port operations and it should include measures for increasing local employment in operational

Anticipated Impact	Mitigation Measures	
	Construction	**Operation**
	workers, allowing access to jobs for the local population in an organised & fair manner.	phase as well.
	Implement skill development locally to improve employability of local population.	Implement skill development locally to improve employability of local population.

Table 5-31: Anticipated Impact and Mitigation Measures

Activity	Anticipated Impact	Mitigation
Construction activities, workers camp and operation of terminals	Reduced availability of drinking water on account of increased pressure on existing drinking water supply scheme Increase in solid waste generation and increased pressure on existing disposal sites	A separate workers camp shall be established by the project developer, in which basic facilities like drinking water, sanitation facilities and sewage/solid waste management for the workers/employees of the port shall be provided. Cooking fuel will also need to be provided for by the contractor to the workers in the camp to avoid destruction of local green cover. Project shall have its own STP for treating wastewater generated in labour camps and other processes. Primary health care and basic first aid shall be provided at construction site / labour camps. Key requirements are: (i) availability of adequate number of properly stocked first aid kits (wrapped sterile adhesive dressings, individually wrapped eye pads, individually wrapped sterile wound dressings of various sizes, triangular bandages, safety pins and sterile gloves); and (ii) first aid training of staff and workers.

5.8.3 Fisheries based Livelihoods

- New fish landing centre is a part of phase-I port layout and will be constructed based on CSR provisions for a cost of INR 160 million (Rs 16 Crores).
- Improve the living conditions of those economically displaced by the Project;
- Aim to maintain or restore catch per unit of effort or catch per unit of cost;
- Design and implement, in a timely manner, culturally sensitive and economically sustainable income restoration measures;
- Provide measures and support for livelihood diversification;
- Identify and provide special assistance to people who are especially vulnerable to economic displacement impacts;
- Conduct consultation processes that achieve free, prior, and informed participation; and
- Monitor and evaluate to ensure that livelihood restoration measures are meeting the needs of affected people and to identify the need for, and implement corrective measures.

Table 5-32: Mitigation Measures during Construction and Operations

S. No.	Type of Impact	Eligibility Project Affected Fishermen	Compensation/ Mitigation	
			Construction Phase	**Operations Phase**
1	Loss of beaches	Fishing households using the lost beaches for shore seine,	Cash compensation equivalent to actual income lost as transitional compensation till the new	Improved transport facilities to the new fishing harbour will be developed. Training in best fishing

S. No.	Type of Impact	Eligibility Project Affected Fishermen	Compensation/ Mitigation	
			Construction Phase	Operations Phase
		boat launching and catch landing. Those eligible include: Boat and gear owners; Crew members; and Labour for loading and unloading.	fishing harbour is ready or access to alternate beaches is provided Preference shall be given to eligible candidates from the affected fishermen households for jobs/ employment subject to vacancy and suitability and/ or training shall be provided for making suitable candidates employable and the Company shall provide jobs. Provision of boats, fishing gear and other equipment to fishermen families to enable them to change to near sea and/ or deep sea fishing. A fishing harbour with all the required infrastructural facilities (i.e., landing terminals, road network, fish processing as well as auction area, ice plant, transportation facilities, drainage and solid waste management facilities) should be constructed with reserved rights to mooring/ berthing the boats for these fisher flock. Training in best fishing practices and techniques. Organise programs in fisheries science/ management, supply boat construction training, materials, and power equipment, provide training, tools, and parts for equipment maintenance and repair, provide training and gear for improving fishing techniques, provide training in Best Management Practices (BMPs).	practices and techniques. Organise programs in fisheries science/ management, supply boat construction training, materials, and power equipment, provide training, tools, and parts for equipment maintenance and repair, provide training and gear for improving fishing techniques, provide training in Best Management Practices (BMPs)

S. No.	Type of Impact	Eligibility Project Affected Fishermen	Compensation/ Mitigation	
			Construction Phase	Operations Phase
2	Loss of fishing grounds in the marine area for breakwater, approach channel and exclusion zone	Fishing households who lost access to the impacted fishing grounds. This will include; Boat and gear owners; Crew members; and Labor for loading and unloading.	One-off cash compensation.	A fishing harbour with all the required infrastructural facilities (i.e., landing terminals, road network, fish processing as well as auction area, ice plant, transportation facilities, drainage and solid waste management facilities) should be constructed.
3	Loss of income	Fishermen (including gear owners, boat owners, crew members, labor) using the beaches of Nellikunnu and Mulloor in the project footprint area for shore seine, boat launching and catch landing. Fishermen fishing in the area affected by the project.	Cash compensation for transitional loss of income till the new fishing harbour is ready or access to alternate beaches is provided.	Preference shall be given to eligible candidates from the affected fishermen households for jobs/ employment subject to vacancy and suitability and/ or training shall be provided for making suitable candidates employable and the Company shall provide jobs. Training in best fishing practices and techniques. Organize programs in fisheries science/ management, supply boat construction training, materials, and power equipment, provide training, tools, and parts for equipment maintenance and repair, provide training and gear for improving fishing techniques, provide training in Best Management Practices (BMPs)
4	Damage to, and loss of gear, equipment and boats	All fishing households experiencing damage of their property (fishing gear, boats etc.)because of Project activities	Compensation at replacement cost for loss of equipment, gear and boats and reimbursement of cost of repairing damaged gear, equipment and boats.	Compensation at replacement cost for loss of equipment, gear and boat and reimbursement of cost of repairing damaged gear, equipment and boats.

5.8.4 Tourism

The direct impact due to land acquisition for the additional back up area will displace 8 resorts. As a sample survey, details of 3 indirectly impact resorts are also provided in **Table 5-33**.

Table 5-33: Resorts to be displaced

Ref. No.	Resort Name	No. of Rooms	No. of Staff	Size*	Start Date
R1.	Lotus Jewel Beach House	2	3	Small	2008
R2.	Merlin Villa	-	-	-	-
R3.	God's Light Resort	1	1	Small	2011
R4.	Medicos Ayurbay Resort	18	16	Major	2004
R5	SEZ Park Resort	-	-	-	-
R6	Thapovan Heritage	31	75	Major	2000
R7.	Coconut Bay Resort	27	125	Major	1997
R8	Nandikulum Beach Resort	4	4	Small	2010
T1	Padme Ayurvedic Beach resort	-	-	-	-
T2	PAdme resort				
T3	Park House				
T4	Kadaltheeram resort				

*** Major Resorts (>10 rooms), Medium Resorts (5-10 Rooms), Small Resorts (<5 Rooms)**

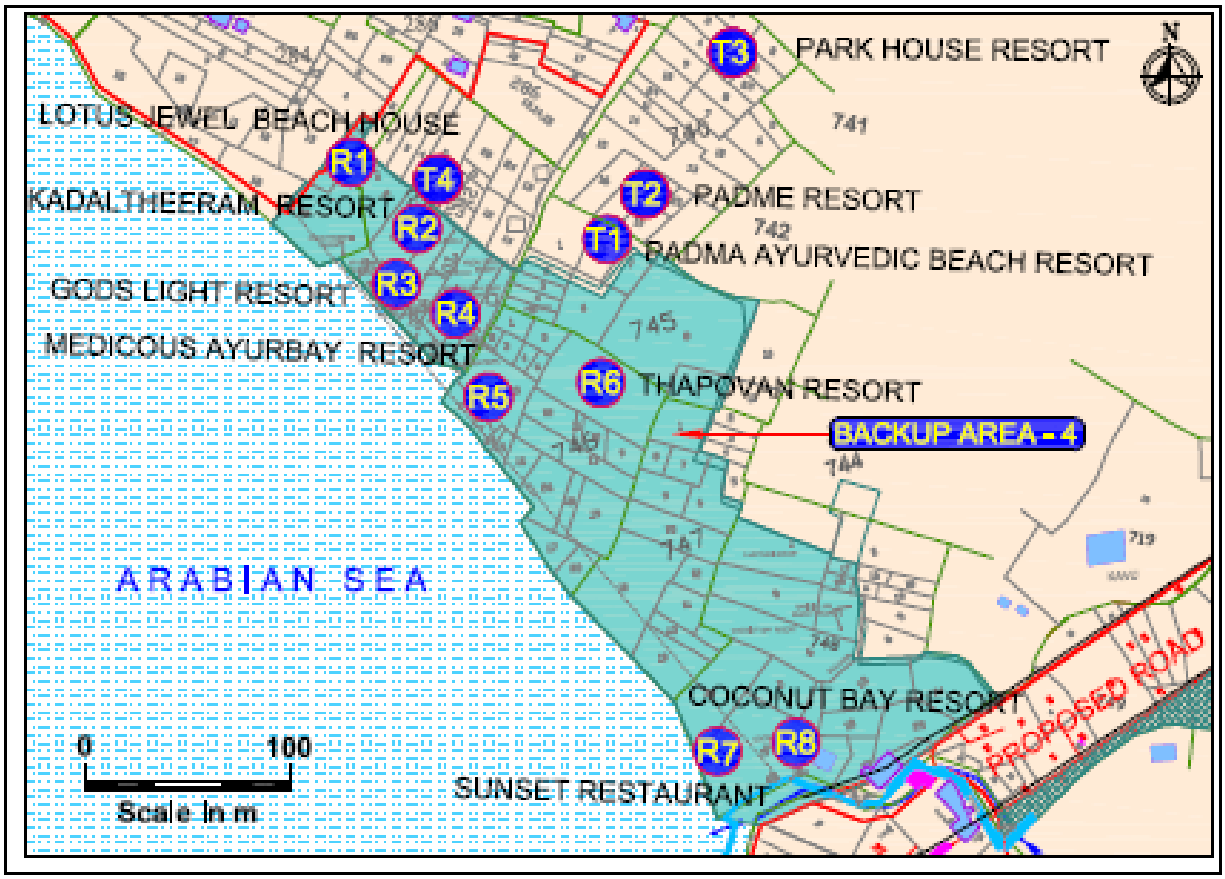


Figure 5-68: Directly affected resorts in Backup Area 4

Exhibit 5-9 to **Exhibit 5-16** show some of the directly affected and indirectly affected resorts in the ancillary site areas.



Exhibit 5-9: Nandikulam Beach Resort



Exhibit 5-10: Vayalkkara Beach Resort



Exhibit 5-11: God's Light Resort



Exhibit 5-12: Padme Beach Resort



Exhibit 5-13: Padme Beach Resort



Exhibit 5-14: Nandikulam Beach House



Exhibit 5-15: Karikathi Beach House



Exhibit 5-16: Kadaltheeram Beach Resort

Memorandum submitted by tourism sector: The South Kerala Hoteliers Forum along with the Kerala Hotel & Restaurant Association and two individuals (M. Shajarkhan and Principal Scientist of Central Marine Fisheries Research Institute – K. K. Appukutan) have all submitted petitions to the authorities; namely: Minister for Environment and Forest, the Environment and CRZ Impact Assessment Committee and also the Chief Minister of Kerala; on behalf of the stakeholders requesting to shift the location of the port since it affects the tourism business in the area and their claims in this connection are summarized.

Table 5-34: Tourism Sector Impact - General Analysis

S. No.	Issues Raised	Complaints/Argument from Tourism Sector	Actual Facts and Figures	Comments and Observations
1.	Employment generation	Only 500 for 30 years	Indirect benefits are many fold than the meagre direct employment. Direct employment at other locations like warehouse, PAF zone and backup areas will be added to this	Actual employment generated by the sector is very less unlike certain sectors like textiles which are very labour intensive
2.	Risk of erosion at tourism areas	1.0 km long stretch north of port will cause risk to Kovalam	All studies as per the regulatory requirements have been carried out	All mitigation plans and relevant construction strategy like design modifications completed
3.	Impact to marine ecosystem	Dredging and construction of breakwater will damage to marine species	These impacts are temporary in nature confined to the construction period only	During the operational period all activities will be stabilized and balanced naturally. The maintenance dredging will be marginal and nussel eco system will be re-developped along break waters.
4.	Revenue raised by tourism sector	₹ 18000 crore revenue will be lost	Tourism sector Loss due to the Vizhinjam port will be a meagre. This assessment is based on the fact that very few establishments are located in the area. Only three Major resorts are of larger category (>10 rooms) located within the backup area	Many of the resorts in this area is established after violation of CRZ rules/ other environmental regulations of the country.
5.	Oil waste water	Oil waste will pollute the sea and coastal region	Implementation of Oil Spill contingency plan and many other measures reported in the EIA report will address all these issues (refer EIA Report)	Project is envisaged as a green port with all regulatory control and an established institutional set up to address all issues holistically.
6.	Access to beaches	Port will destroy access to beaches	Only those resorts left out behind the port will lose the access to beaches. These resorts can still function with adequate transport facility to other beach area located to Kovalam. All the eight resorts located in the project will be acquired. It is expected that most of this will be retained as the port operator facilities for Phase I & II is integral part of the Port	These are micro level impacts to tourism sector, but the project has included cruise terminal in master plan targeting the macro level tourism development in the region.
7.	Vizhinjam port location is	31 resorts are affected that include	Only eight resorts are going to be directly	This spot has only high end travellers and

S. No.	Issues Raised	Complaints/Argument from Tourism Sector	Actual Facts and Figures	Comments and Observations
	hot spot for tourism	the eight directly impacted and one restaurant run by an individual	impacted out of this only three are major resorts (> 10 rooms). Vizhinjam area is never hot spot actually Kovalam area is the hot spot with more number of hotels and resorts	most of them never accommodate Indians due to poor returns. There is lot tax evasion also. Some of them are violating CRZ norms
8.	Most beautiful scenic beaches will be destroyed	All these are very small pocket beaches and rock cliffs except three	Adimalaithura beach will be further improved and can be connected to the resorts on the north through avenues along port boundary.	Definitely to achieve something great like the Vizhinjam port some impacts cannot be avoided
9.	Access to sea for the fishing villages will be impacted	All fishing villages are dependent on Vizhinjam port only. Even people are coming from far way places like Muthapozhy to this place	Nevertheless those who are practicing shoreline fishing non mechanized fishing will be impacted. Shell fishing is seasonal and located mainly along rocky areas	CSR (Corporate Social Responsibility) will be framed suitably to help the marginalized fishermen and several new facilities are also added like marine fish park. This will add employment and living conditions will be improved. Beside several other employment opportunities due to cruise terminal
10.	Environmental Impact	Environmental damage will be severe and irreversible	No such environmental damages have been reported.	Nevertheless the EAC will evaluate the project on all angles and then only they will give the final approval
11.	Port Location	High natural depth is there in many other places also	Finally three sites were examined and found this place as the best among all	ToR has been approved after convincing the MoEF EAC and this analysis will e presented in the EIA report also
12.	Proximity to fishing harbour	Fishing harbor is too close to the port	Several studies has been carried out to see the impacts on the fishing harbour. Design adjusted suitably to address impacts if any arising out of the proximity. In fact the lay out has been shifted towards south to increase the space	Fishing harbor will be adopted by the Vizhinjam port and thereby ensuring all mitigation measures and EMP measures as and when required
13.	Employment	Will lose employment to the tune of 23000 Nos. from tourism sector	Not true the actual loss of employment is 2189 only. Even if you add indirect employment will be something like 3139 only. This considers the directly and indirectly impacted resorts	Actual benefit due to the port is many fold that include Security of the country in the Indian ocean region, and also the benefit to the coast guard for protecting the coastal areas
14.	Impact to fishermen	Will impact two lakh fishermen	This is not true we have the actual figure	Impact to fisherman are negated by proper

S. No.	Issues Raised	Complaints/Argument from Tourism Sector	Actual Facts and Figures	Comments and Observations
			as 20275 nos. from the fishing village's most of them are very small. In fact additional fishing berths, drying yard, fish park. Auction hall, fish landing centre net mending facilities are added benefits.	studies CSR and impact mitigation plans such as adoption of the Fishing harbor and associated facilities
15.	Nesting grounds	Nesting ground of Olive Ridley turtles and other diverse species. Recorded nesting ground	If one look at these issues minutely no port development is possible in the country. These issues are silly and not required to address as many port projects are taken up even in the most sensitive areas like Orissa coast	For example Dhamra port, Subarnarekha port got clearance due to good environmental practices that even MoEF asked to share as best practices. IUCN was also involved in Dhamra port mitigation plan
16.	Rock blasting during dredging	For dredging due to high occurrence of bed rocks need to do rock blasting	Not much rock in the area as per the recent detailed study including Geotechnical and marine geophysical studies. Several bore holes drilled indicated that all dredging depth will be sandy layers.	Ref: Fugro studies Dredging report geotechnical report, Marine geophysical studies etc are a few

The Consultants have interacted with the Tourism stakeholders formally and informally to access the validity of the above points and the findings are summarized below.

- It is true that the serene beaches of the area are a great attraction to the tourists and it generates good revenue to the state. Seeing the tourism potential of the area many foreigners started resorts here partnering with the locals. Out of the displaced resorts four resorts viz. Thapovan Heritage Home, Kadaltheeram Beach Resort, Lotus Jewel and Merlin Villa are owned by foreigners and the partners are mostly ordinary fisher men of the area (except for Thapovan).
- All these resorts came up after 1985 before which these lands were owned by fishermen and other locals from whom property developers and business men with an eye on tourism market purchased this land. Fisherman lost his precious land and other resources. The loss to this fishermen is not small.
- As stated in the details furnished by the South Kerala Hoteliers forum, 2189 employees working in these 31 resorts will be affected by the project; of these 247 employees working in the displaced resorts will lose their employment. Most of the local people are employed in these resorts as security men, cleaners, housekeepers, etc. There are other service providers like transport companies, tour operators, tourists guides, cleaning staff, laundry shops, local art/folk art teams, vendors, plumbers, electricians, ayurvedic treatment providers, etc. Appropriate rehabilitation packages will be considered under R&R policy of the government, for those who lost their job due to displacement. When the port and cruise terminal comes up, others will get further opportunities. However it is true that during the construction phase they will have to look for alternate employments/opportunities.
- Many of these resorts, especially those displaced, fall in the CRZ-1 zone which is ecologically sensitive areas which is declared as **'no development zone'** as per CRZ 1991 notification. Most of these resorts constructed after the notification has actually violated the rules. The same notification permits construction of ports and this further ratifies the positioning of Vizhinjam port.
- Adequate mitigation measures will be ensured by the project to reduce the pollution threat raised by the port to safeguard the environment in the sea as well as in the shore. This will also be regularly monitored. An operational EMP to address all environmental impacts will be very much part of the port project.
- The fishing activities in the area of the port and immediate surrounding may be hampered during the time of construction. This is especially true in the case of fishermen operating from Mulloor beach area collecting mussels etc. Rehabilitation of such fishermen providing alternate options /compensations have been suggested under CSR policy.
- All required steps will be taken to protect the fishing harbor and the interest of the fishermen and separate packages will be planned for them under the CSR funds of the project.
- The possibilities of the Port to bring total development to the state and country will outnumber the loss of the tourism sector. Still it is important that tourism is one of the most valuable industry of the state and all that is possible to protect the industry and its stakeholders, need to be done like integrating the Cruise terminal in the Phase I development.

5.8.4.1.1 Mitigation Measures

Table 5-35: Mitigation Measures during Construction and Operations

Anticipated impact	Mitigation Measures	
	Construction	**Operations**
Loss of business	All resorts to be aquired and its workers will be appropriately compensated as per the prevailing norms. Most of the beaches are being used like private	Duirng operational phase some of the resorts is expected to stay while some others will switch over the

Anticipated impact	Mitigation Measures	
	Construction	**Operations**
	beaches. Unlike Kovalam area very few tourist are using this area per year. During construction phase there will difficulty to entire in the port area. Atleast few of them admitted that it is only meant for foreigners not Indians. Main impact is on transport. The guests from now on wards will have to be transported to other beaches. In this way business model will change and visitiors will also change.	business to other locations. The business model and clients could change. They will have to put additional vehicles and drivers to take to nearest beaches at poovar or Kovalam.
Loss of employment for resorts' employees	This will be appropriately compensated as per the policy of GoK.	Possibility of accommodating the cruise related activities will be explored.
Disturbance to serenity and aesthetics of the touristplaces and resorts	Green belt of native plant species shall be developed prior to construction activities to contain and mitigate the acoustic impact of the construction of BW & allied activities for port development. Quarry material shall be transported through barges at a minimum distance of 2-3 km away from the shoreline. This will reduce the impact on tourism in Kovalam/Adimalathura beaches. Preparing resorts for shift in the nature of tourism activities. Need and scope of this activity should be determined as part of the Assessment of impacts on Tourism.	Landscape design of the back up areas will retain all beauty of the back up areas. All developmental efforts will follow natural landscape with minimum cutting of trees.

Chapter 6
Environmental Monitoring Programme

Chapter 6 Environmental Monitoring Plan

Environmental monitoring of Vizhinjam port assumes very importance due the project location close to the Tourist area like Kovalam and Poovar and the fishing harbour. Besides, this port is also planned to be a green port with all possible green initiatives. The EIA report also recommends a **"zero tolerance to all kinds of pollution"** to achieve to the extent possible. In this project both EMP cell and CSR cell together will be under a one Head of Department who will be in third level of hierarchy of institutional mechanisms as described in chapter 10. Specific details are provided in Chapter 10 EMP. The most important part of the institutional set up is the provision for '**Green stamp with a clear green/sustainability note**' in all files for final execution relating to all port matters. This is **to avoid downgrading** of EMP and CSR Cell to a nominal level for showing to regulatory bodies. During the later phases (Phase II and III), the institutional capability of the EMP Cell and Environmental Management Team will be improved further to tackle higher challenges and other environmental risks and issues. Nevertheless this document is only meant for Phase 1. The port management in general and environmental management team in particular will look in to more innovative and environmental friendly methods to show case the coexistence of port tourism and fishing harbour.

Environmental Monitoring Programme is an important component during environmental management of the project during Construction and Operational phases of this project. Therefore awareness of all EMP measures is required at all levels of institutional capability. Prior to appointment of various positions their capability to implement EMP and CSR initiatives are to be verified. Therefore institutional strengthening, capacity building and training assume importance. Further, contractors **EMP by the Contractor** and **Operational EMP by the Operator** are very important for achieving various standards, action plan and goals prior to entering construction and operational phases of the project. The institutional mechanism required to implement the planned mitigation and monitoring measures during all stages of the project is discussed in **Chapter 10**. The project management especially the Environmental Management Cell (EMC) (described later in **Chapter 10** in detail) should always go for a rational approach with regards to environmental monitoring. This includes judicious decision making in consultation with responsible agencies (e.g. Kerala State Pollution Control Board (KSPCB)) or reputed environmental consultants for appropriate changes in the monitoring strategy, changes in the monitoring frequency, and any new requirements.

The efficacy of the mitigation measures being followed during construction and operational phases of the overall project (Vizhinjam port infrastructure project) can be assessed and the measures can be revised, made more stringent and reinforced based on the monitoring results. The environmental attributes to be monitored during construction and operational phases of the project, specific description along with technical details of environmental monitoring including the monitoring parameters, methodology, sampling locations and frequency of monitoring are presented in **Section 6.2** of this chapter.

6.1 Monitoring and Reporting

Environmental and social performance monitoring of EMP and CSR activities should be undertaken to ensure that mitigation measures are implemented and results achieved during construction and operational phases. Additional remedial measures may be undertaken if mitigation measures are inadequate or the impacts have been underestimated in the EIA report, in particular where the Project would be in breach of permits, National standards and IFC requirements and guidelines. Monitoring requirements have been divided into two main groups:

Performance monitoring of the professional working practice of the Contractor and the implementation of mitigation measures by the work contractor(s); and
Direct monitoring of the effectiveness of mitigation measures during the operational phase of the different Project components.

Performance monitoring is relevant during the execution of works by external contractors, particularly during the construction stage, but also for major maintenance works and decommissioning during the post-construction phases.

The tasks formulated for the Environmental Managers for the construction phase should also be taken up by the EMC. Details on EMC are discussed in **Chapter 10**. In order to make the construction phase and operational phase simpler to understand some basic facilities to be provided and their planned location as on today is also provided in **Chapter 10**.

6.1.1 Monitoring Plan for Construction Phase

From a monitoring point of view, the important parameters are water, air, noise, soil, sediment, plankton, benthos and occupational health. The suggested monitoring plan is outlined, in detail, in the following sections. The sampling and analysis proposed in the monitoring plan shall be carried out by the construction Contractor under the supervision of VISL.

The monitoring of water bodies inclusive of coastal sea water, inland surface water, ground water, sewage, effluent and storm water etc will be a very important focal point of monitoring mechanism to ensure that there is positive improvement in quality of all these streams. Further the solid waste management (otherwise entering the sea through two streams) need to be made zero through waste management plans.

- Monitoring and analysis shall be carried out following methods suggested guidelines of GOI-MoEF in particular. Only laboratories approved by MoEF or National Accreditation Board for Testing and Calibration Laboratories (NABL), Government of India shall be appointed for implementation of this monitoring plan.
- Apart from the proposed monitoring framework, greenhouse gas emissions, carbon foot print etc. shall be monitored to judge the environmental strengths and weaknesses annually on the basis of Environmental Code of Practice (2003) delineated by the European Sea Ports Organisation (ESPO).
- Monitoring of sourcing of material (**Quarry material from Quarry and Borrow material from borrow areas**) although this could be away from the PIA of 10 km radii for all regulatory clearances and approvals, this also being project induced impacts need to be monitored to avoid any potential impacts to the local communities.
- Monitoring details for quarrying are not included in the aforementioned frame, it is given separately, which shall be implemented and supervised by quarry operator. The following parameters shall be monitored during quarrying.
    - Noise (except blasting) shall be monitored continuously in compliance with the Ambient Air Quality Standards and in Respect of Noise, The Noise Pollution (Regulation and Control) Rules, 2000.
    - Record of occupational accidents, diseases, and dangerous occurrences, etc. shall be kept.

6.1.2 Monitoring during the Operational Phase

During the operational phase, VISL shall be responsible for monitoring project activities even when activities are out-sourced to third parties (Supervision consultants). VISL shall develop a separate

Operational EMP for the operation of the different components of the Project (port, transport via railway and road, storage, etc.). The implementation of the EMP should be the responsibility of the EMC within the project complex, which reports on a regular basis (e.g. monthly) to the management.

The main tasks of this Environmental Management and CSR management Cell (EMC & CSR Cell) are in the field of:

- In case on contracting of Environmental monitoring during preconstruction and construction phase, VISL should ensure that Consults are sufficiently experienced capable and committed for best results.
- Monitor environmental quality. This monitoring is related to various aspects, such as air quality, water quality (supply and waste water), marine water quality and noise. Environmental conditions are to meet National standards and IFC guidelines. Prior to project operations, VISL should formulate a plan for monitoring ambient quality parameters, in consultation with the relevant authorities.
- Implement the Health and Safety Management Plan, which is directed at the well-being (health and safety) of the employees, Labourers and the population in the Project's vicinity, directly affected by the project.

6.2 Budgetary Estimates for Environmental Management

The budgetary estimate for Environmental Management for proposed port, road and rail alignment and ancillary sites during construction phase is INR 399.37 Million (₹ 3994 Lakhs) and the annual budgetary estimate during operational phase is INR 33.78 Million (₹ 338 Lakhs). The breakup of environmental management cost of port and all other land ward infrastructure such as road alignment and rail alignment are given separately in **Table 6-2**, **Table 6-3**, **Table 6-4**, and **Table 6-5**.

With Zero tolerance for environmental pollution, the budgetary provision required to achieve this will be naturally high. Some of the key areas identified are the following:

- Cost of employment and cost of solid waste management using Women Self Help Groups (SHG) Kudumbasree units already strong in this area
- Cost of employment and cost of scavenger boat and fishermen to be employed from the people who lost livelihood opportunities due to Mussel/Lobster collection
- Cost of STP operators for the two streams will be from those groups who lost Livelihood opportunities due to Mussel/Lobster collection
- Cost of Rainwater harvesting, after Desiltation using silt traps, solid waste removal using waste trap and finally over flow tank for spill over to the collection tank from where the water will be pumped to the various location for effective use. The excess water will be drained to the sea as per the natural means
- Rainwater harvesting is also planned at warehousing area and PAF zone (three units)
- Cost of compositing infra facility, loading and unloading and distribution
- Cost of groundwater development at Gangayar using Hand dugwell/Borewell/bathing ghat and or bathing rooms for privacy.

In addition, CSR activities are also planned to achieve environmental standards:

- Cost of CSR activities that include Seafood park (rehabilitation of livelihood loses)
- Skill development centre
- Rehabilitation of the existing fishing harbour and integration with new fishing harbour and to the entire Vizhinjam port

6.2.1 Budgetary estimates for Corporate Social Responsibility (CSR)

The estimated total project cost for phase-I is ₹ 4,110 crores (excluding the land & EMP/CSR costs), out of which ₹ 2803 crores is the expenditure by VISL and the rest by the operator. About 5% of the VISL expenses amounting to ₹ 140 crores is suggested to be set apart under the head of EMP (₹ 40 crores) & CSR (₹ 100 crores).

These budgets exclude the land cost.

Table 6-1: Identified Items under Corporate Social Responsibility

S. No	Details of activity	Cost heads – Environment/CSR	Cost (₹ Crores)
1.	Water supply scheme for fishing village	Already implemented	7.0
2.	New fish landing centre	Properly designed and estimated	16.0
3.	Balance budget for CSR activities	General	77.0
		Total	**100**

6.2.2 Environmental Budget

Broadly INR 400 Million (₹ 40 crores) have been earmarked for the EMP and Environmental Monitoring Plan to address all environmental management requirements.

- Environmental (terrestrial and marine) monitoring in both construction and operation phase
- Monitoring of Shoreline changes in Vizhinjam coast in both construction and operation phase
- Sanitation facility at old fishing harbour for the entire fishing village
- Water & wastewater management
- Solid waste management
- Storm water management
- Tree plantation plan
- Environmental enhancement such as landscaping
- Focussed water supply augmentation study in the ten km study area

Table 6-2: Environmental Management – Capital Cost for Vizhinjam Port, Road/Rail Connectivity and Ancillary Sites during Planning & Construction Phase

S. No.	Purpose	Cost Items	Unit Rate (₹)	Area (Ha)	No. of Locations	Frequency	Cost in Million INR (₹)
•	Cost of Contractors EMP for all planned EMP implementation measures	Action plan report	1				10
•	Cost of Capacity building- Training and Institutional strengthening	Training workshop	-	-	-	-	2
•	Cost of Median planting with a suitable species of creepers and metallic wire mesh fencing along the road	2000 m long median planting	Lump sum		-	-	8.3
•	Compensatory afforestation for the green cover lost for the port and its associated facilities	2500 plants per Ha	100	25	-	-	12.5
•	Solid waste management (sector wise)	Collection disposal system					25
•	Storm water Management		Lump sum				50
•	Marine Life Protection out of Oil Spill (Provision for scavenger boat)	One tugboat with booms and skimmer and dust exhausting equipment					200
•	Cost of scavenger boast including manpower	Cost of boat					2
•	Dust Sweeper		2x3000000				6
•	Air Pollution Control	Four water tankers for wetting of road surface and springing system					10
•	Water and waste water treatment plants						40
•	Battery of toilets with bimonthly maintenance provision						10
•	Desilting and strengthen of Streams		lumpsum				5
Environmental Monitoring Cost for Construction Period (36 months)							
•	Air quality monitoring at sensitive locations	-	3,500	-	5	Once a week	2.52

S. No.	Purpose	Cost Items	Unit Rate (₹)	Area (Ha)	No. of Locations	Frequency	Cost in Million INR (₹)
•	Water quality monitoring at major water bodies	-	3,000	-	5	Monthly once	0.54
•	Noise monitoring at sensitive locations	-	500	-	5	Monthly once	0.09
•	Soil quality monitoring at sensitive locations	-	2,000	-	4	Once in a year	0.02
•	Marine water quality and sediment and marine biology		lumpsum			Monthly once	10.8
•	Shoreline changes		lumpsum				3
Social Enhancement Cost							
•	Enhancement of water bodies (ponds along road & rail)	Pond	5,00,000	-	2	-	1
•	Enhancement of religious structures (Temple)	Temple	5,00,000	-	1	-	0.5
•	Cultural property rehabilitation cost for sacred grove	Sacred grove	1,00,000	-	1	-	0.1
						Total	**399.37**
						Rounded off	**340**

Table 6-3: Environmental Management – O&M cost for ancillary sites establishment during Planning and Construction Phase

S. No.	Purpose	Cost Items	Unit Rate (₹)	Area (Ha)	No. of Locations	Frequency	Cost in Million INR (₹)
1.	O&M cost for Solid waste management	Dustbins for waste collection	50,000	-	-	-	1
2.	Dust suppression all along the alignment	Dust sweeper/ sprinkling system	15,00,000	-	-	-	1.2
3.	Capacity building	Training Workshop	10,00,000	-	-	-	1
4.	Greenbelt development				-	-	5.6
5.	Maintenance of booms and skimmer etc						7
6.	Maintenance of Water and waste water treatment						6.6
7.	Maintenance streams and storm water storage tank						3.8
8.	Running cost EMC						3

S. No.	Purpose	Cost Items	Unit Rate (₹)	Area (Ha)	No. of Locations	Frequency	Cost in Million INR (₹)
Environmental Monitoring Cost							
9.	Air quality monitoring at sensitive locations	-	3,500	-	5	Once in a week	0.84
10.	Water quality monitoring at major water bodies	-	3,000	-	5	Once in a fortnight	0.36
11.	Noise monitoring at sensitive locations	-	500	-	5	Monthly once	0.06
12.	Soil quality monitoring at sensitive locations	-	2,000	-	4	Once in a year	0.01
13.	Marine water quality and sediment and marine biology		lumpsum			Monthly once	1.2
14.	Shoreline changes						0.5
Enhancement Cost							
15.	Enhancement of water bodies (ponds)	Pond	3,00,000	-	3	-	0.9
16.	Enhancement of religious structures -Temple	Temple	1,00,000	-	2	-	0.2
17.	Enhancement of religious structures - sacred grove	Sacred grove cost does not include relocation cost and site	1,00,000	-	1	-	0.1
18.	Additional dug wells over and above rehabilitation R&R package	Dug well	70,000	-	5	-	0.35
19.	Enhancement of pump houses	Pump house	30,000	-	2	-	0.06
Total							**33.78**
Rounded off							**34**

Table 6-4: Monitoring Program during Construction Stage

Environmental Attributes	Parameters to be monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
Construction Phase					
Air Quality	PM_{10}, $PM_{2.5}$, SO_2, NO_2, HC and CO	Five (5) • Port Site • Balarampuram • Port colony/Warehouse area	Once in a week during entire construction period	Fine Particulate Samplers for PM_{10}, $PM_{2.5}$, Respirable Dust Sampler for SO_2 and NO_2, CO analyser /portable CO meter for	National Ambient Air Quality Standards released during November, 2009 given

Environmental Attributes	Parameters to be monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
		• Chani • Venganur		CO, and portable HC meter for HC	as **Appendix 6.1**
Noise Levels	Day and night noise levels	Five (5) • Port Site • Balarampuram • Port colony/Warehouse area • Chani • Venganur	Once in a fortnight during entire construction period	Portable hand-held noise level meter.	National Ambient Noise Standards, GSR 1063 (E), 1989 given as **Appendix 6.2**
Water Quality	Physical, Chemical and Biological	Groundwater (3) • Port Site • Port colony/ ware house area • PAF area Surface water (3) • Vizhinjam branch canal • Vellayani lake • Puvar west canal	Once in a month during entire construction period	Grab sampling and analysis by using standard methods.	IS10500, 1991 drinking water standards for Groundwater which is given as **Appendix 6.3** Designated Best Use Classification of Inland Surface Water of National Rivers Conservation Directorate, MoEF for Surface Water given as **Appendix 6.4**
Soil	Soil texture, type, electrical conductivity, pH, infiltration, porosity, etc.,	Four (4) • Port Site • Port colony/ ware house area • Along road network (Mullor) • Along rail network (Balampuram)	Once in a year during construction period	Collection and analysis of samples as per IS 2720	Baseline data
Marine Water Quality	Physical, Chemical and Biological	Five (5) • Port Basin • South of Breakwater	Once in a month both for low tide and high tide periods	Bottom sampler (Nishkin Sampler) and analysis by using standard methods.	Primary water quality standards for coastal water (SW–IV), given as

Environmental Attributes	Parameters to be monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
		• Inner Approach channel • Dredge material disposal site • Near kovalam beach	during entire construction period		**Appendix 6.5**
Plankton and Benthic Communities	Phytoplankton, Zooplankton and Benthic Communities	Five (5) • Port Basin • South of Breakwater • Inner Approach channel • Dredge material disposal site • Near kovalam beach	Once in a month during entire construction period	Plankton net of diameter of 0.35 m, No.25 mesh size 63 μ and analysis by using standard methods.	Baseline data
Sediment Quality	Physical and Chemical	Five (5) • Port Basin • South of Breakwater • Inner Approach channel • Dredge material disposal site • Near Kovalam beach	Once in a month during entire construction period	Peterson's Grab Sampler and analysis by using standard methods	Baseline data
Shoreline changes	erosion/accretion	15 km north and south of Vizhinjam port	Quarterly once	Standards Methods prescribed by MoEF/CESS etc. on shoreline changes evaluation	Baseline shoreline changes
Operation Phase					
Air Quality	PM_{10}, $PM_{2.5}$, SO_2, NO_2, HC, CO and VOC	Five (5) • Port Site • Balarampuram • Port colony/Warehouse area • Chani • Venganur	Once in week of the year	Fine Particulate Samplers for PM_{10}, $PM_{2.5}$, Respirable Dust Sampler for SO_2 and NO_X, CO analyser/portable CO meter for CO, portable HC meter for HC.	National Ambient Air Quality Standards released during November, 2009.
Noise Levels	Day and night noise levels	Five (5) • Port Site • Balarampuram • Port colony/Warehouse area • Chani	Once in a fortnight of the Year	Portable hand-held noise level meter.	National Ambient Noise Standards, GSR 1063 (E), 1989

Environmental Attributes	Parameters to be monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
		• Venganur			
Water Quality	Physical, Chemical and Biological	Groundwater (3) • Port Site • Port colony/ ware house area • PAF area Surface water (3) • Vizhinjam branch canal • Vellayani lake • Puvar west canal Izhuvattirutti	Once in a month of the Year	Grab sampling and analysis by using standard methods.	IS10500, 1991 drinking water standards for Groundwater. Designated Best Use Classification of Inland Surface Water of National Rivers Conservation Directorate, MoEF for Surface Water.
Soil	Soil texture, type, electrical conductivity, pH, infiltration, porosity, etc.,	Four (4) • Port Site • Port colony/ ware house area • Along road network (Mullor) • Along rail network (Balarampuram)	Once in a year	Collection and analysis of samples as per IS 2720	Baseline data
Marine Water Quality	Physical, Chemical and Biological	Five (5) • Port Basin • South of Breakwater • Inner Approach channel • Dredge material disposal site • Near Kovalam beach	Once in a quarter of the Year	Bottom sampler (Nishkin Sampler) and analysis by using standard methods.	Primary water quality standards for coastal water (SW –IV), given as **Appendix 6.5**
Plankton and Benthic Communities	Phytoplankton, Zooplankton and Benthic Communities	Five (5) • Port Basin • South of Breakwater • Inner Approach channel • Dredge material disposal site • Near Kovalam beach	Once in a quarter of the Year	Plankton net of diameter of 0.35 m, No.25 mesh size 63 μ and analysis by using standard methods.	Baseline data

Environmental Attributes	Parameters to be monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
Sediment Quality	Physical and Chemical	Five (5) • Port Basin • South of Breakwater • Inner Approach channel • Dredge material disposal site • Near Kovalam beach	Once in a quarter of the Year	Peterson's Grab Sampler and analysis by using standard methods	Baseline data
Shoreline changes	erosion/accretion	15 km north and south of Vizhinjam port	Yearly twice	Standards Methods prescribed by MoEF/CESS, etc. on shoreline changes evaluation	Baseline shoreline changes

Table 6-5: Statutory Requirements of HMP Plant, Batching Plant, WMM Plant

S. No.	Construction Activity for which Clearance required	Statutory Authority	Statute Under which Clearance is Required
•	Hot mix plants, Crushers and Batching Plants. WMM plants	KSPCB	Air (P&CP) Act, 1981
•	Storage, Handling and Transport of Hazardous Materials	KSPCB	Hazardous Waste (Management and Handling rules), 2008 Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 as amended
•	Sand Mining, Quarries and Borrow Areas	Department of Geology & Mining GoK	Kerala Minor Mineral Concession rules, 1959
•	Groundwater Extraction	PWD, CGWB	Kerala Groundwater Development Board
•	Disposal Construction and Bituminous Waste	KPCB	Hazardous Waste (Management and Handling rules), 2008

6.3 Reporting

6.3.1 Compliance Reports

As a part of environmental monitoring programme, following compliance reports shall be submitted to KSPCB and Regional Office of MoEF.

Half yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions on 1st June and 1st December of every calendar year.
Environmental statement for the financial year ending 31st March to KSPCB on or before 30th September every year.
Format for maintaining records of hazardous waste if any in Form 3 as per Hazardous Waste (Management, Handling and Transboundary movement) Rules, 2008.
Format for maintaining hazardous waste imported and exported in Form 10 as per Hazardous Waste (Management, Handling and Transboundary movement) Rules, 2008.
Safety data sheet for hazardous chemicals shall be maintained as per schedule 9 of MSIHC rules, 1989 (amended 2000).
Format for maintaining notification of major accident in schedule 6 as per MISHC rules, 1989 (amended 2000).
Water Cess returns in Form 1 as per Rule 4 (1) of Water (Prevention & Control of Pollution) Cess Rules 1978 on or before the 5th of every calendar month.

6.4 Plantation Monitoring Programme

Environmental Management team will monitor the following activities of greenbelt development:

Development of nursery	Fencing of plantation area
Treatment and sowing of seeds	Weeding and soil working
Watering	Pruning (trimming of plant)
Transport of seedlings	Replacement/ Inter planting
Planting of seedlings	Watch and ward of plantation

During operation phase periodic monitoring of plantation growth, manuring, watering, pruning, and replacement will be performed in order to properly maintain vegetation, greenbelt and green cover.

6.5 On-site Mock Drills Requirements

On-site mock drills are very important as it helps employees to be aware of the safety procedures and how to react during the time of crisis. Conducting mock drills at regular intervals enhances preparedness and checks the viability of environmental/ disaster management plan. Mock drills are essential for the following reasons helps in:

- revising/improving the environmental/ disaster management plan
- to evaluate whether the responsible officials are trained efficiently for the unforeseen event
- evaluating whether the emergency equipment are being maintained at port premises

To ensure efficient environmental/ disaster management, VISL shall conduct periodic on-site mock drills in case of occurrence of the following activities:

- Fire
- Natural calamities (cyclones, floods,
- Oil spill
- Bomb threats

tsunami, earthquakes)
- Collision of vessels calling at port
- Power break down
- War alerts/ terrorist attacks

Mock drills should also involve fire department, police, municipal authorities, hospitals and other department/agencies that are mandated to provide emergency support. Documenting the outcome of mock drills is an important aspect as this helps in revising the existing plan more efficiently.

Chapter 7
Additional Studies

Chapter 7 Additional Studies

7.1 Social Impact Assessment

7.1.1 Land Acquisition

As the port is to be developed entirely on the reclaimed land no land acquisition is envisaged for the port development. However the port being an international facility with multitude of infrastructure planned including defence requirements the port also require back up areas in the immediate vicinity. In addition for developing other facilities like road/rail connectivity, warehouse, residential areas, truck terminal etc require land in the vicinity. The total land requirement in phase-I is 206.42 Ha, with 66.00 Ha reclaimed land and 140.42 Ha land. Reclaimed land (66 Ha) is required for the marine facilities of port with 36 Ha for container yard & 30.00 Ha for rail/road & other yard infrastructure. The required land for land side infrastructure facilities is 140.42 Ha, with 23.36 Ha for back up; 9.97 Ha for road; 19.88 Ha for truck terminal; 41.53 Ha for warehouse and 45.68 Ha for railway. The land for the land side infrastructure in phase-I, would cater to the needs of phase-II & phase-III as well, i.e. In phase-II & phase-III, additional land requirements will be only for container yard and other yard infrastructure from additional reclamation.

7.1.2 Land Details

For the development of road/rail connectivity and ancillary sites, GoK vide G.O. (Ms) No. 11/2010/F&PD dated TVPM 03/03/2010 ordered to acquire 120 Ha of land and have constituted a special Land Acquisition (LA) unit consisting of staff of revenue and survey department for the acquisition of the land. This team after site inspection recommended acquiring 7.8 Ha for road area, 16.98 Ha of land for the backup areas, 19.94 Ha of land for the PAF (truck terminal) zone, 41.53 Ha for construction of warehouse and 34.00 Ha for railways; totalling to 120.25 Ha.

The GoK has declared this as a fast track project with powers to invoke urgency clause under section 17 of the LA act. This has been notified, and government approval for the purchase value of this land was obtained recently. Later as per the details of the land requirement in the port master plan (MoM for finalisation of the port master plan; a workshop held on February 7th & 8th, 2012, Thiruvananthapuram is given as **Appendix 7.1**, the additional land requirement has been assessed at 20.42 Ha, with additional land parcels at the back up area, road and rail route. The details of land breakup for road & rail connectivity and ancillary sites are given in **Table 7-1**.

Table 7-1: Breakup of Land Details

S. No.	Port Infrastructure	Location	Breakup (Ha)	Total	
				Ha	Acres
8.	Backup Areas	Backup Area-1	11.42	23.36	57.70
		Backup Area-2	6.54		
		Backup Area-3	1.45		
		Backup Area-4	3.94		
9.	Road Connectivity		9.97	9.97	24.62
10.	PAF Zone	Port Operators Colony (Land Parcel-1), Truck Terminal (Land Parcel-2) & 220 KV Substation	19.88	19.87	49.10
11.					
12.					

S. No.	Port Infrastructure	Location	Breakup (Ha)	Total	
				Ha	Acres
		(Land Parcel-3)			
13.	Warehouse		41.53	41.53	102.58
14.	Railway Connectivity		45.68	45.68	112.83
			Total	**140.42**	**346.83**

7.1.3 Extent of Impact – Road Connectivity

A classification of the ownership of properties along road corridor is given in **Table 7-2**.

Table 7-2: Properties and Project Affected Persons (PAPs)

Number of land parcels in possession	PAPs	No. of Properties
1.0	123	123
2.0	25	50
3.0	6	18
4.0	1	4
5.0	1	5
Total PAPs and number of land parcels	**156**	**200**

The R&R package for Vizhinjam Port project-instructions to DLPC the GO (MS) No. 42/10/F& P.D. dated, Thiruvananthapuram of May 29, 2010 is provided in **Appendix 7.2**. In an assessment of the possible impacts of the land acquisition on the families, it was seen that 200 properties belonging to 156 families were impacted. There is a squatter family too living in the Government land. Some of the PAPs own more than one property (two to five plots) in this stretch. A gender analysis of ownership of the properties reveals male dominance. Out of these 200 land holdings, only 36 properties are owned by women while 110 properties are owned by males and 11 properties are jointly owned by men and women.

7.1.3.1 Extent of Land Lost by the PAPs for Road

The extent of the land lost by PAPs ranges from half cents (0.002 ha) to 45 cents (0.182 ha), as detailed in **Table 7-3** and **Table 7-4**.

Table 7-3: Extent of Land Lost by the PAPs for Roads

Extent of the Land (Unit Cents)	Extend of land in Ha	No. of PAPs	Percentage (%)
<1	<0.004	13	6.5
1 to 5	0.004 to 0.020	58	29.0
6 to 10	0.024 to 0.040	62	31.0
11 to 15	0.045 to 0.061	20	10.0
16 to 20	0.065 to 0.081	24	12.0
21 to 25	0.085 to 0.101	12	6.0
26 to 30	0.105 to 0.121	2	1.0
31 to 35	0.125 to 0.142	4	2.0
36 to 40	0.146 to 0.162	2	1.0
41 to 45	0.166 to 0.182	3	1.5
	Total	**200**	**100**

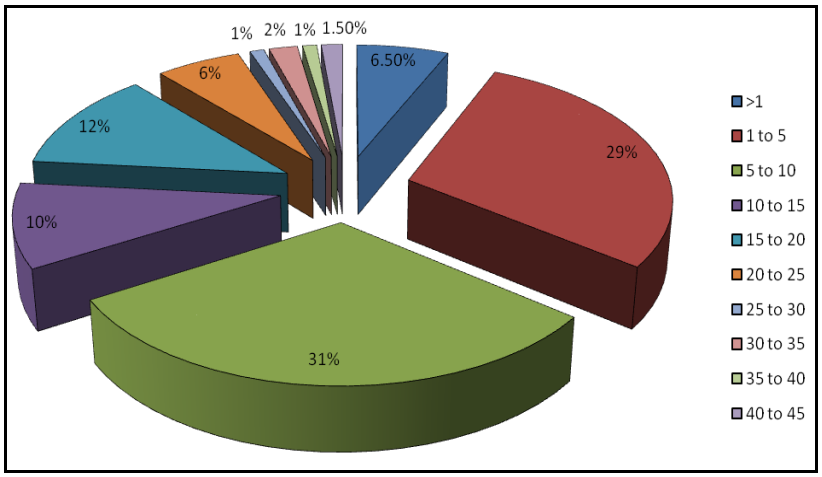


Figure 7-1: Percentage of Land Area Lost by PAPs on a Single Property

The extent of land lost by 6.5% of the PAPs is just nominal as it is less than 1 cent (<0.004 ha) of land. 60% of the PAPs lost up to 10 cents (0.040 ha) of land, 22% of the PAPs lost 11 to 20 cents (0.045 to 0.081 ha) of land, 6% lost 21 to 25 cents (0.085 to 0.101ha) of land and the remaining 5.5% lost between 26 to 45 cents (0.105 to 0.182 ha) of land, as shown in the **Figure 7-1**.

Table 7-4: Cumulative Loss of PAPs from Several Properties in the Corridor of Impact

Extent of Total Land Loss (Unit - Cents)	Extent of Total Land Loss (Unit - Hectares)	No of PAPs	Percentage (%)
<10	<0.040	6	19
11 to 20	0.045 to 0.081	9	28
21 to 30	0.085 to 0.121	9	28
31 to 40	0.125 to 0.162	0	0
41 to 50	0.166 to 0.202	7	22
51 to 60	0.206 to 0.243	1	3
	Total	**32**	**100**

Some of these PAPs own more than one plot in the stretch and their cumulative loss will be more. When cumulative totals are considered, the maximum land lost by a single PAP owning five plots is 60 cents (0.243 Ha) of land.

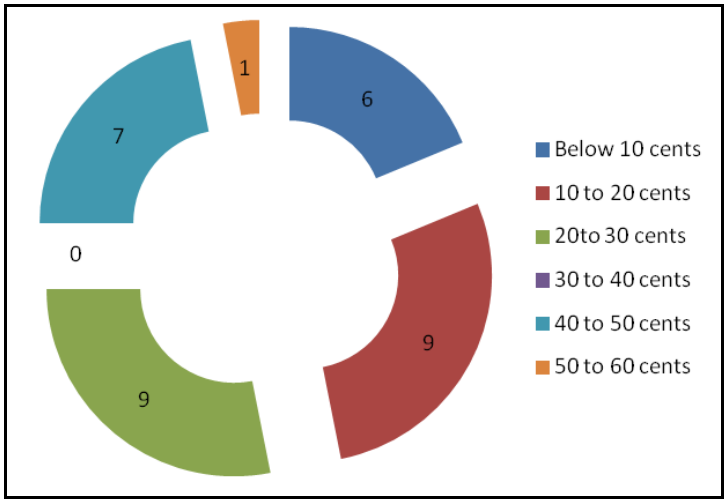


Figure 7-2: Cumulative Loss of Land in Various Properties

7.1.3.2 Type of Impact along proposed Road

In this social impact analysis it is seen that there are four major impacts of the project on persons/families. These impacts are on

(1) Agricultural property,
(2) Residential property,
(3) Commercial property, and
(4) Livelihood.

If a person is totally impacted due to project leading to displacement from the area or occupation, he or she is known as a **'Project Displaced Person' (PDP)** and if they are only partially impacted and not displaced they are known as a **'Project Affected Persons' (PAPs)**. Nevertheless all PDPs are PAPs but not vice versa. Type of impact on each titleholder, due to this road project is detailed in **Table 7-5**.

Table 7-5: Type of Properties and Degree of Impact along Road

Use of Land	PAPs	Percentage	PDPs	Percentage	Total	Percentage
	Nos.	(%)	Nos.	(%)	Nos.	(%)
Agricultural property	143	71.5	46	23.0	189	94.5
Residential property	0	0	6	3.0	6	3.0
Properties – non residential building	0	0	1	0.5	1	0.5
Commercial building (resorts)	0	0	2	1.0	2	1.0
Non-agricultural property	1	0.5	0	0.0	1	0.5
Residential cum commercial property	0	0	1	0.5	1	0.5
Total	**144**	**72%**	**56**	**28%**	**200**	**100%**

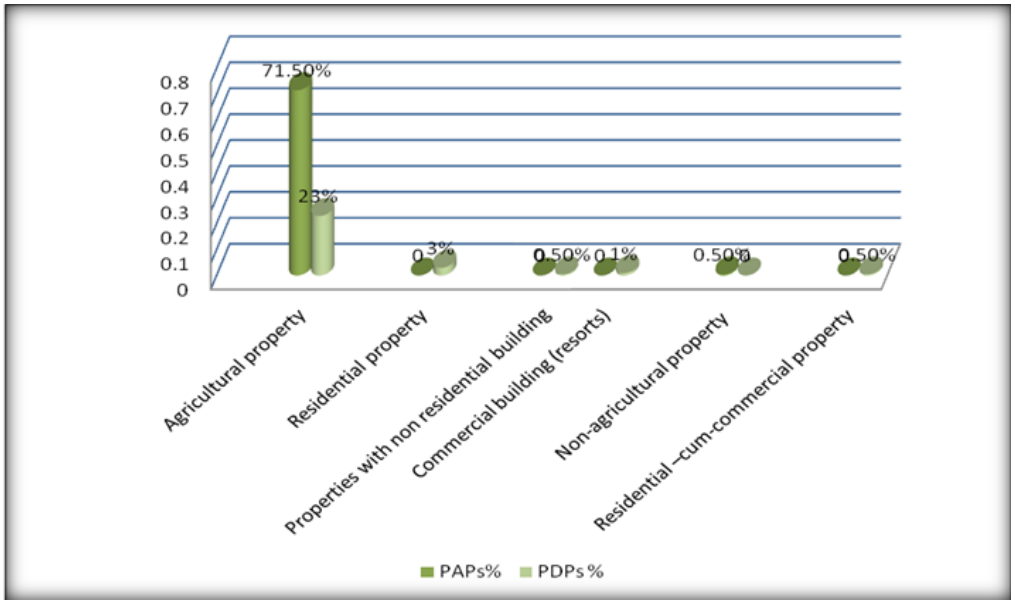


Figure 7-3: Type of Property and Degree of Impact

From the table and figure above, it is clear that 72% of the properties (144 nos.) are only partially impacted, while 28% (56 nos.) are totally displaced. This includes agricultural and non agricultural, residential and commercial properties. .

Table 7-6: PAPs losing more than 70% of their Land for Road

S. No.	Area of Land Loss in Percentage (%)	PAPs (Numbers)
1.	70- 74 of land loss	2
2.	75-80	8
3.	80-85	7
4.	85-90	5
5.	90-95	2
6.	95- 99	1
	Total	**25**

The degree of impact varies among the partially impacted properties as some are only nominally affected, while some others badly impacted. There are 25 families who lose more than 70% of their land (**Table 7-6**) and hence the remaining piece of land is too fragmented for any use and most of them wish to give this land to the project as well. Some of them wish to retain the same considering the future possibilities for constructing a small shop, etc. and use the opportunity of passing road for commercial purposes. The existing rules give ample scope for supporting the PAPs in this context, as they can either sell the remaining land too to the project or if they wish, they can retain it.

7.1.4 Extent of Impact – Rail Connectivity

7.1.4.1 Extent of Land for Rail

The extent of land owned by the PAPs is given in **Table 7-7**. The possession of land varies from one cent to 200 cents of land. 39% of the PAPs posses less than five cents of land, 43% possess 5 to 20 cents of land, 15% possess 20 to 50 cents of land and only 3% people posses more than 50 cents of land and up to 200 cents (Two acres).

Table 7-7: Extent of Land in Possession of PAPs along Rail

Extent of Land in Possession (Unit–Cents)	Extent of Land in Possession (Unit–Hectares)	Number	Percentage (%)
<5	<0.020	133	39
5 to 20	0.020 to 0.081	149	43
20 to 50	0.081 to 0.202	50	15
50 to 200	0.202 to 0.809	12	3
Total		**344**	**100**

Vizhinjam coastal belt has the highest density of population with several families staying together in one house. The facilities in such households are so limited that they do not have space to accommodate even a toilet in their premises. Men go to seashore for open defecation while women have limited choices due to privacy issues and some of them depend on public toilets. At Madavoorpara, several families are staying in a meagre '**two cent houses' (0.008 Ha**), which is encroached land. All of them have ration cards and stated to have title deeds but further verifications with the land records are required to settle their compensatory claims.

7.1.4.2 Ownership of Property for Rail

About 62% of these properties are owned by men while women own 31% of the properties. Husbands and wives jointly own 4% of the properties while siblings and parents jointly own 3% of the properties. **Table 7-8** gives the specific details of ownership of property.

Table 7-8: Ownership of Property for Rail

Ownership of Property	Number	Percentage (%)
Male	214	62
Female	107	31
Husband & Wife	12	4
Joint Ownership of other Family Members	11	3
Total	**344**	**100**

The ownership of the property clearly reveals the male dominance in the society. Women owned properties are mostly inherited from their parents while a direct purchase of land is effected it will be mostly in the name of male and very rarely do couples register together. Joint ownership of the properties by parents and other siblings is mostly an interim arrangement before partition, after which the siblings get fragmented properties.

7.1.4.3 Users of the Properties for Rail

The property in 91% of the cases is used by the owner. Tenants and leasers are there in 2.5% cases who give monthly rent and annual lease to the property owners. **Table 7-9** gives the land use details.

Table 7-9: Land Use along Rail corridor

Land Used by	Number	Percentage (%)
Owner	312	91
Tenant	8	2
Lease	2	0.5
Possess	15	4.5
Encroacher	7	2
Total	**344**	**100.0**

Encroachers and possessors are also seen. Some of them have possession certificates and such cases need further verification with the records to get a clearer picture.

7.1.4.4 Loss of Residential Structures - Rail

The residential structures impacted in the 14.5 km stretch are found to be 276 in total. Of these, 154 are concrete buildings and 14 among these are two storied. The remaining are tiled roofed, thatched sheds and tin/asbestos roofed structures. Some of these houses are outside the alignment, but very close to it and hence are likely to be affected. **Table 7-10** gives the details about type of building.

Table 7-10: Type of Building along Rail

Type of Building	Number	Double Storied	Percentage (%)
Concrete	154	14	56
Tiled	48	0	17
Thatched	15	0	5
Sheeted	42	0	16
Concrete and Sheet	17	0	6
Total	**276**	**14**	**100**

Many of them were staying in these houses for ages, as detailed in the **Table 7-11** There are several newly constructed buildings too and people generally are unhappy to leave their dwelling place. Many

of them requested the Government to spare the house and are apprehensive about the compensation packages to build a new dwelling place.

Table 7-11: Years of Stay in the Building

Years of Stay	Number	Percentage (%)
Below 3	33	13
4 to 10	58	22
11 to 20	84	32
21 to 30	46	18
31 to 40	19	7
41 to 50	10	4
51 and above	9	4
Total	**259**	**100**

Along with the announcement of the port, the cost of land in this area is also shooting up. So it is likely that the compensation received may not be adequate to purchase land in the surroundings. Hence, the rehabilitation package will have to ensure that those who lose residence get land in the vicinity to construct a dwelling house (Replacement cost). **Exhibit 7-1** to **Exhibit 7-4** are a few structures along the road alignment.



Exhibit 7-1: A Concrete House Impacted



Exhibit 7-2: A Squatter House



Exhibit 7-3: Sheeted House likely to be Impacted



Exhibit 7-4: Double Story Building near Madavurpara N.H Crossing

7.1.4.5 Loss of other Structures-Rail

Other structures impacted are listed in **Table 7-12**. There are three private ponds, 20 dug wells, etc. Among them, a private temple is also included as it is in the land attached to the house of the owner and is considered as a private property, but the land is an encroached land.

Table 7-12: Loss of other Structures - Rail

Other Structures	Frequency/Number	Percentage (%)
Pond	3	9
Well	20	58
Cowshed/Other Sheds	7	21
Toilet	1	3
Pump House	2	6
Private Temple	1	3
Total	**34**	**100**

Exhibit 7-5 & **Exhibit 7-6** show a temple and a pond along the alignment.



Exhibit 7-5: Private Siva Temple (Rail)



Exhibit 7-6: Nearby Pond at Mudavurpara

7.1.4.6 Trees and Vegetation – Rail

There are several yielding trees especially coconut, mango, jackfruit and tamarind in the area. Every household with a minimum space will have coconut trees cultivated in their home garden. It is a source of income without much investment for many families. Since coconut is an inevitable ingredient of Kerala cooking, most of the families use the coconuts for their own use and surplus quantity is sold out. Timber trees which are cultivated include mainly Aanjili, Teak and Mahogany. Tapioca and Plantain cultivations can be found in almost all cultivable land, in the village side. Paddy and rubber are also seen in some areas. The R&R packages include the compensation for the loss of such vegetation, considering the type of plant and annual yield. Generally people are hesitant to cultivate in such land once they come to know that the land will be acquired soon and they even cut all the timber trees.

7.1.4.7 Expected Compensations - Rail

People expect adequate compensations for their loss and they are aware of the R&R packages offered. When asked to mark their expectations 67% of the people demanded cash compensation for the loss. Those who lose residential properties are worried as they are not sure of constructing a similar or better building with the offered sum. As per the R&R policy the living standard of the people after rehabilitation shall be equal or better off and never worse than is an important aspect to be considered. In general, all of them welcome the port at Vizhinjam and feel that it will help to improve their status too, due to the fast economic development envisaged. The opportunities for better employment is one such expectation and many demanded that they must be considered for employable opportunities in the port or associated developments, giving reservations for compensating their loss and sacrifice. The details of compensation expected are given **Table 7-13**

Table 7-13: Compensation Expected - Rail

Compensation	Number	Percentage (%)
Cash Compensation	231	67
Cash and Land	90	26
Cash and Employment	9	3
Cash, Land and Employment	14	4
Total	**344**	**100**

The land value is shooting up day by day in this area because of these developments and those who lose land are apprehensive whether they can purchase alternate land with the compensation money in the same area. So they demanded quick settlement of payments after clearing the land acquisition processes.

7.1.5 Extent of Impact – Ancillary Sites

7.1.5.1 Backup Areas in the vicinity of proposed port

The total land notified for the backup area (designated as 1 & 2) in Vizhinjam village is 17.97 Ha (44.39 acres). The total amount estimated for the land acquisition will be INR 1290.71 Million (₹ 129.07 Crores). Now as per the port master plan, VISL propose to purchase 5.39 Ha (13.31 acres) of land in the middle portion abridging the backup area 1 and 2 (backup area 4) and north of back up area 1. **Exhibit 7-7** and **Exhibit 7-8** show partially felled coconut plantations by the owners prior to handing over to VISL. Out of notified land, 11.32 Ha (27.97 acres) of the land has been purchased (at the time of the survey) and taken into possession for the backup areas at a cost of INR 906.98 Million (₹ 90.69 Crores). **Table 7-14** gives the breakup of land already procured.

Table 7-14: Land Details of Backup Areas Already Procured

S. No.	No. of Properties	Owners	Extent of Land		Details
			Acres	Ha	
1.	1	108	26.32	10.65	106 persons posses less than one acre land
2.	2 to 3	5			-
3.	5 to -6	2			
4.	20	1	4.46	1.80	Vimal Jyothy Singh
5.	59	1	7.49	3.03	C. D. Vincent (Chemmannur)

S. No.	No. of Properties	Owners	Extent of Land		Details
			Acres	Ha	
6.	82	1	3.68	1.49	K. Muraleedharan (Muralaya properties)
Total		**118**	**41.95 acres**		**16.98 Ha**

The land for the backup area is prime property with tourism value and 37% of these properties were owned by three property developers as detailed above. 90% of this land is coconut trees, 5% paddy and 5% coastal sand.



Exhibit 7-7: Felled Coconut Plantations



Exhibit 7-8: Coconut Trees in the Backup Area

There are 280 properties owned by 109 PAP's in this area. Among them 29 are residential PDP's to be rehabilitated. Three resorts viz. Eco Topia (Panavilakode), Coral reef (Mulloor) and Seven Leaves (Mulloor) in this area are displaced. Land value was fixed by DLPC (District Land Purchase Committee) and approved by the government.



Exhibit 7-9: Coral Reef Resort at Mulloor



Exhibit 7-10: Eco Topia Resort at Panavilakode



Exhibit 7-11: Houses in the Backup Area



Exhibit 7-12: Avoided Temple in Backup Area

7.1.5.2 Additional Land Proposed to be Purchased for Backup Area

Details of additional land to be procured for backup area and other facilities by the road side are summarized in **Table 7-15**.

Table 7-15: Additional Area to be procured

Location	Extent of Land	Extend of land in Ha
Area in north (Backup area 3)	3.58	1.45
Area between backup 1 & 2 (Backup 4)	9.73	3.94
Total	13.31	5.39

As discussed earlier 5.39 Ha (13.31 acres) of additional land is required to be purchased vide port master plan in the backup area for the navy/ coastguard) and for operators service area for all the phases, entry/exit gate area, customs/security/scanner facilities, waste treatment facilities including connectivity between backup area south & north (3.94 Ha/ 9.73 acres) and 99 properties will be impacted. Of these3.86 Ha (9.54 acres) is owned by Thapovan Heritage home and Coconut bay (49.38%) and the remaining by different owners. 95 plots in this are compounds with compound walls and 77 numbers are open lands. There are 4.09 Ha (10.1 acres) of Government land in this area which includes two ponds and Panchayat roads.

7.1.5.3 Project Annex Facility Zone (PAF Zone)

The total land availability for the PAF zone is 19,87 Ha (49.10 acres) in three separate land parcels. The total amount estimated for the land acquisition will be INR 1500 Million (₹150.00 Crores). These two land parcels are free from major dwellings or village areas. **Exhibit 7-13** shows partially felled coconut plantations by the owners prior to handing over to VISL. So far most of the land for the PAF zone has been procured and taken into possession (19.02 Ha of the 19.87 Ha required). Land acquisition cost was accounted to be INR 1185.88 Million (`118.58 Crores) with another INR 49.99 Million (₹ 4.99 Crores) remaining. Land value was fixed by DLPC and approved by the government. There are 102 properties with various survey numbers in this PAF zone owned by 69 PAPs. Out of these only nine residential PDP's need resettlement. Of the land owners 62% possess less than 30 cents of land, and another 19% possess more than 30 and up to 100 cents. The remaining 19% possess more than one acre and up to 5 acre. 95% of these lands are coconut trees and 5% open scrub and 5% buildings. **Exhibit 7-14** to **Exhibit 7-16** shows some PDPs in the PAF zone.



Exhibit 7-13: Coconut Plantations



Exhibit 7-14: PDP in the PAF Zone



Exhibit 7-15: PDP in the PAF Zone



Exhibit 7-16: PDP in the PAF Zone

Table 7-16 gives the extent of land owned by people in the PAF zone.

Table 7-16: Extent of Land and Owners in PAF Zone

S. No.	No. of Properties	No. Of properties (Ha)	Owners	Details
1.	Less than 30 cents	<0.121	43	62%
2.	30 to 100 cents	0.121 to 0.405	13	19%
3.	100 to 200	0.405 to 0.809	4	19%
4.	200-300	0.809 to 1.214	2	
5.	300-400	1.214 to 1.619	4	
6.	400-500	1.619 to 2.023	3	
102 properties			**69**	**Total**

Compensation was paid accordingly to all PAPs and PDPs. About 1.012 Ha (2.5 acres) of land from the PAF zone towards south area will be allotted for R&R sites.

7.1.5.4 Warehouse Area

Land purchase for the warehouse area 41.53 Ha (102.58 acres) has been initiated and is estimated to cost INR 2438.63 Million (₹ 243.86 Crores). There are three categories – 106 Properties under A category, 151 Properties under B category and 605 Properties under C category. Approval of this valuation was only recently approved by government. While the Land value fixed by DLPC was pending approval with the Government, two years were completed on July 28, 2012, after 4(1) notification and hence it was de-notified and then re-notified.



Exhibit 7-17: Land and Road in Warehouse Area



Exhibit 7-18: Road side Pumping Station of KWA

Now in the context of government approval the valuation and procedure for payment and purchase are progressing and 4.37 Ha (10,79 acres) have been purchased till 10th May 2013. There are 614 PAPs owning up 862 properties, which mean that many PAPs own more than one property. 85% of these properties are coconut trees and remaining 15% banana, paddy and other plantations. Karichal River and Poovar West Canal runs parallel to these plots and KWA has installed a pumping station in it. **Exhibit 7-17** shows the road running parallel to the warehouse area and **Exhibit 7-18** shows the KWA pumping station next to the road.

For the SIA only 125 PAPs were interviewed (20%) as the landowners are staying in faraway places and was not available for interview. People complained that the LA process is unduly delayed as almost two years is over after the LA notification. This has caused several problems such as they stopped agricultural activities in the land and the yield is very bad now which caused heavy loss. Another issue is that those who wish to sell their land for meeting various needs like to arrange the marriage of their daughters or to send the children for higher studies are handicapped because of the LA notification as no transactions are possible. Several of them complained that illegal sand mining is done in several of their lands by miscreants causing severe damage to the properties. All of them wanted GOK to take up the land immediately paying compensation and are happy about the compensation value fixed. Some NGOs in the area submitted a petition to the authorities that these are wetlands and need to be protected. There was heavy reaction from the public when enquired about this as they own up the land and is doing agricultural operations mainly coconut plantations since 30 years. Now as the process of LA is proceeding as the Government approved the land value and people are happy about the proceedings.

7.1.5.5 Additional Land to be Procured Adjoining the Road

An area of 2.43 Ha (5.99 acres) of land adjoining the approach road will be additionally procured for the development of greenbelt, rainwater harvest area, resting/restaurant place for truck drivers/helpers, etc. This land belongs to 105 land owners which is agricultural property without any structures in it, and forms part of the bits & pieces of land remaining after the earlier purchase of land for the proposed 2 km stretch of port access road.

7.1.6 Resettlement & Rehabilitation for the PDPs

For the project displaced persons who lost their residence, Government vide the G.O (ms) No. 42/10/F & PD dated 29/1/2010 ordered to provide five cents of land as rehabilitation sites in nearby areas.

Squatters or those in possession of land/house without pattas/documents are also given five cents each for rehabilitation compensation for structures, though they will not be paid for the purampokku land occupied.

For the PDPs of the road connectivity/backup area/PAF zone sites, 3.60 acre of land was purchased and divided in to 50 plots with road access, and is distributed as R&R plots. These plots are located in survey nos. 606/5 and 606/6 on the right side of the road turning to right from Mulamukku Junction in Mukkola-Balaramapuram road.

In a meeting on 16/08/2012, 31 PDPs were invited at the office of the Special Tehsiladar for Land acquisition at Vizhinjam port project to allot the lands. Tehsildar explained the formalities for selection of plots by lots and showed them the sketch of the plots divided in to 50 plots. Out of these 31 plots were selected by these PDP,through lots picked by them numbered from 1 to 31.

Remaining PDPs were also accommodated in the remaining area and some area of the PAF zone also is divided in to R&R plots to accommodate the remaining PDPs. It is ensured that all these plots have road access, electricity and water connections. Many PDPs obtained better plots than their lost properties with road access and other facilities.

For PDPs of warehouse and rail connectivity sites, appropriate rehabilitation sites will be identified in respective areas, to resettle them properly.

7.1.6.1.1 Impact on Cultural Properties

There are no known archaeological sites in the acquired or to be acquired ancillary sites areas.

7.1.6.1.1.1 Religious Properties

There is a Bhagavathy temple in the backup area which is an age-old temple overlooking the sea. This temple land will not be acquired and an access road to reach out to this temple is provided and will be maintained as statues quo. There is a money collection box (hundi) established at Mullur beach and a Naga temple behind it at the backup area. This Hundi has to be removed for the approach road construction but the temple will not be impacted. **Exhibit 7-19** and **Exhibit 7-20** show pictures of a temple and a hundi.

Some groups of temples can be seen very close to the backup area at Panavilakode but these will not be directly impacted but the approach road will have to be shared.



Exhibit 7-19: Chamundi Temple North of Backup Area



Exhibit 7-20: Hundi Established at Mullor Beach

7.1.6.1.1.2 Holy Cross

There is a Holy Cross (Christian) established facing the sea in the southern end of the backup area, will have to be shifted. The impacted cultural properties by way of proximity to backup area operation during construction and operational stage shall be enhanced with adequate budgeting in the EMP related BoQ. Cultural property enhancement measures for all three cultural properties close to the project ancillary developments need to be incorporated in the CSR fund.

7.1.6.1.2 Impacts to Common Property Resources

No common property resources like ponds, bore wells, hand pumps, etc. were found in the proposed backup areas. Four open wells located in the backup areas may be avoided from filling as this could be used for the sites.

7.1.6.1.3 Transport Connectivity

The backup area is part of the road connectivity and therefore is well connected to the road network. Internal roads are also available as shown in the high resolution Google imagery (Exhibit 4.1) just west of the Temple marked. Otherwise the backup areas are connected to the seaside. This will provide adequate access provisions from the road, rail and port areas facing the seaside.

7.1.7 Stakeholder Consultations

Consultations with the stakeholder groups have been an integral part of the SIA process. The purpose of these consultations was to:

- Identify issues of PAPs related to the project and discussion of measures to address the same,
- Developing sense of ownership,
- Get support for the project, and
- Integrate and address their concerns through suitable measures in the project design and implementation.

The stake holder cooperation to carry out these activities was praise worthy especially from Fishing communities and Tourism resort communities. Details of these consultations are also provided in the subsequent sections.

7.1.7.1 Consultation Process

Stakeholder consultations were done formally and informally throughout the project process viz during pre-feasibility, feasibility, Social and Environmental Assessment and preparation of Social Management Plan. These consultations are usually carried out in formal, informal manner or in forms of focus group discussions. Such consultations helped in improving the project design and thereby improve the quality of planning. Participatory planning was the prime tool for mitigation measures which brought out the ***'felt needs and problems'*** of people more realistically. The stakeholders can be categorized as primary and secondary stakeholders. Primary stakeholders are those with direct impact of the project, positive or negative, on them. Those whose land and assets acquired for the project will be direct primary stakeholder and those who will be impacted by the project due to loss of common property resources, or benefited due to the nearness of the project, etc. are indirect primary stakeholders. Both are those living in the project area or very close to it. Secondary stakeholders are those who will impact the project directly or indirectly, through their interventions and this includes

institutional stakeholders from Government or private organizations represented by chief functionaries working there. The primary and secondary stakeholders of this project are listed in **Table 7-17**.

Table 7-17: Identified Stakeholders of the Project

Primary Stakeholders	Secondary Stakeholders
• Project Displaced Persons (PDP) • Project Affected Families (PAF) • Project Affected Persons (PAP) • Squatters • Encroachers • Project impacted communities • PAPs and PAFs in the road-rail connectivity alignment and in the buffer zone	Institutional stakeholders such as • Kerala State Pollution Control Board (KSPCB) • State Science Technology and Environment (CRZ related) • Ports Department • Project Proponent – VISL • Revenue department • Department of Roads and Buildings • Ground water/surface water/irrigation departments • Sanitation departments • Agricultural department • Fisheries department • Forests Departments • Tourism department • Non Governmental Organizations (NGOs) active in the area • Local self governments (LSGs) – Panchayats, municipalities and Corporation • Political parties • Religious institutions • RVNL, RITES • Associations of tourism resorts, fishermen, agriculturists, residents etc. • Trade unions, etc.

Focus Group Discussions (FGD) in Fishing Villages: 28 FGDs were conducted in 22 coastal villages, located up to 25 km in the Northern side and 15 km towards the southern side of the Project stretch, to understand the perception of the fishing population about the proposed Project. People stated that they had little idea about the proposed Vizhinjam Port Project. The community members who were aware of this Project generally had negative perceptions of the Project. The following key concerns are important:

- Access to the sea in the proposed terminal area will be obstructed.
- There is no scope for alternative employment as a) most fishermen are either un-educated or do not possess sufficient educational qualifications (most are non-matriculates) to seek alternate jobs; b) unskilled and semi-fishing has been their traditional livelihood and have never been exposed to other alternative jobs.
- Wave pattern may change resulting in sand deposition and erosion of beaches, potentially resulting in the loss of fish landing centres and fishermen's houses near to beaches.
- Diseases like STDs, HIV/AIDS, and antisocial activity like child trafficking and sex trade may be introduced in the area as a result of the Project.
- Risks of collision of fishing vessels with ships, loss of fishing equipment in accidents with ships and/or damage to fishing nets due to the passing of ships were also of serious concern.



Exhibit 7-21: FGD At Kochuthope



Exhibit 7-22: FGD At Kochuthope another view



Exhibit 7-23: FGD at Kovalam



Exhibit 7-24: FGD at Vizhinjam South

Exhibit 7-21 to **Exhibit 7-24** shows photographs of FGDs in various fishing villages.

Focus Group Discussions in Resorts: FGDs were conducted during the social survey in nine resorts, i.e. in around a third of the resorts present in the shadow zone of the breakwater and approach channel. These included the Travancore Heritage, Vayalkara, Coconut Bay Resort, Surya Samudra, Nikki's Nest, Somatheeram beach resorts, Somatheeram Ayurveda and Manaltheeram. Apart from the resorts, FGDs were also conducted in tourist places namely Kovalam and Mulloor. Totally 15 FGDs were conducted. Major concerns of the people involved in tourism sector are described below:

- Noise and air pollution from the proposed construction and, later, from operation of the Port may occur thereby decreasing the tourist flows & leading to closure of the resorts and loss of jobs.
- If the tourist inflow decreases, tourism-associated economic activities will suffer i.e various social services and local handicrafts.
- Most of the resorts are dependent on Ayurvedic treatments and Spas, whose effectiveness is strongly linked to the existence of attractive beaches and microclimates of the area, which would be spoiled and changed by the Port development. This might lead to loss of business mainly dependent on foreign tourists, thereby creating a loss of current revenue provided by the tourism industry to the State.



Exhibit 7-25: FGD at Coconut Bay Resort



Exhibit 7-26: FGD at Manaltheeram



Exhibit 7-27: FGD at Surya Sumudra



Exhibit 7-28: FGD at Somatheerum Resort



Exhibit 7-29: FGD at Nikki's Nest



Exhibit 7-30: FGD in Kashmiri Shop at Kovalam

Exhibit 7-25 to **Exhibit 7-30** shows photographs of FGD at various resorts and related establishments. In addition to the resorts, mails were received from foreign tour operators with respect to the Ayurveda resorts in the proposed Project area. These mails also emphasised the potential adverse impacts of this Project on tourism

Major Social Concerns Raised by Stakeholders in Focus Group Discussions

- Generation of Noise and air pollution, which will alter the calm and aesthetic nature of the region.
- Risk of ecological marine changes resulting from Project execution
- Both direct and indirect loss of employment amongst the fishing community
- Decrease in employment in the tourism sector
- Introduction of new diseases and pests into the area
- Possibility of changes in wave and current patterns resulting in the increase of shoreline erosion/accretion, thereby changing the existing coastline and impacting on local livelihoods

7.1.7.2 Informal Consultations

Consultations with the primary stakeholders were meeting with the potential project affected families and those around likely to be impacted in the project area (**Exhibit 7-31** to **Exhibit 7-36**). They include agricultural-commercial- residential PAPs, squatters, encroachers and users of common property resources likely to be impacted. These consultations could be one to one consultations involving two to ten people. Local ward members were contacted during such field visits, who helped in establishing rapport with the local communities. During social surveys, the social surveys team had extensive consultations with the project affected/ displaced communities and the details of each family were recorded in the data sheets. Well structured questionnaires were used for collecting information about the socio-economic background and likely impact of the project on them with suggestions for mitigative measurers.



Exhibit 7-31: Local Informal Consultation



Exhibit 7-32: Local Informal Consultations II



Exhibit 7-33: Consultation with PDP Backup Area



Exhibit 7-34: Along the Road Alignment



Exhibit 7-35: Interview with a Shop Owner



Exhibit 7-36: Road Bordering Warehouse Location

People generally have a welcome attitude towards this project as Vizhinjam port project was a long cherished hope of the local communities. But people have several apprehensions about the land acquisition process are more keen to get clarifications about compensations and other resettlement and rehabilitation packages. All relevant government orders and policies of LA and resettlement and rehabilitation packages were explained to them and copies were made available in LSG offices, for cross reference. Their suggestions for mitigate measures to reduce the negative impacts were noted down and incorporated in the project designs, as far as possible. Minutes of the Meeting (MoM) were documented and circulated to all decision makers. Minutes of the public consultations at Grandasala, Kottukal Panchayat with the PAPs of warehouse area on May 31, 2012 is given in **Appendix 7.3**. Such meetings were also video documented.



Exhibit 7-37: Auction – 1, Far South of Vizhinjam



Exhibit 7-38: Auction – 2, South of Vizhinjam



Exhibit 7-39: Fish Catch, South of Vizhinjam



Exhibit 7-40: Ward Councillor at PAF zone

7.1.7.3 Formal Community Consultations

Formal Community consultations (**Exhibit 7-41** to **Exhibit 7-44**) are organized in each area, with the support of the VISL office, issuing formal invitations to the participants. Vide publicity was also given through notice boards in Public places and local news papers. Common meeting places such as Panchayat offices, Government office premises, guest houses, public meeting halls connected to the temples/churches, schools, etc. were utilized as per convenience in each area. Minutes of the community consultations at backup area and PAF zone on May 31, 2012 is given as **Appendix 7.4** & **Appendix 7.5** respectively.



Exhibit 7-41: Project Affected Persons



Exhibit 7-42: Formal Consultation – Backup Area in the Acquired Building



Exhibit 7-43: Recording of Events by VISL



Exhibit 7-44: VISL Team explaining at Backup Area

7.1.7.4 Project Specific Consultations

Project specific consultations were organized for the road and rail connectivity sites to discuss specific issues raised by the local people and civil society details are summarized in **Table 7-18** and detailed minutes annexed.

Table 7-18: Specific Consultations

Venue, Date & Participants	Issues Raised by the Public	Response of the Project Proponent
Meeting at Krishnavilasom N.S.S. Karayogam, Mulloor 9th February 2012, 11.00 a.m. (**Appendix 7.6**) Participants Temple committee members Officials from CWRDM-Neyyattinkara, and CWRDM Kottayam regional offices Central Groundwater Board (CGWB) State Ground Water Department, P.W.D, Design team for the road Environmental /Social Consultants from L&T RAMBOLL, Officials from VISL (**Exhibits 7-45** to **7-48**)	1. Proposed road connectivity to Vizhinjam port through Mulloor area will bisect the Temple pond of Mulloor Sreekrishna-Siva temple	• Pond will be protected making appropriate design changes in the road • Temple pond will be protected with lining for better conservation • Officials of CWRDM, Ground water department and PWD (road division) will assess the possibilities
	2. Height of the proposed road connectivity near the bye-pass junction is 8 m and is a source of concern. It will curtail the social interactions and hinder annual religious rituals of the temple. 3. Road safety issues another concern	• Modified design for road lowering to ground level with junction development will be considered • Road safety measures will be ensured.
	4. Local apprehensions about further land acquisition for rail connectivity	Explained that the Rail connectivity will pass through Kottapuram and hence will not be further impacted.
	5. Protection of the Panchayat pond near Thalacode, used by the local community.	Pond will be conserved. If required the pond in will be further extended towards east acquiring land, after verifying the ground water potential of the area.

7.1.7.4.1 Meeting to Explain about the Rail Connectivity to Vizhinjam Port

A meeting of various key stakeholders was organised at the Government Guest House Thiruvananthapuram to explain about the proposed rail connectivity from Neyyattinkara to Vizhinjam Port. RVNL who prepared the DPR, made a detailed slide presentation and this was followed by discussions. Ministers for Ports, Minister of Transport & Devaswom, Deputy Speaker, MLAs, etc. participated in this meet. Details are summarised in the following Table.

Table 7-19: Specific Consultations II

Venue, Date & Participants	Issues Raised by the Public	Response of the Project Proponent
Rail connectivity	1. RVNL report says that the Rail	• RVNL entrusted to study

Venue, Date & Participants	Issues Raised by the Public	Response of the Project Proponent
Vizhinjam port- Stake holder consultation meeting at Thiruvananthapuram Government Guest house on Dec 20th 2011 2.30pm -5.00pm All-party meeting (**Appendix 7.7**) Shri. K Babu Minister for Ports, Shri. Siva Kumar, Minister for Transport and Devaswom Board, Shri. Sundaran Nadar, Deputy Speaker, MLAs Smt. Jameela Prakasam and Shri. Sivan kutty participated Stakeholder representatives includes leaders of all political parties, NGO leaders, Press people, CBOs, etc Official representation from VISL, RVNL, other related Departments, and LTR Consultants	alignment from Neyyattinkara to Vizhinjam will impact 4 temples and 114 buildings including residential plots, shops and offices. 2. Demand of stakeholders to save ancient temples especially Koottappana Maha deva temple	alternate alignment • Possibility to divert to Nemom railway station to be assessed. • RVNL studied and submitted the technical feasibility to shift to Nemom
	3. At Vizhinjam Port area the rail line passes through the shore and will impact shoreline fishing. 4. Apprehensions about the impact of the port and rail connectivity on fishermen colonies	• Explained that the proposed rail alignment at the coastal side will be on 4- m high pillars and will not impact access to the sea and shoreline fishing activities • A detailed study will be done in 10 km radius to assess the impact • Appropriate mitigative measurers and R&R packages will be worked out to compensate the livelihood loss
	5. Apprehensions about acquiring 48 hectares of land including wetland, dry land and some Govt land for laying the tracks.	• R&R package of the Government will take care of the issues • Copy of the G.O on R&R package made available to LSGs and political leaders for reference
	6. Anxiety about the watershed in the agricultural lands in the area due to the construction works	• Appropriate ground water studies will be done and measures taken to protect the drains and watershed



Exhibit 7-45: Official Site Visit at Mullor Pond



Exhibit 7-46: Officials Inspecting the Pond/Road Sites



Exhibit 7-47: Meeting in Progress



Exhibit 7-48: Discussion on Various Issues

A GoK initiated district level stakeholder meeting held at Government Guest House at Thycad, Thiruvananthapuram (**Exhibit 7-49** to **Exhibit 7-51**). All consultants and VISL officials participated and the local elected member (MLA) was also present. She has emphasised the need for supporting the livelihood of the affected fishing communities and requested to include this as a priority in the CSR.



Exhibit 7-49: Consultation with local elected member (MLA)



Exhibit 7-50: Presentation at Government Guest House



Exhibit 7-51: Stakeholder Consultation in Progress

7.1.7.5 Institutional Consultations

Institutional consultations were carried out with the State level regulatory agencies such as CRZ committee and Kerala State Pollution Control Board (KSPCB). Meetings with the various institutions at the project district i.e. Thiruvananthapuram has been taken up to understand their concerns and views about the project development. The inputs from these stakeholders were helpful to improve the overall design of the project and sub projects. As a part of the reconnaissance site visit the team leader and

the senior environmental engineer carried out the consultation with the State level regulatory agencies such as CRZ committee and Kerala State Pollution Control Board (KSPCB).

7.1.7.6 Consultation with State Science and Technology Department

The consultant team met Dr. K. Kokkal, Principal Scientific Officer & Head (Coastal & Environment Division, KSCSTE) and Mrs. Alphonsa, The Under Secretary and discussed about CRZ and CZMP of Kerala State Govt and its relevance to the VISL port. The implication of the project development on coastal stretches of Vizhinjam Port relating to shoreline changes and maritime ecosystem was also discussed.

7.1.7.7 Consultation with Kerala State Pollution Control Board

Consultant team met the Member Secretary of the Kerala State Pollution Control Board in order to have information regarding the acts, rules, laws, policies and guidelines that can be followed in maintaining the environment sustainability of the project and thereby controlling the pollution. As KSPCB is also an important stakeholder of the project playing an important role in pollution control and abatement and thereby helping in enhancing and maintaining sustainable development of the project area.

7.1.7.8 Consultations with PRIs (Panchayats, Corporations and Municipalities)

Consultations with the Local Self Govt (LSG) offices in the project area were most important for micro level planning of the infrastructure requirements. The elected representatives helped the social survey teams' visiting their area to conduct the survey successfully mediating with people. They also provided additional information about the water bodies such as ponds, canals and drains, etc. in the project area and details of Panchayat roads and public property resources from the office records available in the LSGs. The support of the elected representative of each area in furnishing the details of PAPS not available in the area was very much helpful. All these helped in the integration of the stakeholder concerns and requirements at Panchayath levels and contributed to multiply the benefits for better appreciation from the local communities. Consultations focused mostly on the four Panchayaths influenced by the project viz- Vizhinjam (Thiruvananthapuram Corporation), Venganoor, Kottukal and Balaramapuram. In these consultations the details and status of local planning for development were also assessed.

7.1.7.9 Meeting with Women Groups

Women members and groups were given special attention in house to house consultations and in focus group discussions (**Exhibit 7-52** to **Exhibit 7-54**). With 50% representation of women PRI leaders in the area, their voice is well represented. Kudumbashree mission under the Local Self Government's poverty eradication mission is a group of self help women spread over the State and they are empowered to interact and share their views and opinions. Meetings with Kudumbasree and other women groups in the area was helpful to collect information from the women point of view.



Exhibit 7-52: Stakeholder Posing Questions during the Session



Exhibit 7-53: Explaining the Facts



Exhibit 7-54: A Woman Stakeholder

7.1.7.10 Consultations with NGOs

NGOs in the project area have significant influence on the people who organize them for various causes. It is important to have consultations with genuine NGOs to learn their views and concerns. There are several active interactions (**Exhibit 7-55** to **Exhibit 7-58**) with NGOs working among various groups of people such as Thiruvananthapuram Social Service Society (working with Christian fishermen - Community consultations at Bishop House Vellayambalam; dated May 30, 2012 is given as **Appendix 7.8**), Jamaath committee (working with Muslim fishermen), Janapaksham (general public interested in port development; consultations held on May 30, 2012 is given as **Appendix 7.9**), etc.



Exhibit 7-55: Meeting at Thiruvananthapuram



Exhibit 7-56: Section of the Participants



Exhibit 7-57: Social Service Society Officials at Bishop's House



Exhibit 7-58: NGO Janapaksham Meeting

7.1.7.11 Meeting with Civil Society Organisations

Consultation meetings (**Exhibit 7-59** to **Exhibit 7-62**) were also organised with civil society organisations like Chamber of Commerce, Citizens forum, etc. The project details were explained to them and all of them supported it whole heartedly. Vizhinjam port is a long awaited dream and they expressed their wish that it will boost up the development of the State and business sector. Tourism sector is a bit apprehensive about the business at shore area, at least during construction phase. The possibility of a cruise terminal was welcomed by the tourism sector and it is expected to boost up their business too.



Exhibit 7-59: VISL M.D. Addressing the Audience



Exhibit 7-60: Consultant Explaining the Facts



Exhibit 7-61: Meeting with Chamber of Commerce



Exhibit 7-62: Local Vizhinjam MLA at Thiruvananthapuram Hotel

7.1.7.12 Framework for Continued Consultation

The consultation would be continued as the project enters the implementation stage. Several additional rounds of consultations with PAPs and local communities will have to be undertaken with the help of Package NGO. These consultations during SMP/RAP Implementation should help to reach agreements on compensation norms and R&R options and entitlements. Further consultations will be held when compensation and R&R assistance are provided and actual resettlement begins. The following set of activities will be pursued for effective involvement of stakeholders in the implementation of SMP/RAP.

- For the benefit of the affected community, the executive summary of RAP and R&R entitlement framework will be translated into Malayalam and will be disclosed at local public offices and for easy access to RAP related information
- Key features of the R&R entitlements will be displayed in billboards along the project Corridor
- Together with the NGO, Social Management Unit (SMU) will conduct information dissemination sessions in major intersections and ensure involvement of local community and encourage their participation in RAP implementation
- Focus attention will be made for vulnerable groups to ensure that their specific needs are addressed
- Package NGO will organize public meeting, and appraise the communities about the progress in the implementation of SMP and project works
- Update census survey data through field level verification by Package NGO and this should be done by involving affected communities. This will help in updating their R&R options and issuance of ID Cards to eligible PAPs
- Package NGO will record options and preferences (if changed) of each PAP about R&R entitlement and update them on regular basis.
- Package NGO will organize public meetings to inform the community about the disbursement of R&R entitlements to the eligible PAPs.
- Updated status of SMP/RAP implementation will be placed for public display at Package office
- Involvement of local (including affected) communities will also be ensured through their participation in various local committees such as, VLC, DLC, and R&R Committee (for addressing grievances). State management unit (SMU) will maintain an ongoing interaction with PAPs to identify problems and undertake remedial/correction actions.

7.1.8 Impression of the PAPs about the Project

During the interactions with the people as part of the SIA, it was felt that Vizhinjam port is a long cherished dream of all people concerned and they are looking forward for the same. They know that the port will bring total development and prosperity to the area and they will get more life opportunities. The positive and negative perceptions of local stakeholders with respect to the project, as heard in various public consultations, FGDs and from the household survey, are summarised below.

Perceived Benefits:	Perceived Risks:
• An opportunity to develop the area and the quality of life of people. • A great opportunity to increase the financial status of government. • Development of institutions like schools, colleges and offices and health care facilities • Agricultural development through better irrigation facilities. • Better infrastructural development, road and transportation facility and property values. • Better employment opportunities. • Improvement of cultural and social affairs. • Development of small scale industries and overall development of the economy, technology and communication system. • Increase in export and import business.	• Increase in corruption. • Depletion of natural resources due to inflated demands. • Change in worker and employer relationships. • Challenges to traditional norms and value system due to introduction of new culture. • Traffic and congestion. • Increase in crime rate. • Introduction of new diseases including HIV and pests due to influx of peoples and containers.

The response of the people surveyed is summarized in the **Table 7-20**

Table 7-20: Impression of PAPs about the Vizhinjam Port project

Impressions	Frequency (Number of Persons)	Percentage (%)
Very good	63	21
Good	218	73
Bad	1	0.3
Neutral	13	4.3
Apprehensive	3	1.4
Total	**298**	**100**

94% gave a good or very good impression about the port and associated developments. 6% are apprehensive, neutral or negative in their attitude. Even those, whose properties are impacted, welcome the project but demand reasonable compensations for their loss. While welcoming the development of the port, people have several apprehensions about the shooting up value of the land, rising living standards, presence of strangers, possibility of increased crimes in the area, safety issues, etc. But they are sure that such developments will change the face of the area creating more economic opportunities for them. More employment and business development opportunities are dreamed by all and the project affected families (PAFs) demanded priority considerations for their 'sacrifice' giving them weightage in employments related to the port. Over exploitation of the natural resources like water and dumping of the waste materials is another concern and they want adequate interventions of the authorities in all such issues while planning ahead. However, the following demands were put forth by them which need to be considered by giving due weightage.

- With the developments, the cost of living in the area also will raise up. To compensate, better employment opportunities need to be given to local people. Reservations for jobs to those whose land is acquired.

- Over exploitation of the natural resources like water and dumping of the waste materials is another concern and they want adequate interventions to provide enough water to the local people and ensure environmental sanitation of the area.
- Since the port will impact the fishing harbour and thereby the livelihood of fishermen, adequate compensations must be ensured to safeguard the life of fishermen of the area.

Along with the development of the port adequate funds need to be set apart under '**Corporate Social Responsibility'** for the overall planned development of the area.

7.2 Preliminary Risk Analysis

This section addresses proposed project actions related risks associated with explosion, fire, or release of hazardous materials in the event of accident or a natural disaster. Risk analysis is an extensive hazard analysis, which involves the identification and quantification of hazards. Risk analysis involves assessment of the damage, injuries and financial costs likely to be sustained in a geographic area over a given period of time.

The main objectives of the risk analysis studies are:

- To define and assess emergencies
- To control and contain incidents
- To safeguard employees and people in vicinity
- To minimise damage to property and environment
- To inform the employees, the general public and the authority about the hazards / risk assessed, safeguards provided, residual risk if any and the role to be played in them in the event of emergency
- To inform authorities and mutual aid centres about the potential hazard
- To secure the safe rehabilitation of affected areas and to restore normalcy
- To provide authoritative information to the media.
- To preserve records, equipment, etc., and to organise investigation into the cause of emergency and preventive measures to stop its recurrences.

The phase-I of port will handle container, multipurpose cargo including timber, raw cashew and cruise terminal. The following risks are associated with the establishment of proposed project:

- Fire and Explosion risk.
- Marine and Land based traffic accidents.
- Leakage and Release of Oil/Hazardous Materials.
- Risks associated with use of Heavy Equipment.
- Natural Hazards.

The analysis of risks is an extensive hazard analysis to identify and quantify the hazards and assessment of the damage, injuries and financial cost. Based on project details and the baseline environmental status, possible risks to the proposed port site and its surrounding have been identified with possible measure/initiatives.

7.2.1 Natural Hazards/Calamities

The selected site is affected by the following natural events:

7.2.1.1 Flood

With 3000mm annual average rainfall (AAR) the State is one of the high rainfall regions of the world. Thiruvananthapuram district (PIA district) experiences localised flooding due to heavy rainfall especially during the SW monsoon, resulting damage to life and property. The PIA district comes in high risk zone. As per GoK (2006), two taluks and 13 villages in the district are flood affected areas. The project can be affected by flash floods, which occurs on the coast when high intensity rainfalls in a localised area happens over a short period of time, in combination with high and spring tide. Most of the flooding problem in the area is due to poor or choked drainage conditions

The port authority shall consider the following precautionary measures to meet any such events:

- Drainage routing to check blockages along the drainage
- Conduct flood route analysis.
- Installation of water pumping stations.
- Installation of warning systems (alarm, audio-visual public address system, etc.).
- Coordination with State and district level disaster management authorities.

7.2.1.2 Cyclone and Wind Storm

The State is also vulnerable to cyclones and experiences high winds due to the westward movement of the cyclonic storms crossing the Tamil Nadu coast. Almost 96.9% of the State falls in high wind speed areas. Thiruvananthapuram district falls under medium level risk zone.

The following initiatives shall be taken:

- Engineering designing for the port facilities such as buildings, transmission systems, storage facilities, etc. will be based on national level codes/standards for buildings and facilities.
- Coordination with State and district level disaster management authorities.

7.2.1.3 Coastal Hazards

Coastal Hazards such as erosion, storm surge, tidal waves, swell waves, etc.; have the potential to harm the people, property and the environment.

The following initiatives shall be taken:

- Strict shoreline monitoring programme shall be undertaken.
- Erosion control fabrics in critical areas if any.
- Establishment of shoreline protection wall if required.
- Coordination with State and district level disaster management authorities.

7.2.1.4 Tsunami

The Tsunami was one of the most devastating disasters in modern history. In 2004, Indian Ocean Tsunami struck the 11 countries and killing more than 225,000 people. In Kerala, Tsunami waves hits Kollam, Ernakulam and Allapuzha districts of Kerala, which resulting death of 177 persons and 13,735 damaged houses.

Although these are rarest events and the port facility is planned for more than 50 years or so the following measure shall be taken:

- Safety measures in accordance with mathematical study of Tsunami wave's height with respect to mean sea level (MSL).
- Tsunami Warning Systems.
- Coordination with State and district level disaster management authorities.

7.2.1.5 Earthquake

As per Seismic Zoning Map of India, the project area falls under Zone-III (moderate to low risk zone) as per the IS: 1893, Part-I, 2002. With regards to Earth quake all design of the facilities should incorporate factor which would give the required structural integrity.

7.2.2 Man-Made Events

The risks of the man-made events on the project site and its surroundings like fire/explosion, ships collision; release of hazardous materials, etc. have been considered appropriate for analysis.

7.2.2.1 Ships Mishaps/Vessel accident

During towing and berthing of the ships, owing to natural calamity or piloting errors, there can be remote possibility of mishap of one to one ship collusion or ship hitting against the wharf or ship getting grounded. During such events, the ship may sink/break and could lead to accidental oil spill inside the port basin or in the vicinity. The ships mishaps/collusion shall be avoided by adopting following measures:

- Direct, control and manage the movement, position, timing and manner in which a vessel may enter and leave the port waters.
- Maintenance of safe and navigable channels and coordination of vessel movements.
- Removal of damaged vessels in order to avoid interruptions in marine traffic.

7.2.2.2 Oil Spillage

Due to the presence of Tourist area the area need to be seen as **zero tolerance** with regards to oil spillage. This is necessary to achieve maximum with regards to oil spill contingency plan. The risk of accidental spillage of oil from ship and cargo handling pose a threat to marine and land based resources and could also affect tourism at least for shorter duration. This requires careful and advance planning to ensure that the impact of the oil spill on environment is minimised or contained. Proactive measures such as display of zero tolerance information boards for all kinds of pollution in all important areas of Operation is expected to lead to extra care with regards to pollution.

Port authority will prepare a comprehensive action oriented Oil Spill Contingency Plan prior to construction phase, which shall be updated from time to time. Such a Contingency plan shall be defined as a predetermined communications and action sequence, which can be quickly initiated to cope with an event of possible but uncertain occurrence.

7.2.2.3 Fire/Explosion

There is risk of fire or explosion due to the electrical fault, handling, transportation and use of petro-chemical and flammable products. The Port authority should implement cost effective mitigation measures as per National and international rules and regulations.

There are some recommendations that may be implemented as follows:

- Installation of Audio-Visual public address system to alert the personnel working in the terminal.
- Smoke or fire detectors will be placed at critical locations in the terminal.
- Fire alarm system.
- Strict ignition control such as prohibition of ignition source (smoking etc.).
- Periodic inspection and maintenance and adequate measures in the safety system design.
- Personal Protective Equipment (PPE) such as masks, respirators etc. may be provided to the workers.
- Fire extinguishers will be provided to withstand the fire or explosion condition.
- Training and Drill exercise.
- First aid box shall be provided.

7.2.2.4 Terrorist Activity

A terrorist action could be the cause of explosion, hazardous materials release or any such events which may damage the life and property within the Port area. Terrorism risk is a combination of threat, vulnerability and consequence. The expected threat of terrorist activity can be reduced by implementing security measure and emergency response preparations as per ISPS rules and regulations. The following security initiatives shall be taken:

- Establishment of port's waterside camera system.
- Establishment of restricted areas for non-commercial vehicles and vessels.
- Installation of additional shore side cameras at critical locations.
- Preparing and updating security plans for Port and ships.
- Developing a security awareness training program.
- Coordination between State and District Level authorities especially with the security agencies.

7.2.2.5 Hazardous Material handling

Hazardous materials have adverse effect on public health and safety as well as environment due to the release or leakage of hazardous materials. Hazardous materials that may be stored, transported and handled within the Port area are classified by the following: (USDOT Categories)

- **Corrosive materials** – solids, liquids, or gases that can damage lining material or cause fire.
- **Flammable Liquids** – a liquid having a flash point of not more than 60.5°C (141°F), or any material in a liquid phase with a flash point at or above 37.8°C (100°F) that is intentionally heated and offered for transportation or transported at or above its flash point in bulk packaging.
- **Flammable Gas** – any material that is a gas at 20°C (68°F) or less and 101.3 kilopascals (kPa) (14.7 pounds per square inch absolute [psia]) of pressure (material that has a boiling point of 20°C [68°F] or less at 101.3 kPa [14.7 psia]), which is ignitable at 101.3 kPa (14.7 psia) when in a mixture of 13 percent or less by volume with air; or has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 percent regardless of the lower limit.
- **Explosive Materials** – any substance or article (including device) that is designed to function by explosion (an extremely rapid release of gas and heat), or that by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion.
- **Toxic materials** – gases, liquids, or solids that may create a hazard to life or health by ingestion, inhalation, or absorption through the skin.

The Port authority shall develop a Hazardous Material Management Plan as part of its Environment and Social Management Plan (ESMP) prior to entering Operational phase. This plan describes mitigation and management measures to avoid or reduce the impact of hazardous material due to release or leakage. The objective of the Hazardous Material Management Plan is:

- Prevention of uncontrolled or accidental release, leakage or spillage of any hazardous materials during transportation, storage, use and handling.
- Prevent injury to personnel, damage to property or the environment as well as minimising or eliminating the impact to surrounding communities.

The following measures shall be defined:

7.2.2.6 Storage

- Storage installations and equipment shall conform to the provision of statutory and other regulations of Government of India (GoI).
- Storage facilities equipped with isolating and relief valves and fire protection systems.
- Leak detection systems are provided to warn if leak occur, and protected by insulation at support and deluge systems.
- Incorporate overfill protection measures in permanent tank design and install level gauges on tanks to measure volumes.

7.2.2.7 Loading/Unloading

- Loading/unloading area should be equipped with fire fighting facility including the fire hydrants. Any spills or leakage in the area should be contained and cleaned immediately.
- Adequate training in operation of heavy equipment.
- Routine inspection of cranes and preventive maintenance to ensure safety operations.
- Operations at lay down areas and stockyards are performed under strict supervision from suitable trained personnel

7.2.2.8 Truck Transportation

- Access corridor is a dedicated route for transportation of chemicals between the facilities and the Port. No other vehicles are expected on the route
- Access corridor shall be maintained properly and have adequate markings for dividers
- Adequate lighting along roads and Regular maintenance schedules for Port vehicles
- Sufficient traffic signs and speed limits.

7.2.2.9 Others

- Use of Personal Protective Equipment (PPE) such as gloves, masks, boots, etc.
- Use of engineering controls such as containment, automatic alarms and shut-off systems etc.; in accordance with the nature of the hazard.
- Warning and Restriction Signage.
- Regular inspection and maintenance.
- Good House Keeping and better solid waste management system
- Appropriate Labelling on vessels and vehicles with name or description of hazardous material.
- Implementation of Evacuation Programme if incident occurs.

7.3 Oil Spill Contingency Plan (Tier 1)

The guidelines related to Oil Spill Contingency Plan has been delineated and reviewed by the Indian Coastal Guard. This Oil Spill Contingency Plan is in line with the National Oil Spill Disaster Contingency Plan (NOS-DCP), District Oil Spill Disaster Contingency Plan for Kerala, Lakshadweep and Mahe (DOS-DCP: Kerala, Lakshadweep and Mahe) and the Guidelines and Inspection Handbook for Pollution Response Facilities of Ports and Oil Handling Agencies by the Indian Coast Guard

(CGBR No. 774). This Plan is for Tier -1 class i.e., for spillage of up to 700 Ton quantity of oil. This plan will be finalised and approved by the Indian Coast Guard.

"Zero Tolerance for kinds of pollution" will be adopted as the core philosophy of EMP. This plan delineates the response to the emergency actions to be taken during oil spillage. The major objectives of this plan are:

- Early detection and effective communication system for reporting about oil spill/discharge.
- Accurate collection, situation analysis and dissemination of information related to oil spill/discharge.
- Outlining of a response system, which is both effective and categorised, to counteract the oil spill/discharge and also ensures safeguard of public health as well as welfare.
- Delineation of format for records which is indispensable for successful implementation and review of this plan

7.3.1 Oil Spill Response Organisation

The zero tolerance Oil Spill Contingency Plan shall have the organisational structure as shown in **Figure 7-4**. This organisation structure is delineated as per the Guidelines and Inspection Handbook for Pollution Response Facilities of Ports and Oil Handling Agencies by the Indian Coast Guard (CGBR No. 774).

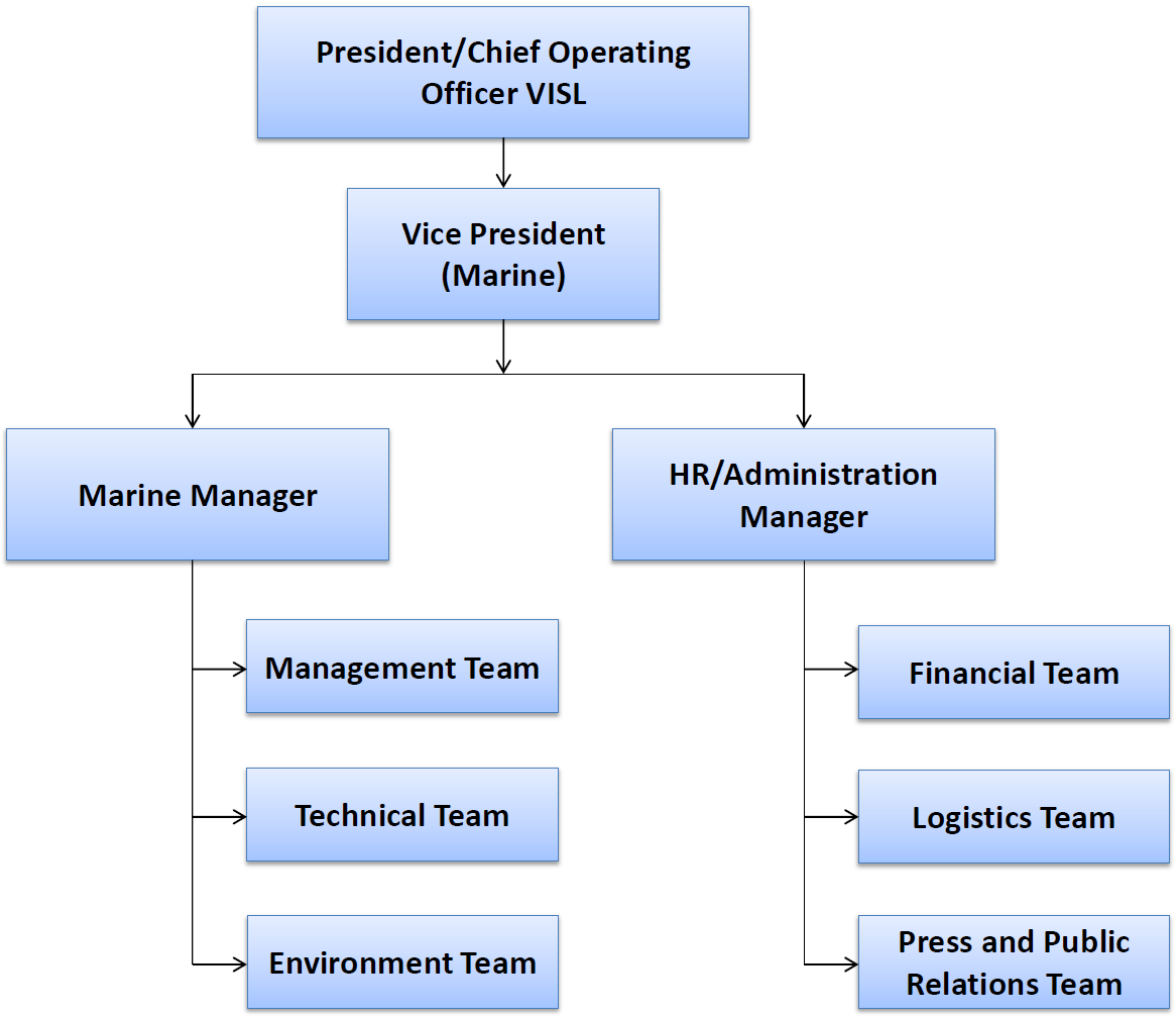


Figure 7-4: Oil Spill Response Team

The following Teams shall comprise of the Oil Spill Contingency Response Organisation:

7.3.2 Management Team

The management team should have overall responsibility of the spill response operation. Its main functions relate to:

- Overall execution of the plan.
- Determining strategies for priority areas and the various polluted sites.
- Reviewing operations.
- Gathering and collating information.
- Authorising media releases.
- Controlling general financial aspects of the operation.
- Interacting with other agencies involved in the clean-up operation, GoI agencies, the media and public.
- Preparing formal detailed management and situation reports.
- Deciding when to terminate operations.

7.3.3 Technical Team

The technical team should be responsible for the management of all operations at the site of the incident. On the basis of the oil pollution risk assessment, the technical team working in close co-operation with the environmental team, should assess the situation, plan and implement the response operation. The basic function of technical team is as under:

- Collecting and evaluating incident information.
- Identifying high risk areas.
- Determining the best response strategy at each of the various polluted sites.
- Monitoring the progress of the operation.
- Preparing daily incident logs of operations.
- Allocating resources on a priority basis.
- Allocating outside contractors to specific sites and tasks.
- Implementing the chosen strategy.
- Directing the clean-up operations.

7.3.4 Environmental Management Team

The environmental management team should have extensive, detailed local knowledge of shoreline habitats and species likely to be affected by clean-up operations. All clean up operations shall be based on the **zero left over concept** for termination of cleanup operation with the all available latest technologies. The team should be able to provide advice on human health, ecological and amenity interests. Working in close co-operation with the technical team, this team should fulfil several basic functions, including provision of advice on:

- Risk and vulnerability of environmental features due to oil pollution.
- Possible/probable impacts of the oil.
- Priority for protection of sensitive sites.
- Effect of clean-up methods on the local environment.
- Potential and real effects on human health.
- Help to implement the chosen strategies.
- Monitoring and ensuring that priorities of clean-up techniques adequately reflect environmental concerns.

- Coordinating all environmental monitoring and sampling programmes.
- Providing liaison links with other interested environmental organisations.

7.3.5 Financial Team

The financial team should be responsible for establishing an effective and efficient financial accounting system and outlining procedures for preparing and submitting compensation claims in advance of an oil spill incident. It should establish a detailed financial accounting system for effective and efficient management of the financial aspects of an oil spill incident. The procedures need to be implemented in advance, wherein all expenditure incurred during an incident can be logged and tracked. Once these have been determined, all teams must be informed of the correct procedures to be followed in every transaction that they carry out.

It may be accepted that local authorities are responsible for shoreline clean-up, but economic assistance may not be offered by GoI. Therefore, local authorities should prepare a budget for the possibility of a major oil spill incident occurring within their area. A Memorandum of Understanding could be drawn up, taking account of the prospects of the successful recovery of costs and defining how much expenditure will be allowed and on what services. However, it is impossible to accurately estimate the level of expenditure that may be incurred during an incident and it is likely that the constraints of having an '**approved emergency budget'** may still have to be lifted temporarily.

Therefore, the financial arrangements cannot be too rigid. The local authorities should, however, have some means of control over the discretion of those responsible for acquiring necessary equipment, personnel, etc. to avoid the creation of further unnecessary financial problems.

7.3.6 Logistics Team

The logistics team should be responsible for organising, providing, marshalling and routing essential personnel, vehicles, equipment, facilities, services and supplies to meet all the requirements of the teams involved in the incident management. In order to determine the short and long term needs of the incident, the team should take into account the fact that the incident may last only for few days or, on the other hand might prolong up to several weeks or months.

7.3.7 Press and Personal Relations Team

In every oil spill incident, media management is one important activity to develop confidence among all sections of the society and also among the affected parties.

7.3.8 Oil Spill Response Equipment

The oil spill response equipment list is given in **Table 7-21**. This list shall be finalised after discussion with Indian Coast Guard officials.

Table 7-21: Oil Spill Response Equipment

S. No.	Response Equipment	Units	Capacity/Dimension
1.	Canadyne Fence Boom on reel with power pack	M	225
2.	Lamour brush skimmer system (12 m^3/ h)	Sets	2

S. No.	Response Equipment	Units	Capacity/Dimension
3.	Floating storage tank (25 m^3)	Nos	2
4.	Lamour side collector (123 m^3/h)	sets	2

The marine control room shall have the following equipment:

- Tidal stream gauge: Rate of flow and direction of current.
- Tide gauge: Tide height.
- Wind gauge: Wind speed and direction.
- VHF set with complete range of marine frequencies: Communication

7.3.9 Training, Inspection and Drill Schedule

The training, inspection and drill schedule for the management team and workers is given in **Table 7-22**.

Table 7-22: Training, Inspection and Drill Schedule

Training	Duration	Frequency	Participant	Remark
IMO Model course	2-5 days	Once	Key persons	By maritime training institute
Oil spill	1-5 days	Once every 5 years	Key persons	Coast guard
Oil spill equipment	1-5 days	Once every year	Team Managers	In house
Internal checking	1-2 hours	6 Month	Operational staff	Checking of systems and communications
Mock drill	6-8 hours	Once in a year	All	In house

7.3.10 Directory

The list of telephone numbers and contact addresses required in the time of emergency need to be prepared in the suggested format presented in **Table 7-22**.

Table 7-23: Format for preparation of Telephone Directory

S. No.	Name /Designation	Address	Phone No.

7.4 Disaster Management Plan (DMP)

Disasters can be due to human error or to rough weather conditions, they can cause serious injuries, loss of lives, and extensive damages to property and equipment. Most of the time disasters arise with no warning and sometimes they may not be controlled. The first few minutes determines the effectiveness of the emergency plan. Dealing with an emergency situation may require external aid. The quickest and well prepared the response is, the less likely there will be serious damages. Emergency planning enables to reduce the thinking time and thus permit to decrease the potentiality of damages. Emergency plans and equipment may never be used but they are essential.

The key objectives of the disaster management plan are:

- Provide the framework for an integrated multi-agency crisis response to a significant disaster incident within the Port
- Clarify specific roles and responsibilities
- Port community preparedness for any emergency incident

- Provide members of the port community affected by a significant emergency incident with
- Timely advice
- Safest possible environment during the resolution of the incident
- Reduce the adverse impacts of an emergency incident on personal, business and the general port community
- Provide a management framework for the sub plans and associated specific response plan
- Provide continued education review and testing.

7.4.1 Classification of Emergencies

In an emergency situation defining the level of risk is the initial step. Classifying emergencies enable to understand quickly what is likely to happen and to what extent the emergency plans will be driven. The nature of the emergency refers as if it is a man-made disaster or a natural one and the level of an emergency refers to the intensity of potential damages.

Nature 1 refers to natural disasters/calamities;
Nature 2 refers to man-made disasters.

7.4.2 Potential emergencies

The potential emergencies likely to occur in a Port like Vizhinjam port include:

Nature 1- Natural Disasters and /Calamities'	Nature 2 man-made disasters
• Flood • Cyclone • Coastal hazards: erosion/storm surge/tidal waves/swell waves • Earthquakes • Tsunami	• Fire and Explosion • Major release of flammable/toxic chemical or gases • Person falling in harbour water • Collapse of lifting appliances • War and terrorism • Industrial unrest • Food/ water poisoning • Collision of ships • Oil Spill, it will be noted that an Oil Spill Contingency Plan must be prepared separately and thus is not referred further to in this plan

7.4.3 Categorisation of Emergency

Any emergency situation has to be first categorised as an onsite emergency or an offsite emergency, the difference being that the effects of the onsite emergency are confined within the premises while those of an offsite emergency spill over beyond the port premises or even beyond the project site premises. Thus, the onsite and offsite emergency plans are detailed below:

7.4.3.1 Onsite and offsite Emergency Plans

These plans would have the following components:

Components of an Onsite Emergency Plan	**Components of an offsite emergency plan**
• Formulation of Disaster Management	• Identification of location of hazardous or dangerous

Components of an Onsite Emergency Plan	Components of an offsite emergency plan
Plan and Emergency Services • Organisation Structure • Roles and Responsibilities of Emergency Teams • Communication • Emergency Control Centre • Alarm Systems & Assembly Points • Mutual Aid Scheme • Onsite Emergency Plan and Rehearsals • Spillage & Contingency Plan • Formulation of Disaster Management Plan for Cyclones	substances, personnel and emergency control rooms • Technical information such as chemical and physical properties, dangers, etc. Background information, past accidents, control techniques and effects of hazardous materials of relevance • Identification of facilities and transport routes for toxic materials • Contact for further advice such as meteorological information, transport, temporary food and accommodation, first aid and hospital services, water, etc. • Establishing communication links including fire fighting materials, damage control and repair items • Detailing emergency response procedures • Notification to public at large • Evacuation arrangements • Press / media handling • Addressing longer term environmental cleanup.

7.4.4 Onsite Emergency Plan (Formulation of DMP and Emergency Services)

The assessment of the risks and hazards leads either to improvements being made at the installation in the form, for example, of additional safeguards or better procedures, or the decision being taken that the risk is sufficiently small to be accepted. The DMP must be related to the final assessment and it is the responsibility of the VISL management to formulate it. The plan will include the following elements.

- Assessment of the magnitude and nature of the events foreseen and the probability of their occurrence
- Formulation of the plan and liaison with outside authorities, including the emergency services
- Procedures for raising the alarm and communication both within and outside the port
- Appointment of key personnel and their duties and responsibilities (organizational structure)
- Emergency Control Centre
- Action on site and Action off site

7.4.5 Scenarios

Coastal flooding: Coastal flooding occurs when high tides, combine with low barometric pressure and high winds. During the south west monsoon heavy rainfall and flood are more likely to occur.

Cyclonic storms: Storms vary in size and intensity, in severe situation Port operations should be interrupted. High winds are particularly hazardous. In their wave modelling prediction, The L&T Ramboll (2013) modelling study have shown that the highest near shore wave height is 4.7 m **Earthquake:** Project area falls under earthquake zone III which corresponds to a magnitude of 6.5 or more on the Richter scale. That means that the risk of earthquake and its consequences are non-negligible. Buildings and facilities construction must be designed to minimise the consequences of an earthquake.

Tsunami: The phenomenon Tsunami is a series of travelling ocean waves of extremely long length generated primarily by Submarine earthquakes.. Tsunami has already occurred in the southern Kerala coast and thus is likely to occur again. Nevertheless Tsunamis are unexpected and un predictable but are a rare natural phenomenon.

Coastal erosion: Coasts of project Kerala are subject to high erosion during the South West monsoon period. It has been shown in the past that some human coastal activities may have increased this phenomenon.

Fire and explosion: A fire incident is described as the destruction or partial destruction by fire of a building or its contents. In Port there are a lot of sources of fire ignition because of the presence of wooden facilities and inflammable substances. A fire spread can be very fast, to confine the fire to manageable limits the reaction must be very quick.

Collapse of lifting appliances, buildings, sheds: Port operations include the intervention of a lot of lifting and heavy appliances, which can collapse under man-made error or rough weather condition. When it appears, lives and safety of container terminal workers could be endangered and property and equipment damaged. The terminals operators and managers are trained to respond to this problem. They should monitor all safety measures necessary and coordinate response with other Port authorities if necessary.

Major release of flammable/toxic / hazardous goods: The Vizhinjam port region is an area where there are not many transportation of dangerous goods, thus spillage incident could be rare. The potential impact of a spillage will depend on the nature, the quantity of the goods spilled and the area involved. It may be necessary to coordinate the response with Fire and Safety section.

Transportation Accidents: Transportation mishaps could endanger human lives, lead to chemical spills, fires, explosions and other problems. These emergencies may call for special operations such as evacuation and rescue. Usually transportation incidents affect only relatively small areas and involve only a small number of people.

Industrial unrest: Industrial unrest can appear for many reasons such as employee's dissatisfaction. They can express their dissatisfaction by doing strike, sabotage, intimidation etc. With defence and Coastguard berths and facilities Vizhinjam Port will be a very sensitive area where a lot of material and equipment potentially harmful are present. That is why such event must be contained.

Terrorist attack and Bomb threat: Due to political climate, emotional and psychological stresses that exist, terrorist acts could happen anywhere at any time. Bomb threats are the majority of the time false threat, however the threat itself is a crime and appropriate action should be taken to provide safety of employee.

7.4.6 Response organisation

7.4.6.1 General Action Plan

The primary role of the emergency response organisation should be to determine the degree to which the emergency action plan should be activated, to coordinate the response and to assess the consequences. We can define three or four phases that composed an emergency action plan regarding the fact that there had been or not a warning.

- First phase: Planning and preparedness: This phase generally consist of constituting an emergency response team and making all the liaisons with all the parties susceptible to intervene. The number of person constituting the emergency response team will be based on the need to ensure safety to all Port workers, property and equipment.
- Second (optional) phase: Action before effective period: It consists of ensuring that all the protective measures are well implemented. It is only possible when the danger has been identified by advance. Generally, the evacuation of the personnel which is not implicated in the emergency action plan takes place during this phase whenever possible.
- Third phase: Action during effective period: It consists of stopping all the activities at stakes and ensuring the safety of the employees, taking the action to minimise damages.
- Action after effective period: When the normalcy and safety of the area is ensured, it consists of making impacts assessment, undertake repairing measures and restart Port activities.

7.4.6.2 Assembly Point

A list of all the emergency assembly points should be made, notified on a plan and distributed to employees. All personnel that are not involved in handling the emergency response should assemble at the appropriate assembly point.

7.4.6.3 External Aid

In some cases, qualified personnel and equipment may not be sufficient to control appropriately the emergency situation, and then external aid will be required. Additional resources can be mobilised from other agencies such as neighbouring industries involved in a partnership. This partnership could consist of an agreement with neighbouring industries for help when necessary, which include the respect of the following conditions:

- Respond promptly to emergency calls when communicated;
- Send personnel, supplies, equipment when required;
- Personnel will work under the management of the Site Incident controller;
- Site incident controller shall be responsible for their safety.

Additional resources can also be mobilised by government authorities. The Kerala State has designed a Disaster Management Policy, to minimise damages, through the authority of the State Disaster Management Authority and the District Disaster Management Authority. The GOK acknowledges the following set of institutional stakeholders that play key roles in disaster management:

- State and Central Government Departments;
- District Disaster Management Authorities;
- Local authorities such as Municipal Corporations/ Municipalities, District/Block /Grama Panchayaths;
- Voluntary and civil society organisation;
- Red Cross, multilateral aid agencies ad U.N agencies;
- Community – village disaster management committees/task forces
- Public/Private sector undertakings
- Army, Navy, Air Force, Coast Guard, Airport Authority, National Disaster Response Force etc.

7.4.6.4 Emergency Control Centre

The emergency control centre should be established separately for port and should be equipped with the following:

- An adequate number of external telephones. If possible, one should accept outgoing calls only, in order to bypass jammed switchboards during an emergency.
- An adequate number of internal telephones, Radio equipment/pager system.
- A layout plan of the facility.
- Location of possible spillage/fire points.
- Sources of safety equipment and other fire-fighting system elements.
- Escape Routes.
- A nominal roll of employees at the facility.
- A list of KEY PERSONNEL with addresses, telephone numbers, etc.
- An adequate number of personnel protective/safety equipment available on site / back up in warehouse or with other member groups of mutual aid programme.

7.4.6.5 Alarm Systems

The emergency (due to fires or spillages) should be initiated by the first person noticing it by activating the fire alarm from the nearest call-point or by contacting the fire control room immediately on the internal telephone in case of any emergency.

If in the opinion of the shift in-charge in consultation with the fire safety officer, the severity of the emergency is such that it can primarily be coped with by VISL's own resources (aided by fire fighting appliances from the fire brigade, if required) the siren code for ONSITE CRISIS will be sounded through the hooter. The siren codes for distinguishing between an ONSITE & OFFSITE CRISIS will be clearly established. The onsite/ offsite siren codes should be informed to the neighbouring population of the facility.

7.4.6.6 Communication

Communication is a very important issue, a good communication that liaise all the services will enable a more effective response.

Some means of communication	
inside the Port include	**with government authorities include**
• Telephone • Mobile • Port announcement system • Wireless radio • Email • Emergency vehicles	• Telephone • Fax • E-mail • Emergency vehicles

7.4.6.7 Training

Emergency response drills should be conducted once in a month, all types of siren codes should be exercised, and a clear notice should be distributed to all the employees. A record of siren and drills testing should be kept with the following information:

Date	**Duration**	**Port level**	**Complex level**	**District level**	**Frequency**	**Notes**
…						

Appropriate training to learn how to react in case of emergency should be conducted and all the training courses recorded as following

Date	Course purpose	Duration	New recruit	Existing staff	Frequency	Notes
…						

7.4.6.8 Reporting and investigation

Reporting: Any minor or major incident should be reported and a complete analysis of the incident should be done to understand causes, consequences and the level of failure. Special procedure and forms should be provided for this purpose (Incident report form, Work injury report etc.). A report should also be provided to government authorities.

Investigation: Each incident should be investigated to identify the causes, take appropriate preventive measures and comply with requirements. Special procedures and forms should also be provided for investigation.

Individual Plans: Following are proposed general mitigation measures for emergency action plan related to the disasters described above.

Nature 1 disasters:

	Action By	Action
Cyclonic storm and Hurricane	**Port Control Room**	• Immediately inform pilot • Consult Pilot and activate Emergency Action Plan
	SIC	**Planning and preparedness** • An inventory of emergency items and supplies should be done, it may include (but not be limited to): • Torches, Ropes, lines, wires, tarpaulins, plastic sheets, tool kit, duct tapes, assorted gears, first aid box, sand bags etc. **Before effective period** • Contact all ships • Inform all Masters to keep the ships ready to proceed to sea at short notice • Ensure precautionary measures are taken by all the vessels in the Port • Ensure that barges, small vessels are directed to go to the sheltered area • Secure loose or heavy items/ electrical equipment

Flood

	Action By	Action
Flood	**Individual**	• Do not panic • Avoid standing near to sea side • Stand near columns or duck under sturdy furniture • Assembly at emergency assembly point
	SIC	• Ensure all emergency equipment in order& keep the rescue team ready • Evacuate people • All ships in Port close all hatches and move out to sheltered or safe area • Shift hazardous cargo out of the Port • Cut off electrical supply as relevant • Carry out rescue operation

Earthquake

Earthquake	Action By	Action
	Individual	• Do not panic • Avoid standing near windows, external walls • Stand near columns or duck under sturdy furniture • Assembly at emergency assembly point
	SIC	• Take head count • Activate Emergency Action Plan • Shut down of Ports if required • Arrange medical assistance

Tsunami

Tsunami	Action By	Action
	Individual	• Do not panic • Avoid standing near to sea side • Stand near columns or duck under sturdy furniture • Assembly at emergency assembly point
	SIC	• Activate Emergency Action Plan • Shut down of Ports if required • Arrange medical assistance

Coastal erosion: Construction work such as a breakwater shall be done to avoid and minimise the risk of coastal erosion.

Nature 2 disasters

Collision of Ships

Collision of Ships	Action By	Action
	SIC	• Inform Port Control Room and Activate Emergency Action Plan • Consult Master of the vessel to take any action
	SIC + Master	• Assess the situation for injuries, leakages, take sounding of tanks and bilges • Check for Oil Spill • Check for vessel damage and damaged areas • Check assistance to other vessel • Arrange evacuation of personnel if necessary • Prepare life boat and keep life saving equipment stand by

Person falling in the harbour water

Person falling in the harbour water	Action By	Action
	SIC	• Inform Port Control Room and Activate Emergency Action Plan • Throw lifebuoys in water • Inform all crafts/vessels in the vicinity to start rescue operation

Grounding of Vessel

Grounding of Vessel	Action By	Action
	SIC	• Inform Port Control Room and Activate Emergency Action Plan • Consult Master of the vessel to take any action
	SIC + Master	• Check for oil spill • Prepare life boat and keep lifesaving equipment stand by • Decide whether the vessel can be refloated by using its own power/ towing arrangement/ uploading of cargo/ waiting for high tide

Collapse of lifting appliances, buildings, sheds

Collapse of lifting appliances,	Action By	Action
	Port Control Room	• Inform shift in charge • Consult Pilot and activate Emergency action plan

buildings, sheds	**SIC**	• Stop cargo work if necessary • Secure and shift cranes to safer place • Cut off electrical supply if necessary • Give priority to rescue injured/trapped person

Fire and/or explosion

Fire and/or explosion	**Action By**	**Action**
	Anyone who notices fire	• Sound alarm • Call Port Control Room and Fire station • Try to find nature of the fire
	Port Control Room	• Inform pilot/ shift in charge • Consult Pilot and activate Emergency action plan
	Fire Coordinator	• Check type of fire/leaked material • Refer response procedure (fire on board, in Port terminal, in cargo storage areas) • Use proper personnel protective equipment
	SIC	• Evacuate the immediate vicinity through the nearest safe exit • Ensure that all barges/ small vessels are directed to go to the sheltered area • Stop activity if necessary • Inform Engine room and shut down electricity if necessary • Arrange fire fighting team • Alert vessels in vicinity • Keep the vessel ready to move out
	Medical team	• Administer first aid

In addition to above, port authority will propose some fire fighting equipment that may be required (but not limited to) in different Port areas:

Fire fighting system at the Berth	Fire station: some of the equipment stowed
• Monitors: They should cover the entire area of largest tanker berthed at jetty. • Curtain nozzles • Water hydrants • Mobile monitor • Foam concentrate drums	• Spare fire extinguishers and foam compound drums • Delivery Hose pipe • Branch pipes and foam making equipment • First aid fire fighting extinguishers • Explosive meter • Oxygen meter • Fire suits • First aid kit • Safety belt • Ropes • Cutting tools • SCBA • Safety helmets • PPEs- goggles, Apron, shoes, gloves, nose mask, and gumboots.

Major release of flammable/toxic chemicals or gases

Major release of flammable/toxic chemicals or gases	**Action By**	**Action**
	Anyone who notices release	• Inform Port Control Room and fire station • Try to know the nature of release
	Port Control Room	• Inform Pilot/Shift in charge • Consult Pilot and activate Emergency action plan
	Fire Coordinator	• Check type of leaked material • Refer response procedure (Nature of the leakage and location)

Major release of	**Action By**	**Action**
		• Use proper personnel protective equipment
	SIC	• Isolate contaminated area • Evacuate the immediate vicinity through the nearest safe exit • Ensure that all barges/ small vessels are directed to go to the sheltered area • Stop activity if necessary • Inform Engine room and shut down electricity if necessary • Arrange fire fighting team • Alert vessels in vicinity • Keep the vessel ready to move out
	Marine Pollution Coordinator	• Give advices to minimise marine pollution

Industrial unrest

Industrial unrest	**Action by**	**activity**
	SIC	• Strengthened security at sensitive points • Ensured lives and property protections • Conduct vigilance and patrolling to maintain law and order

Bomb threat: The measures described below are applicable for a warned threat of bombing.

Bomb threat	**Action By**	**Action**
	SIC	**Planning and Preparedness** Increased awareness in the Port personnel regarding threat perception (not to handle suspicious objects, report suspicious movements by unknown person) **Before effective period** • Arrange to evacuate people • Inform all personnel to provide information regarding unidentified or suspicious objects/ persons • Initiate bomb search • Increase vigilance and patrolling

Food/ Water poisoning

Food/ Water poisoning	**Action By**	**Action**
	Medical team	**Planning and Preparedness** Make available medicines and specific supplies equipment regarding food/water poisoning **During effective period** • Arrange medical assistance to the victims • Identified the contaminant source • Seize contaminated material • Arrange sample analysis

7.4.6.9 Hazard kit

Hazard kit should be provided in each emergency situation, its components will depend on the situation. Following is a list of some required elements needed in hazard kit.

- Protective clothing: chemical protective suits, proximity suits, neoprene 14" gloves, natural rubber gloves, surgical gloves, high voltage lineman's gloves, overall, goggles, hardhats with headband suspension, face shield, boots, safety harness, ear muffs.
- Breathing Apparatus: Safety harness, positive pressure self-contained breathing apparatus, spare cylinders, full-face cartridge type respirators.
- First aid equipment: Extinguishers capable for handling, first aid kit, resuscitator.

- Oxygen trauma, first aid and emergency box kit: Oxygen cylinder, water jet blankets, rescue blankets, oxygen breathing kit, instant glucose, paramedic scissors, forceps, gloves, ring cutter, cervical collar, eye pads, tourniquets, multi trauma dressing, adaptec dressing, flexible bandages, pocket masks, eyewash bottle, bag mask resuscitator, Portable respirator, Portable lamps, mouth-to-mask, blood pressure equipment

7.4.6.10 Contacts in Case of Emergency

The number of all the person involved in handling emergency responses as well as all the people that may be involved as an external aid, have to be listed in order to be quickly aware of the situation.

List of In-site contacts

Sr. No. …	Designation	Name	Tel No.	Fax No.	E-mail

List of off-site contacts

Sr. No. …	Designation	Name	Tel No.	Fax No.	E-mail

An Emergency Preparedness and Response Plan should be developed by the Contractor and approved by the Developer prior to construction. An Emergency Preparedness and Response Plan should be developed by the Operators and approved by the local Authorities prior to start of operations.

7.4.7 District Disaster Management Authority

The District Disaster Management Authority shall act as the district planning, coordinating and implementing body for disaster management and take all measures for the purpose of disaster management in the district in accordance with the guidelines laid down by National Authority and State Authority.

7.4.8 District Disaster Management Committee

The District Level Disaster Management Committee is set up for major off-site emergencies along with Port Officers for Thiruvananthapauram. This committee is proposed to comprise of the following members:

District Collector/District Magistrate	Chairman	Collectorate,	Thiruvananthapauram
District Panchayat President	Co-Chairman	District Panchayat,	
Additional District Magistrate (ADM)	Convener	Collectorate,	
Superintendent of Police	Member	SP Office,	
Principal Agriculture Officer		Civil Station,	
District Medical Officer		DMO Office,	
Assistant Divisional Officer, Fire & Rescue services		Asst. Divisional Office, Fire & Rescue services	

7.4.9 Disaster Management Plan for Cyclones/Floods

Flooding frequency is quite frequent in many talukas of the district. Strict enforcement of flood zone regulations needs to be done to prevent constructions. Community awareness should be built up so

that people respond effectively to the flooding. Persons living in the low lying parts of floodplains, areas unsafe. Some aspects of flood planning and response are:-

- Issuing warnings at the local levels
- Participating in flood fighting by organizing work parties to repair
- Embankments or clear debris from drainage areas, pile sandbags
- Stockpile needed materials
- Facilitating agricultural recovery
- Planning emergency supplies of flood and clean drinking water
- To conduct trainings on search and rescue for Search and Rescue
- Teams formed at District, Taluka and Village level from time to time

In line with the Disaster Management Plan (DMP) of Thiruvananthapauram., VISL will develop a customised DMP to cope during disasters from natural calamities such as rough weather conditions, cyclones, Tsunami and floods, etc. Proper planning can reduce the potential damage from disasters in terms of losses to human lives, port assets, and environmental damage and rehabilitation costs. The DMP for Cyclones and Tsunami will be prepared by VISL in consultation with the Department of Ports, GoK. The rough weather operations will be controlled in three stages:

- **Green Status** – All operations of loading / unloading will be carried out as planned.
- **Yellow Status** – This is an alert stage indicating possibility of rough weather. Still operations can be continued with all emergency precautions
- **Red Status** – Emergency situations or rough weather; operation will be suspended.

Activities controlled by in-charge of emergency operations. The vessel / tanker are to be moved to safe anchorage or will be advised to proceed to sea. The main components of the DMP for cyclones will include the following:

- Pre-Disaster (or Pre-Cyclone/Flood) Plan
- On (or During Cyclone/Flood) Disaster Plan
- Post (or After Cyclone/Flood) Disaster Plan

Pre-Cyclone/Flood Plan

Pre-Cyclone/Flood Measures: Port will maintain and exchange information continuously with the local IMD authorities for continuous updates of meteorological conditions in general and emerging / predicted weather phenomenon such as cyclones in particular. Upon issue of a cyclone warning by the IMD, the management would immediately initiate the Pre-Cyclone Measures. The Department of Ports and District Collector of Thiruvananthapuram would be informed of the imminent cyclone. All Port officials dealing with operations and disaster management will be informed.

Pre-Cyclone/Flood Exercise: On signalling of a cyclone alert, the Control Room will be manned 24 hours a day for disaster management. The **'Weather Signals'** depending on the data available about the cyclone and it's threat perception will be informed to all personnel. The marine side operations will be regulated as per the rough-weather classification and will be continued with all emergency precautions. The different personnel of Port would assume their roles and responsibilities as previously identified for disaster management. The standby arrangement for power supply will be checked. All pre-identified '***Rescue Centres'*** will be kept ready. A pre-alert will be issued regarding suspension of all operations in case of emergency and to await instructions regarding the same. All Port Crafts and Ships will be fully secured inside the harbour area. Communication system including standby arrangement will be tested for working condition. Vehicles involved in rescue operations will

be checked for working condition. Port crafts to be engaged in rescue will be kept in readiness. The safety in the project area will be ensured.

The following Flood warning messages will also be given:

- Flood Alert – Flooding is possible
- Flood Warning – Flooding of homes, businesses and main roads is expected
- Severe Flood Warning – Severe flooding may cause Imminent danger
- All Clear – No Flood Alerts or Warnings are in force

When a flood warning message is received, an Emergency team In-charge shall alert relevant agencies. The following advice shall be given to the Public:

- Flood warning: 'GO IN, STAY IN, TUNE IN'
- Stay calm
- Ensure that neighbours know of the warning, and be prepared to help them
- Monitor local radio
- Make a flood kit: medications, warm clothing, sealed food, blankets, matches, candles, flashlights, portable radio, spare batteries, rubber gloves, personal documents

During Cyclone/Flood Plan: The emergency alarm siren will be raised as per the '***Alarm System'***. All personnel will be evacuated except essential operational personnel and personnel dealing with disaster management. The cargo handling operations will be suspended. The vessel will be moved to safe anchorage or will be advised to proceed to sea. Power supply will be disconnected and alternative power supply will be restored in essential operational areas. Port Crafts and Tugs will continue to be in readiness for rescue.

Depending upon the scale of potential flooding, the following steps shall be taken:

- Care of evacuated, hurt or homeless people
- Protecting of utilities
- Availability of transport
- Flood alleviation e.g. clearing blocked culverts and drains
- Providing emergency health advice
- Providing road barriers and signs
- Coordinating emergency support

Post Cyclone/Flood Plan: This would be the rescue and rehabilitation stage after passing of the cyclone. The damages would be assessed and rehabilitation work initiated to restore operations at the earliest. The records of the events during the cyclone will be maintained and reviewed for possible enhancements to the DMP.

7.4.10 Management Plan during Tsunami

The management plan for likely emergency of Tsunami is addressed below:

Characteristics: Tsunamis are a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite. A tsunami can move about 500 miles per hour in the open ocean. Once the wave approaches the shore, it builds in height. The topography of the coastline and the ocean floor will influence the size of the wave. There may be more than one wave and the succeeding one may be larger than the one before. Tsunami waves and the receding water are very destructive to structures. The Tsunami warning is issued on earthquake having intensity of **>6.0** on Ritcher scale.

Documentary Record to be maintained; Port Authority shall prepare and maintain the following documents:

- A tsunami hazard map graphically shows damage-prone areas with expected degrees of damage caused by possible tsunami
- A map showing inundation depth and probable inundation areas of port area shall be prepared.
- Evacuation maps shall be prepared and placed in the port premises
- Display of evacuation route on inundation maps

Warning/Confirmation: Early warnings/confirmation from the following sources shall be carefully examined:

- Meteorological Station
- TV and radio News

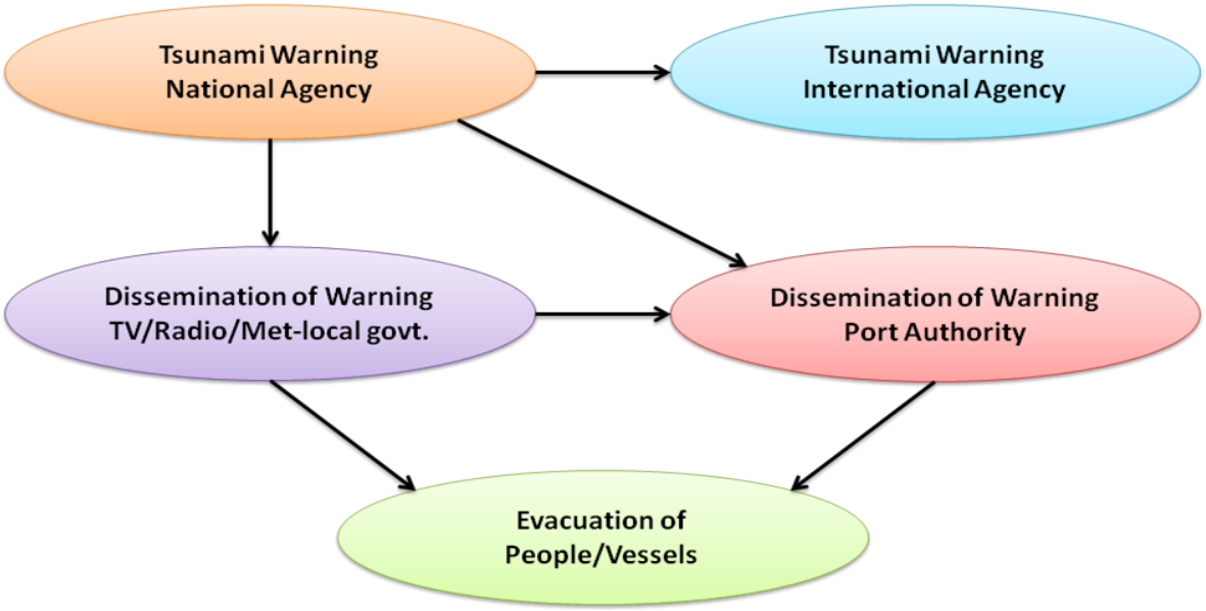


Figure 7-5: Tsunami Warning and Evacuation

Dissemination of Tsunami Warning: Port authorities shall have multiple channels for receiving early warning, including a direct channel from national meteorological agency. When an early warning was received by port shall disseminate to the personnel including those in vessels, in and around the site. Communication shall be made through telecommunications, loud speakers and siren.

Onsite Action Plan: Alarm system to be initiated

- Through Signal Station informs all the ships to evacuate from the berth to open sea. Signal Station keeps in touch with all vessels on VHF
- Move tugs and launches to safe areas or deep water anchorages
- Crew to wear life jackets.
- Cease cargo operations immediately.
- Arrange transport to evacuate to safer inland areas
- Keep sand bags ready
- Ensure proper secure of the cargo handling equipment and the shore cranes.
- Evacuation of Personnel and cordoning off the area
- Treatment of injured personnel

Evacuation: At least one or two evacuation places such as high rise building shall be identified within Port (Administrative building and Medical Aid Centre)

- Evacuation place shall be safe and have enough space to accommodate the expected people
- Evacuation place shall be clearly identifiable and route shall be clearly indicated on map
- Vessels shall be evacuated from the jetty area
- Counter measures against Tsunami that can be taken up by ships as given in **Table 7-23**.

Table 7-24: Ship Action Policy against Tsunami[26]

Tsunami Forecast		Time until tsunami arrival	Ship Action				
			Moored ships at Berth		Anchored ship, buoy-moored ship	Navigating Ship	
			Large Ship, Medium ship (Cargo handling / working ship)	Small Ship (Port crafts)		Large Ship, Medium ship	Small Ship
Tsunami Warning	Major tsunami (3m, 4m, 6m, 8m >10m)	Short	Halt cargo handling, land evacuation	Land evacuation	Use engine	Offshore evacuation	Offshore evacuation/ Land evacuation after berthing
		Medium	Halt cargo handling, offshore evacuation/land evacuation	Landing and lashing/ land evacuation (in some cases, offshore evacuation)	Use engine/ offshore evacuation		Offshore evacuation/ Landing and lashing after berthing (in some cases, land evacuation)
		Long	Halt cargo handling, offshore evacuation	Landing and lashing (in some cases, offshore evacuation)	Offshore evacuation		Offshore evacuation/ Landing and lashing after berthing
	Tsunami (1m, 2m)	Short	Halt cargo handling, land evacuation/ Strengthen mooring	Land evacuation	Use engine	Offshore evacuation	Offshore evacuation/ Landing and lashing after berthing
		Medium	Halt cargo handling, offshore evacuation/land evacuation/ Strengthen mooring	Landing and lashing/ land evacuation (in some cases, offshore evacuation)	Use engine/ offshore evacuation		Offshore evacuation/ Landing and lashing after berthing (in some cases, land evacuation)
		Long	Halt cargo handling, offshore evacuation/ Strengthen mooring	Landing and lashing (in some cases, offshore evacuation)	Offshore evacuation		Offshore evacuation/ Landing and lashing after berthing
Tsunami Advisory	Tsunami warning (0.5 m)		Halt cargo handling, Strengthen mooring/ offshore	Landing and lashing/ offshore evacuation	Attention to conditions (in some cases, offshore	Offshore evacuation	Landing and lashing/ Offshore evacuation/strengthen mooring

[26] Source: Japan association of marine safety, 2004

Tsunami Forecast		Time until tsunami arrival	Ship Action				
			Moored ships at Berth		Anchored ship, buoy-moored ship	Navigating Ship	
			Large Ship, Medium ship (Cargo handling / working ship)	Small Ship (Port crafts)		Large Ship, Medium ship	Small Ship
			evacuation		evacuation/ use of engine)		
Notes			-	Offshore evacuation is suggested if there is a sea area where even small ships are safe against tsunami outside the jetty and if there is adequate time for evacuation	Sea areas where rapid tsunami currents are anticipated should be investigated beforehand	-	

NOTES:

Time until tsunami arrival:

- **Short:** Little time is available for evacuation after tsunami warning (until a ship is under safe conditions such as offshore evacuation, landing and lashing etc.).
- **Medium:** Between long and short.
- **Long:** Adequate time is available for evacuation after tsunami warning (until a ship is under safe conditions such as offshore evacuation, landing and lashing etc.).

Land evacuation: Crew members take refuge in a high land area because evacuation by ship is anticipated to involve a high degree of risk. Also prevent the outflow of ships and exercise safety precautions regarding dangerous goods.

Offshore evacuation: Ships evacuate to deep and wide offshore area outside the jetty (if there is no time for offshore evacuation, ships should wait).

Landing and lashing: Crew members land small ships such as port crafts/tug boats and lash them to prevent from being washed away by tsunami.

Use of engine: Crew members start the engine of an anchored ship to drive, if necessary.

Attention to conditions: Although crew members do not take evacuation measures, they pay attention to changing conditions and take measures for ship safety until the cancellation of tsunami advisory.

7.4.10.1 Recommendations for Implementation of Off-site Emergency Plan

- Emergency control centre will be the focal point to co-ordinate emergency activities. Emergency control centre would be equipped with adequate number of equipment mentioned under heading "**Emergency Control Centre"**.

- Succession or second-line controllers would be named for assuming responsibilities in case disaster occurs in absence of principal co-ordinators.
- Hot line would be provided between Port and Fire Brigade at Thiruvananthapuram.
- VISL would make arrangement for coded siren system or through some other suitable means to alert people in surrounding areas in case of off-site crisis.

A summarised version of action procedures detailing the "***Role of Essential Staff in Major Emergency"*** would be issued in a flip chart like booklet form to all concerned persons (officers and supervisors) at work places and also to senior officers of the civic administration.

7.4.11 Emergency Preparedness and Response Plan

The general emergency action plan for the port in case of an emergency is given under this section. This plan is concerned with the safety of all port workers and general measures to minimise damages on equipment.

7.4.12 Organisational structure chart

The emergency response implies the intervention of the personnel described in **Figure 7-6**.

7.4.13 Responsibilities

- Chief Emergency Controller: The Chief Emergency Controller is responsible for informing government authorities such as District Disaster Management Authorities and whenever necessary Kerala State Disaster Management Authorities. S/he shall also liaise with Ministry of Shipping, MoEF, MoD and inform the media. If necessary he will activate the off-site plan.
- Site Emergency Coordinator: S/he will direct operations from the Emergency Control Center. He takes over the central responsibility of the emergency plan. He decides the level of crises and whether to activate off site emergency plan. He directs the shutting down of the activities and the evacuation plan and monitors all the operations. He shall authorise the termination of the emergency plan when safety is ensured.
- Site Incident Controller (SIC): S/he directs and coordinates all field operations at the scene of the accident, from the beginning of the implementation of the emergency plan to its termination and return to activities. He conducts initial briefing, coordinates search and rescue operation of non-essential workers. He coordinates action requests for additional resources when necessary.
- Fire Coordinator: S/he shall inform the fire station and fire fighting team, lead them to the incident location. They should lead workers to assembly points, and ensure that all the fire fighting appliances work correctly. The Fire Coordinator will inform SIC if additional help is required.
- Security and Evacuation: They should close the visitor gate and ensure unauthorised person do not enter. They should occupy their predetermined post for controlling the safety of the Port: control the traffic, leading authorities and emergency vehicles to the incident area, control the scene of disaster, facilitate the evacuation etc. They should provide security men for fire fighting and rescue and be able to call additional help. They should ensure that residents within the Port area are notified about disaster and instruction to evacuate if necessary.
- Operation Coordinator: S/he should direct the operation staff and coordinate the movement of vessels and cargoes whenever necessary.

- Port Control room coordinator: S/he is responsible for the main communications, he may ensure the entire emergency team advises, he may notify the fire brigade/ police/ hospitals/ district collector/ mutual aid partners whenever required. S/he may refrain the exchange of information with unauthorised persons.
- Medical Coordinator: S/he should refer to the Chief Emergency controller. He directs the medical team and ensures adequate paramedical staff equipment and medicines are available. S/he should ensure the evacuation of injured people whenever it is necessary. The medical team should organise first aid arrangement. They should maintain a list of blood groups of each employee.
- Maintenance Coordinator: S/he directs the maintenance staff. He recommends the appropriate procedures to isolate damaged units without introducing new hazards. S/he provides the necessary utilities. S/he elaborates plan for providing continuity of emergency supplies and services such as water lies, electric power, emergency lighting etc.
- Marine Pollution Coordinator: He makes recommendations to minimise the impact of an accident on the environment. He monitors the clean-up actions during and after the incident. S/he determines the level of contamination of a site as a result of the accident.

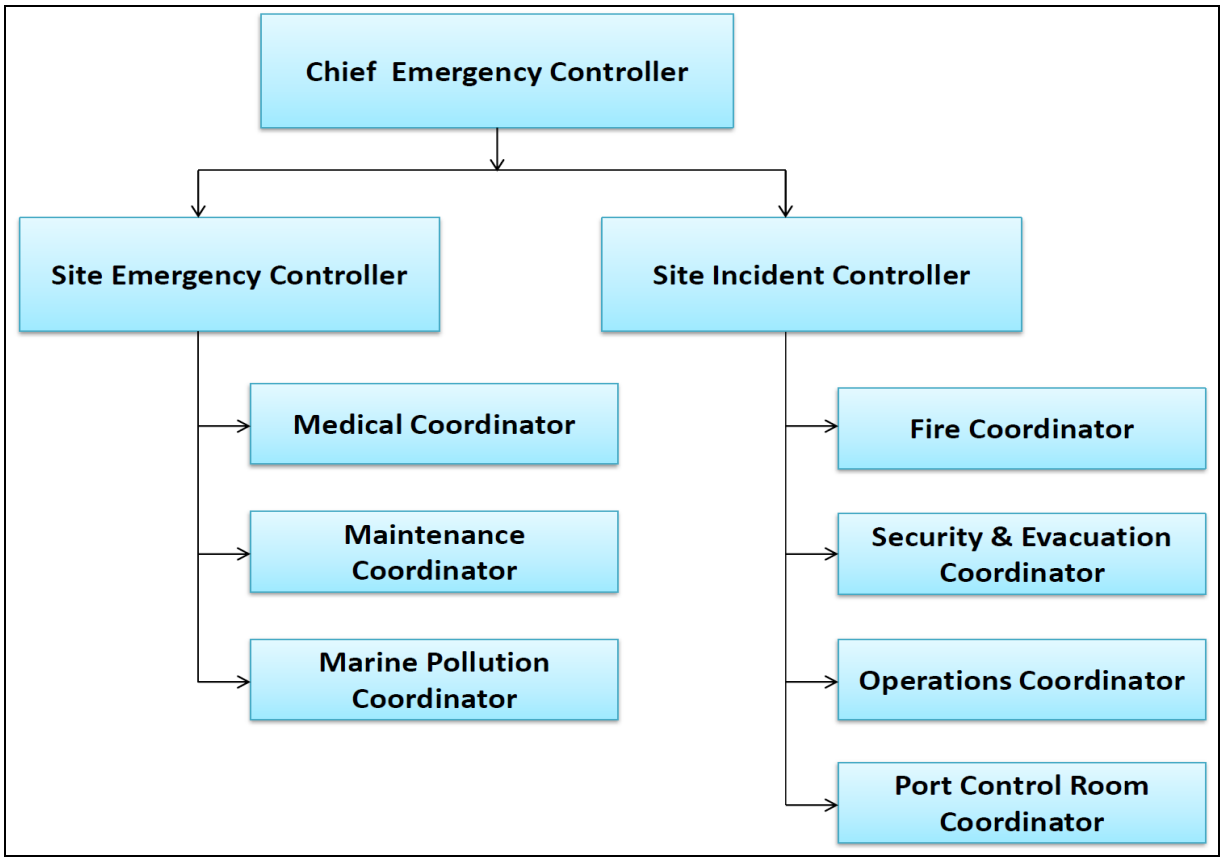


Figure 7-6: Organisational Structure Chart of the Emergency Response Team

7.4.14 Purpose

This document gives guidelines to harmonise action during an emergency. Emergency action plan broadly consist of defining key personnel, giving guidelines to contain the incident and bring it under control and coordinating action with government authorities. In order for this plan, to be effective in rescuing and evacuating workers to safe area, to minimise damages to lives, property and environment during emergency, it is essential that:

- All the personnel are familiar with the action plans
- On site resources are mobilised in minimum time
- Assistance from outside is readily available

Emergency action plans shall be distributed to all users and they shall be aware of any changes. To ensure compliance to aforementioned three points, plans must be regularly exercised and emergency responses reviewed and updated.

7.4.15 Revision Record Sheet

All revisions made to an emergency action plan should be notified as presented below in the revision record sheet in the following suggested Format.

Sr. No.	Chapter	Section/ Annexure	Page No.	Revision No.	Date of revision	Details of revision	Approved by

7.5 Port Security and Security Personnel Management Plan

The safety and security of any Port in question at international level is governed by rules issued by International Maritime Organisation and its, International Ship and Port Facility Security Code (ISPS Code) whereas for the purpose of information security, International Organisation of Standard (ISO) and International Electro Technical System (IEC) published ISO/IEC 27001 (Information Security Management System) in 2005, which is applicable to all industry sectors. This plan is the guidelines given in ISPS code.

In 2002, IMO adopts ISPS Code as an amendment to the 1974 Safety ofLife at Sea (SOLAS) convention, which is designed to help detect threats to international security. India is also the signatory of SOLAS convention, which is an internationally legal binding treaty for maritime security.

ISPS Code set the guidelines and mandatory requirements for preparation of Ship Security Assessment (SSA), Ship Security Plan (SSP) for ships and Port Facility Security Assessment (PFSA), Port Facility Security Plan (PFSP) for Ports. As per ISPS code, Port Facility Security Assessment and plan is to be conducted by Port Facility Security Officer (PFSO) or may be Recognised Security Organisation (RSO) under the guidance or approval of Contracting Government whereas Ship Security Assessment and Plan is conducted by Shipping Company (Company Security Officer) or may authorise Recognised Security Organisation (RSO). The purpose of the Code is to provide a standardised, consistent framework for evaluating risk, enabling governments to offset changes in threat with changes in vulnerability for ships and Port facilities.

ISO/IEC 27001 (ISO/IEC 27001:2005) specifies regulatory and statutory requirements for information protection and systematically analysis the organisations risks, taking account of the threats, vulnerabilities and impacts. It is the only standard with global acceptance. Organisations that claim to have adopted ISO/IEC 27001:2005 can therefore be formally audited and certified compliant with the standard.

The objective of these international regulations and certification is to adequately describe how outcomes based security strategies and measures have been implemented in order to protect and safeguard against acts of unlawful interference with maritime transport aimed at persons, Port infrastructure, ships and equipment.

7.5.1 International Ship and Port Facility Security Code (ISPS Code)

This code mainly deals with the security of ship and Port facility. Ships shall be subject to a system of survey, verification, certification, and control to ensure that their security measures are implemented. This system shall be based on a considerably expanded control system as stipulated in the 1974 Convention for Safety of Life at Sea (SOLAS). Port facilities shall also be required to report certain security related information to the Contracting Government concerned, which in turn shall submit a list of approved Port facility security plans, including location and contact details to IMO.

The ISPS Code contains detailed security-related requirements for Governments, Port authorities and shipping companies. These requirements describing in two-part documents, Part A and B. Part A provides mandatory requirements and Part B provides guidance for implementation. These Code applies to ships on international voyages (including passenger ships, cargo ships of 500 GT and upwards, and mobile offshore drilling units) and the Port facilities serving such ships. Ships or shipments arriving from Ports that do not fulfil the ISPS requirements could face sanctions including denial of entry to other international Ports.

7.5.2 Responsibilities of Contracting Government

The ISPS Code defines various responsibilities of Contracting Government. They are:

- Setting the applicable Security Levels
- Ensure completion and approval of Port facility Security Assessment (PFSA) and Port Facility Security Plan (PFSP)
- Determining which Port facilities located within their territory are required to designate and train PFSO
- Approving SSPs and any amendments to a previously approved plan
- Issuing statement of compliance for Port facilities
- Issuing the relevant International Ship Security Certificates (ISSC)
- Exercising control and compliance measures over ship.
- Verifying the compliance of ships with the provisions of SOLAS chapter XI-2 and part A of the ISPS Code

Contracting Governments can designate, or establish, within Government to undertake their security duties and allow Recognised Security Organisations to carry out certain work with respect to Port facilities, but the final decision on the acceptance and approval of this work should be given by the Contracting Government or the Designated Authority.

7.5.3 IMO/ISPS Security Levels

In order to communicate the threat at a port facility or for a ship, the Contracting Government will set the appropriate security level.

- **Level 1: normal** - Level for which standard security measures shall be maintained at all times
- **Level 2: high** - Level for which appropriate additional security measures shall be maintained for a period of time as a result of heightened risk of a security incident.
- **Level 3: exceptional** - Level for which further additional security measures shall be maintained for a limited period of time when a security incident is probable or imminent, although it may not be possible to identify the specific target

The security level creates a link between the ship and the port facility, since it triggers the implementation of appropriate security measures for the ship and for the port facility.

7.5.4 The Port Facility

Each Contracting Government has to ensure completion of a Port Facility Security Assessment for each Port facility within its territory that serves ships engaged on international voyages. The Port Facility Security Assessment is fundamentally a risk analysis of all aspects of a Port facility's operation in order to determine which parts of it are more susceptible, and/or more likely, to be the subject of attack. Security risk is seen as a function of the threat of an attack coupled with the vulnerability of the target and the consequences of an attack. On completion of the analysis, it will be possible to produce an overall assessment of the level of risk. The Port Facility Security Assessment will help determine which port facilities are required to appoint a Port Facility Security Officer and prepare a Port Facility Security Plan.

7.5.5 Port Facility Security Assessment (PFSA) and Port Facility Security Plan (PFSP)

The Port Facility Security Assessment (PFSA) may be conducted by a Recognised Security Organisation (RSO). However, approval of a completed PFSA should only be given by the relevant Contracting Government.

- Security assessment requirements apply to all facilities servicing SOLAS cargo and passenger ships on international voyages.
- Port facility security officers shall ensure that security assessments are conducted.

PFSAs shall include, at least, the following elements:

Identification
- and evaluation of important assets and infrastructure;
- of possible threats and their likelihood of occurrence;
- selection and prioritisation of counter measures and procedural changes; and
- of weaknesses, including human factors, in infrastructure, policies and practices
- of vulnerabilities

Port Facility Security Plan is the application of measures designed to protect the Port facility and ships, persons, cargo, cargo transport units and ship’s stores within the Port facility from the risks of a security incident. Preparation of the Port Facility Security Plan (PFSP) is the responsibility of the Port Facility Security Officer (PFSO).While the PFSO need not necessarily personally undertake all the duties associated with the post, the ultimate responsibility for ensuring that those are properly performed remains with the PFSO. The plan shall address, at least, the following:

- prevention of weapons or any other dangerous substances and devices intended for use against persons, ships or Ports and the carriage of which is not authorised, from being introduced into the Port facility or on board a ship;
- prevention of unauthorised access to the Port facility, to ships moored at the facility, and to restricted areas of the facility;
- procedures and provisions for responding to security threats or breaches of security and maintaining critical operations of the Port facility or ship/port interface;
- procedures for responding to any security instructions the Contracting Government, in whose territory the Port facility is located, may give at security level 3;
- procedures for evacuation in case of security threats or breaches of security;
- duties of Port facility personnel assigned security responsibilities and of other facility personnel on security aspects;
- procedures for interfacing with ship security activities;
- procedures for the periodic review of the plan and updating;
- procedures for reporting security incidents;

- identification of the Port facility security officer including 24- hour contact details;
- measures to ensure the security of the information contained in the plan;
- training drills and exercises;
- measures designed to ensure effective security of cargo and the cargo handling equipment at the Port facility;
- procedures for auditing the Port facility security plan;
- procedures for responding in case the ship security alert system of a ship at the Port facility has been activated; and
- procedures for facilitating shore leave for ship's personnel or personnel changes, as well as access of visitors to the ship including representatives of seafarers' welfare and labour organisations.

Ships using port facilities may be subject to Port State control inspections and additional control measures. The relevant authorities may request the provision of information regarding the ship, its cargo, passengers and ship's personnel prior to the ship's entry into port. There may be circumstances in which entry into port could be denied. Under the terms of the code, shipping companies shall be required to designate a Company Security Officer (CSO) for the Company and a Ship Security Officer (SSO) for each of its ships. The Company Security Officer's responsibilities include ensuring that a Ship Security Assessment is properly carried out, that Ship Security Plans are prepared and submitted for approval by (or on behalf of) the Administration and thereafter is placed on board each ship. A Port Security and Security Personnel Management Plan should be developed by the port Authorities and approved by the local Authorities prior to start of operations.

7.6 Dredging and Dredge Disposal Management Plan

The proposed construction of the Vizhinjam International Seaport envisages dredging in phase1. The capital dredging capacity in Phase I of the proposed Project is 7.6 MCM. This outline of a Dredge and reclamation Management Plan is based on the Revised OSPAR Guidelines for the Management of Dredged Material (Reference number: 2004-08). As the dredged material will be mainly used for the reclamation purpose in the berthing area, the adverse impact on the disposal of dredged material elsewhere is reduced. The following measures will be adopted to mitigate the potential impacts from dredging and when reusing the dredge material:

- Dredging will be carried out using suitable dredgers only, depending upon the terrain of the area to be dredged.
- Use techniques (e.g. silt curtains), to minimise adverse impacts on aquatic life from the re-suspension of sediments.
- Potential pollutants in the dredged material should be analysed for their physical, chemical, biological, and engineering properties prior to material dredging and reuse. (as per Technical Annex II of the Revised OSPAR Guidelines for Management of Dredged Material) shall be applied before using that material for reclamation.
- Reclamation with the dredged material should be conducted in a way that no negative impacts may occur, meaning not discharge of polluted excess water, no discharge of fines, etc.

The dredging Contractor is to develop a proper Dredging and Dredge Disposal EHS Management Plan as a part of Contractors EMP following the appropriate standards (IFC, OSPAR and Indian) and PS 2, 3 and 4.

This Dredging and Dredge Disposal EHS Management Plan should be developed by the Contractor and approved by the Developer prior to commencement of dredging works.

Chapter 8
Project Benefits

Chapter 8 Project Benefits

8.1 Introduction

The proposed Vizhinjam port is very beneficially located for many reasons that will bring in many benefits to the (1) Country (2) Government of Kerala (GoK) and (3) The people of Kerala and Tamil Nadu. Although it falls in Kerala, Vizhinjam is also close to towns in Tamil Nadu; namely Kanyakumari and Nagarcovil. The traffic for the proposed Vizhinjam port will be generated from the hinterland consisting of South Kerala, Southern Tamil Nadu, Western Tamil Nadu and Central Tamil Nadu. There are several major industries/agricultural centres in these areas involved in economic activity. Hence development of Vizhinjam port offers an efficient and cost effective supply chain/value proposition to the local importers and exporters. This could trigger a new set of opportunities as induced development. This will accomplish one of the main aims of the proposed port project; which is to bring significant socio-economic benefits to the local people and also to the region as a whole.

The project and its benefits must be taken for the overall Vizhinjam port project in its entirety. As a part of the port project, there are several components that are linked to the port which will also add to the list of benefits. For example, the road and rail connectivity, which will play an integral part in the overall undertaking, will also bring several benefits to the region. The benefits of all these components which will together be integrated with the port development are detailed in the following sections.

8.2 Infrastructure Facilities

As a part of Vizhinjam port development, several infrastructure facilities have to be developed along with the road and rail connectivity. Most of these infrastructure facilities are to be developed close to the port. **Figure 2-10** shows the infrastructure facilities planned in and around the port. Therefore adequate backup area and other land resources have been acquired in the vicinity of proposed port. These are together termed as ancillary sites which will be a part of the overall port infrastructure. These ancillary sites and facilities are for developing:

Warehouse area
Port Annex Facility (PAF)[27] zone which includes a truck terminal, a 220 KV substation & port operator's colony.
Port backup areas for administrative and other office requirements for all the three phases of the port project including the backup and connectivity for operations of Navy/Coastguard & cruise service

There will be coastguard and defence related infrastructure for coordinating with the respective departments. In addition to these, there will be facilities with regards to cruises/tourism, customs, railway terminal offices and other security establishments.

The benefits to the port from having a dedicated road and rail corridor includes faster turn round times, port productivity, better operational efficiency, and the availability of supporting business infrastructure and services. Good infrastructure facilities improve the functioning of the Vizhinjam port and GoK tourism activities and assists in huge savings in terms of the usage of power, fuel, manpower, safety and security, etc. Since the railway alignment is currently dedicated only for cargo emerging from the port, which is basically container traffic, most benefits will be for the port operations as there will a

[27] People residing in the port operators colony may not be interested to be linked to truck parking - social concern

smooth movement of cargo to the hinterland because of the new rail connectivity. The rail route is also strategically important, since it connects to India's only amphibian infantry base in the country, for quick movement of defence personnel/supplies and other military hardware during times of emergency.

The road infrastructure will include safety features for the access roads which will help with handling the traffic by use of traffic signals and signs, etc. Also the addition of pavements, zebra crossings, speed breakers, parking areas and shelters along the road will also add to the safety aspects of the area. This road will avoid disturbance to local people in terms of traffic congestion, additional traffic load to the existing road and existing level of service, etc. Furthermore, people residing around the area close to the proposed road will have easy access to the other parts of the country through NH bypass. This connection to people of India could be attributed to not only because of presence of cruise terminal but also due to the defence and commercial angle of this very important project. The dedicated road and rail connectivity proposed for the Vizhinjam port will provide access to major existing road and rail network which offers an efficient and cost effective supply chain/value proposition to the local importers and exporters in the State of Kerala.

8.3 Biodiversity and Climatic Benefits

The project also involves improving the landscape of the area by planting indigenous trees (greenbelt/green areas development along the road/rail corridor) of low economic value to add to the cause of biodiversity. All trees normally very good for direct use like mango, jackfruit, tamarind, coconut, rubber, etc. will be avoided and all other generally unwanted even for timber will be planted. Indigenous fast growing forest trees having high biodiversity value will be planted on the sides of rail connectivity and creepers are proposed for median plantation along the road corridor. All these biodiversity components will be dedicated to the cause of climate change and carbon benefits.

Strip plantation for a width of 10 m on both sides is proposed to be developed along the road length of 2.0 km and rail alignment of 15 km. The road side will be mostly planted with flowering trees such as Kanikonna (yellow flowers) and Arali (red flowers) trees. Outer line will include Ashoka of coniferous category. This is mainly because the strip plantation area may be required for future expansion programmes if any. Therefore, VISL needs to document this fact to avoid any future issues with local communities.

None of the above is part of the compensatory plantation required to mitigate the total green area lost due to the land acquisition and construction of the project. VISL will plant in an equivalent lost area of land acquired of the project in any chosen area of degraded forest/other Government land, as available. Discounting the agricultural area and the various plantations committed in the EMP in port premises the total area to be planted is taken as 25 Ha.

8.4 Induced Development

Behind the proposed port of VISL, it immensely augments the usability of this location by various industries. The benefits may be realized from generation/providing of either direct or indirect employment to the local people. The new connectivity will be a facility to improve the trading and marketing local products as well as value addition of local products. VISL port development will be a boon for the development of the local area and the region.

Due to the proposed Vizhinjam port, apart from the surrounding region, the adjoining State (Tamil Nadu and Karnataka) would also get maximum benefits due to a number of triggered chain reactions for new development. Rather than Kerala State, the maximum such benefits will be across the border in Kanyakumari district due to the availability of labour and land/water and other resources.. Other benefits would be generation of either direct or indirect employment to the local people. The new connectivity through rail and road there will be a facility to improve the trading and marketing of local products as well as value addition of the local products. The road and rail connectivity will play an important role in making the Vizhimjam port a boon for the development of region.

The proposed road connecting Trivandrum to Madurai through Ambsamudram will lead to the development of a new and vibrant commercial corridor connecting Kerala and Tamil Nadu with the development of Vizhinjam port.

It is a possibility that the Vizhinjam port project will attract further investments to this region and the road corridor, common access roads and other road facilities will help achieve this. Investors will count it as an advantage if the region has a good connectivity with the major roads, railways and airports.

The project also planned to avoid/arrest all unwanted induced ribbon developments whole along the road and rail corridor. Suitable strip plantation and barbed wire fencing at the boundary of RoW (only in the critical/required areas) will be provided. Environmental management cell of VISL should make sure that this planning should not affect the local communities. The planned strip plantation will show case the VISL green brand by addressing biodiversity and climatic change related issues. While the strip plantation along road is mainly flowering plant those planned along railways is planned with uncommon trees of no economic value..

8.4.1 Major Boost to South Indian Tourism Industry

The project will open up a new tourist circuit in its full potential (like Delhi – Jaipur - Agra) and will remain as the first ever booster project for improving the tourism prospects of Kerala and Tamil Nadu. The **Kochi - Thiruvananthapuram – Tuthukudi** tourist circuit will evolve as tourist attraction of South India with Kanyakumari- Kovalam and Varkala as important beach attractions. With Thiruvananthapuram airport, proposed Vizhinjam cruise terminal, proximity to the National Highway and Indian Railways make it very convenient for all tourists budget traveller. The presence of Arabian Sea (Note: absence of sea coast in Delhi - Agra - Jaipur circuit) could open up new avenues for 5-8 hour ship travel for the domestic tourists connecting various backwaters like Ashtamudi, Vembanad, Colombo, Mali and so on. The cruise terminal will open the tourism to an affordable level for most of the middle class Indian and foreign tourists. More over this will help boost all unexpected multi sectoral (industry, commerce and trade, education, export, import, pilgrimage, local art and culture, etc.) growth for the overall economic growth of both the States.

8.4.2 Cruise Terminal and Tourism

Realising the significance of tourism potential, GoK has decided to include a well planned cruise terminal in the proposed Vizhinjam port infrastructure. It has the potential to become the cruise hub of India branded as **"God's own country"**, which is well connected by air, road and rail, to the rest of the country. Although cruise movement happens in some of the existing ports, Vizhinjam port will be the first planned cruise terminal in an Indian port with all related infrastructure facilities. This could be an encouraging factor for many ports located near tourist circuit in Goa and other coastal states. Overall such inbuilt tourist facilities in the port will nullify any malefic influence of Vizhinjam port for the tourist traffic in this area.

Therefore, there will be an increase in tourism in the surrounding areas. Since the Vizhinjam port will have the cruise terminal at the southern end close to the start chainage of the road, many tourists will use the road and thereby increase the local economy in and around the road corridor. As cruise liners can directly call at Vizhinjam port after its development, the tourism sector will also get a boost and it would be appropriate to explore the possibility of tourism activities bringing economic growth to the area around the road corridor.

8.5 Improved Socio-Economic Conditions

Vizhinjam port is likely to have positive impact on the socio economic conditions of the region. The social infrastructure in the region is likely to change due to the creation of more job opportunities and avenues for income generation. People will have higher income due to direct employment as well as indirect employment and will have higher earning and purchasing capacities.

The proposed project will have a positive impact on the socio economic conditions of the region. The social infrastructure in the region is likely to change due to the creation of more job opportunities for the local people and avenues for income generation. This will allow the dependency changes and there will be more than one earning member in the family, which will provide economic freedom. People will have higher income due to direct employment as well as indirect employment and will have higher earning and buying capacities.

8.5.1 Quality of Life

The quality of life in the region is likely to improve due to the creation of jobs for the local people so that the dependency changes and there will be more than one earning member in the family, which will provide economic freedom. The employment generation also reduces the migration of local people to nearby areas.

The connectivity to the Vizhinjam port from the hinterland will enhance and add value to the scope of exports, trading and marketing of the local products, commodities, handicrafts, and crop from the surrounding areas. The very planning stage of the project brought in lot of speculation that triggered an increase of land value along the proposed project vicinity which in turn helped people more confidence and improved social status.

Also because of these developments, there will be an increase in the number of settlements in the region which will add to the economy generation.

A much more organised Integrated fishing harbour (old and new together) with advanced facilities such as good road, drying yards, etc. will address most of the unhygienic unhealthy practices in and around the fishing harbour.

8.5.2 Health

As a part of the Corporate Social Responsibility (CSR) initiatives, it is envisaged to create health infrastructure in the form of primary health centre, which will be beneficial to the employees and also local people living in the region as their dependence on nearby towns and cities for quality medical treatment will be reduced. As part of CSR, it is also proposed to provide one health clinic or hospital with two fully equipped mobile dispensaries and conduct periodic health camps which will lead to better health conditions of the local people. Improved sanitation facilities, solid waste management

systems, water management systems, and overall health, safety and environmental awareness will improve to new levels.

8.5.3 Adoption of Fishing Harbour

The adoption of existing fishing harbour will lead to the improvement of the quality of the fishing harbour on all fronts (heath/environment/hygiene/facilities, etc). Overall the entire working environment itself will change positively for the fisherman. Maintenance work will be carried out regularly.

8.6 Employment Opportunities

The proposed port would have beneficial impacts through provision of direct and indirect employment opportunities. At the time of construction and operational phases, there would be requirement for large number of skilled, semi skilled and unskilled work force. VISL port will open up new avenues of development through creation of direct and indirect employment opportunities. It is imperative that local people would be employed based on their skills and educational qualifications. The employment potential from the construction phase of the proposed port is estimated as 2000 persons and expected direct employment during operation phase will be 600 persons and 2000 persons of indirect employment (truck driving, truck repair, taxi service, eateries, cruise service, navy/coast guard base service, CFS service etc.).

In addition to this there would be:

- Container Freight Stations – with supply chains to the whole of Kerala
- Transport of building materials (cement, tiles, timber, etc.) from various ports of India & china)
- Stuffing/destuffing & supply chain management
- Apparel park and related exports through port – women empowerment in garment making
- IT /Computer assembly & export corridor- proximity to techno park
- Seaport-Airport-Technopark--corridor as a commercial avenue of IT & ITES

There would also be a significant number of spin-off opportunities created within the region in other establishments catering to the needs of the port that will also employ a substantial number of people. The proposed project is likely to have positive impact on socio-economic condition of the region overall. Indirect employment will be generated due to overall improvement of socio-economic growth of the project region.

The Vizhinjam port including the road and rail connectivity will increase the employment opportunities. The proposed project will provide direct as well as indirect employment to the local people. The employment opportunities will be there in all phases of the project i.e., preconstruction, construction and operational phases.

During preconstruction stage the various studies, design, surveys and investigation including clearing and felling of the area is going to add opportunities for both highly skilled as well as unskilled workers. Currently Kerala State is facing the problem of labour shortage. Therefore such shortages especially unskilled category will be recouped mostly from neighbouring Tamil Nadu State.

There will be a demand for skilled, semiskilled and unskilled work force during the construction phase of the road and rail connectivity and it is imperative that mostly local people would be employed based on their skills and educational qualifications. The employment potential from the construction phase of the proposed port connectivity (rail/road) is estimated more than 300 persons for a period of two years. The expected direct permanent employment will be 50 persons during operation phase. The proposed

project will have direct positive impact on the socio-economic condition of the region that will bring opportunities to many sectors like tourism, health, hospitality, transport, commerce, trade, etc. With the addition of this employment potential, the indirect employment will be increased by many folds.

Overall the project is going to be an important asset for the Nation as well as for the State of Kerala and Tamil Nadu which will develop the region with much better employment opportunities.

8.7 Corporate Social Responsibility (CSR)

Ministry of Corporate Affairs, Government of India has released ***Corporate Social Responsibility (CSR) Voluntary Guidelines*** in year 2009 which focuses on integrating social, environmental and ethical responsibilities into the governance of businesses to ensure their long term success, competitiveness and sustainability.

Most of the local communities and elected representatives are looking at GoK-CSR activities as an opportunity to address local peoples' day to day issues/problems. Initially, as a part of CSR, VISL will propose to take up the following activities for improving the way of living of people of Vizhinjam and other nearby villages in 2 km radii area and in later stages VISL will extended these activities to 15 km radius after CEPT study.

8.7.1 Fisheries Sector

- Construction of an additional 500 m long jetty in the fishing harbour to promote fishing activity in the region.
- Construction of breakwater to provide more tranquillity and increase in operable days.
- Adopting the existing fishing harbour and to enhance the infrastructural facilities for fish landing, auction, boat parking, net storage, outboard engine storage, vehicle parking, etc,
- Development of Sea Food Park in association of State Government for export oriented value addition of marine resources with the aim of employment to women and the marginalised.
- Skill development centres for fisheries and container operation related logistic courses like ship/boat repair, net preparation; crane operations & repair, container freight management, truck terminal and related repair facilities /training in association with Maritime University and CMFRI Vizhinjam/Cochin and the State Fisheries Department.

8.7.2 Agriculture Sector

- Provision of adequate subsidy and financial supports for farming items, equipments and marketing tie ups, in consultation with various govt. departments like Horticulture, Agriculture, Animal husbandry departments.
- Development of agricultural food park in association with State Horticulture Mission, Kerala, to promote cultivation/harvesting/processing/packaging and exporting value added food products from locally available agricultural products like Pineapple, Tapioca, Mango, Jackfruit, Coconut and coconut oil and allied products.

8.7.3 Tourism Sector

- Development of a cruise terminal to promote tourism in the area and to benefit the local economy to a larger extent while utilizing available infrastructure.
- In association with the State Tourism Department to chart out programmes for developing the Kovalam –Vizhinjam - Poovar as a tourism local corridor.

- Starting govt. approved tourist guide course in the region which may provide livelihood supports and alternate employment opportunities to the people.
- Establishing small scale commercial ventures like eateries, antique shops, taxi service outlets, ayurveda/yoga oriented treatment centres, lodging services, etc., linked with cruise terminal.

8.7.4 Common Infrastructure Facility

Development of new facilities as well as maintenance of existing common infrastructure facilities are very important part of CSR plan of VISL. Following are the details of such CSR activities:

8.7.4.1 Water Supply

- In consultation with Kerala Water Authority (KWA), development of water supply scheme is being augmented to provide drinking water in fishing villages. Already 1.5 MLD of water from the 3.3 MLD water treatment plant at Vizhinjam is being distributed to the locality within 2 Km radii of the project.
- Groundwater recharge through infiltration ponds and controlled out flow of water to sea will be practiced.
- Recycling and reuse of the water in the port buildings and storage tank & pumping facilities for reuse of waste water generated in Vizhinjam area

8.7.4.2 Environmental Sanitation

- Separate community latrine complexes for men and women in each location will be provided and may be maintained by a team of locals on a pay and use basis of operation.
- Total sanitation within 2 km radii of the project site shall be implemented in association with the Kerala Suchitwa Mission, the LSGDs, etc. Use of the services of Kudumbasree units at Vizhinjam and 2 Km radii will also be ensured.

8.7.4.3 Decentralized Wastewater Treatment

Decentralized wastewater treatment like soak pits, digestion tanks, advance compact treatment units may be developed to treat the wastewater at site within the 2 km stretch of the project, by dividing it into 4 wards and commercial centres over and above that for the VISL requirements.

8.7.4.4 Solid Waste Management

- Developing community based vermin composting plants for biodegradable waste management.
- Plastic waste management with the help of local SHGs.

8.7.4.5 Educational Facility

- Upgradation of Upper Primary school at Mullor to High school.
- Financial assistance for educating the children of project affected people like providing sum of ₹ 1000/- as tuition fees per year for the poor children and providing annual scholarship of ₹ 5000/- for meritorious students scoring more than 75%, are prime considerations.

8.7.4.5.1 Medical Facility

- Up gradation of local public health centre at Vizhinjam to a fully fledged hospital equipped with ambulance.
- Establishment of Rural health centre for traditional yoga class, Ayurvedic healing centre, etc.
- Anti-alcoholism campaign & treatment (de-addiction centre).

8.7.4.6 Promotion of Renewable Energy

Following the concept of sustainable development and to reduce the carbon footprint, VISL proposes to promote use of renewable energy in the region like, biomass, wind, solar, wave, etc., for its energy requirements to the extent possible.

8.7.5 Other Welfare Measures

The women folk of the area may be organized and capacitated to generate better employment opportunities through active Kudumbasree linkages.

8.7.6 Benefits Accrued Out of CSR

Most of the local communities and elected representatives are looking at GoK- CSR activities as an opportunity to address local people's day to day issues/problems. As a part of CSR, VISL will propose to take up the following activities for improving the way of living of people of Vizhinjam and other nearby villages. This section discusses various aspects of direct and indirect benefits due to the project that will emerge from the CSR related activities of VISL for Vizhinjam port.

8.7.6.1 Fisheries Sector

The biggest benefit of the CSR to fisheries sector from the proposed project is the adoption of the fishing harbour into the infrastructure of the port. VISL has decided that the entire Vizhinjam fishing harbour and its activities will fall under the management of the port authorities who will take up the responsibility of the operations and upkeep of the harbour. This is a big step towards the welfare of the fishermen as VISL will look to improve the existing conditions of the fishing harbour by developing better facilities and providing utilities to the fishermen who use the harbour.

Alternate livelihood rehabilitation for fishermen in the immediate vicinity of the port (such as shoreline fishers, catamaran fishing groups/maintenance groups, etc.) need to be considered. Such requirements are emerged from the SIA study (by RH/Asian Consulting Engineers) appropriate rehabilitation packages under CSR, have been planned for them. The women folk of the area may be organized and capacitated to generate better employment opportunities. It is possible to maintain the environmental sanitation and hygienic maintenance of these areas, entrusting local task forces (SHG groups). A convergent action by all other related departments (fisheries, social welfare, LSGs, central schemes, etc.) also may be pooled. Skill development/upgradation training for creating better employment opportunities must be part of this effort.

8.7.6.2 Agriculture Sector

Agriculture has been the primary occupation of the people of the district and many of them are focused on the project area. Many of them may be temporarily happy with the compensation packages offered for the properties lost. Adequate subsidy, supports, farming items, equipments and marketing tie ups may be provided under the CSR package in consultation with Horticulture, Agriculture, Animal husbandry departments.

A seafood/ agriculture food park is part of the CSR plan and such an initiative could open up several opportunities to the people in the agricultural areas. The various agri products like banana, coconut products, mango and jackfruit. Jackfruit (an otherwise neglected agri commodity of Kerala State) alone

is increasingly becoming an important commodity with more than 98 products (Ref: TV morning news food festival @ Delhi May 18, 2013). Several export oriented activities can be initiated especially in the PIA district and neighbouring Kanyakumari district.

8.7.6.3 Tourism Sector

A portion of the CSR funds need to be kept apart for tourism development and a more realistic plan will be developed in consultation with the tourism department/private tourism operators in the area. The Tourism sector will benefit due to the cruise terminal provision in the project phase 1 design itself. There is immense potential in this area due to the opening up of a new tourist circuit Kochi-Thiruvananthapuram-Thoothukudy, and possible tourist linkages to Sri Lanka and other Indian Ocean islands.

8.7.6.4 Recreational Sector

Under tourism and local development possible recreational facilities need to be planned and developed for this area. CSR plans should consider such possibilities as a priority.

8.7.6.5 Preserving Culture and Heritage

Christian, Muslim and Hindu religions are practiced in the area and religious institutions (Temples, Churches and Mosques) of all these types can be seen in the project area, although Christianity is considered the dominant religion in the coastal belt. So it is better to link them to the local culture and heritage more strongly through creative activities. They already have annual events organized which may be spread out eventually to bind people together. Participatory exercises for this item can bring out the possible options in a much better way.

8.7.6.6 Project Benefits to Construction and Operation Phase (Threats & Opportunities)

The project is likely to result in increased urbanisation of the local area, with a knock on requirement for more commercial land uses and other support facilities such as offices, hotels, transport garages, fuel stations, etc. This could lead to a change in the land use land cover pattern of the area. Spatial planning for management of such developments needs to be considered under the town planning division. A study in this direction has been already been initiated by CEPT University, Ahmedabad. Preference should be given for PAPs/PDPs for employment opportunities in these areas. Considering this link, a skill development training for youngsters and job seekers under CSR can be undertaken (Kudumbasree (for men and women) wing can manage this too).

8.7.6.7 Drinking Water Problem

Among all CSR activities water resource development deserves highest priority. First a comprehensive study and later implementation of all schemes for the overall development of the PIA area (10 km or 15 km radius) is required. This shall be based on considering the operational phase and institutional support for such activities. It is important to accurately assess the water potential of the area for any water resources crisis management due to excessive draught and drying of all water bodies including Vellayani Lake.

8.7.6.8 Other Welfare Measures

Medical check-up camps will be arranged in the project area, for the labourers as well as local community throughout the phase in regular intervals as a package under CSR. Provision for toilets and Solid waste management in the fishing villages will be a part of the CSR activity. Common community halls for recreational facilities need to be constructed in each area associated to the local religious institutions and appropriate entertainment options like films, local folk arts and cultural competitions. This may be tied up with tourism plan also (village tourism). Common facility centres, constructing flats etc combining various housing schemes of the government and pooling the CSR funds, better educational improvements to younger generations, cleaner coastal area, and improvement of the fishing harbour are to be planned.

8.7.7 Area Development Plan by CEPT University

Spatial planning for management of such common infrastructure facilities needs to be considered for the overall development of the region, which in the near future may develop into a port city- a satellite city to Thiruvananthapuram. A study in this direction to prepare a planned area development plan for 15 km radii has been already been initiated by VISL though the Centre for Environment Planning and Technology (CEPT) University, Ahmedabad. Apart from above identified CSR activities/projects, based on the CEPT's study on area development plan for 15 km radii area other required CSR projects will be planned subsequently. A token amount of ₹ 34 crores are set apart as the initial funds for implementation of the prioritised activities to be brought out by the CEPT study.

8.7.8 Phase Wise Implementation of CSR and Budgetary Provision

As mentioned earlier, VISL CSR plan will be executed in two phases. First phase of CSR plan includes the activities already identified and to be implemented within 2 km radii area. The second phase includes activities to be implemented within 15 km radii area based on the detailed area development plan study by CEPT. As proposed by VISL, around 5% of total project cost share of VISL; ₹ 2800 crores excluding land cost for phase 1 amounting to ₹ 140 crores are earmarked for EMP and CSR activities. Out of this, approximately ₹ 40 crores are estimated for EMP. The remaining ₹ 100 crores are the total budget allocated for CSR activities which is around 3.5% of the total project cost (₹ 2800 crores). The budgetary provision is as given below:

Table 8-1: Identified Items under Corporate Social Responsibility

S. No.	Details of activity	Cost heads of Environment & CSR	Cost (₹ Crores)
1	Water supply scheme for fishing village already commissioned	CSR already implemented	7.3
2	New fish landing centre	CSR properly designed and estimated	16.0
3	Adoption of existing fishing harbour	To be implemented	5.0
4	Sea food park		5.0
5	Logistics training courses		5.0
6	Agricultural sector		5.0
7	Tourism sector		5.0
8	Rejuvenation of streams & ponds	To be identified	5.0
9	Recycling & reuse of water		2.7
10	Environmental sanitation		3.0

S. No.	Details of activity	Cost heads of Environment & CSR	Cost (₹ Crores)
11	Decentralized wastewater treatment		2.0
12	Solid waste management		2.0
13	Up gradation of School at Mulloor	-	1.0
14	Scholarship and financial assistance for education	To be implemented	0.5
15	Medical facility		0.7
16	Renewable energy promotion		10
17	Other welfare measures		0.3
18	Balance budget for CSR activities based on area development plan	To be identified	24.5
		Total	**100**

8.7.9 Implementation

The proposed CSR plans are to be implemented through a systemized structure that measures and reflects progress of CSR goals/targets. Identification of CSR projects/activities, setting measurable physical targets with timeframe, organizational mechanism and responsibilities, time schedules and monitoring are important aspects for implementation. The specific organizational mechanism/institutional structure as CSR cell shall be identified for effective check on implementation, operation and monitoring activities. The proposed organizational structure of CSR cell is shown as **Figure 8-1**.

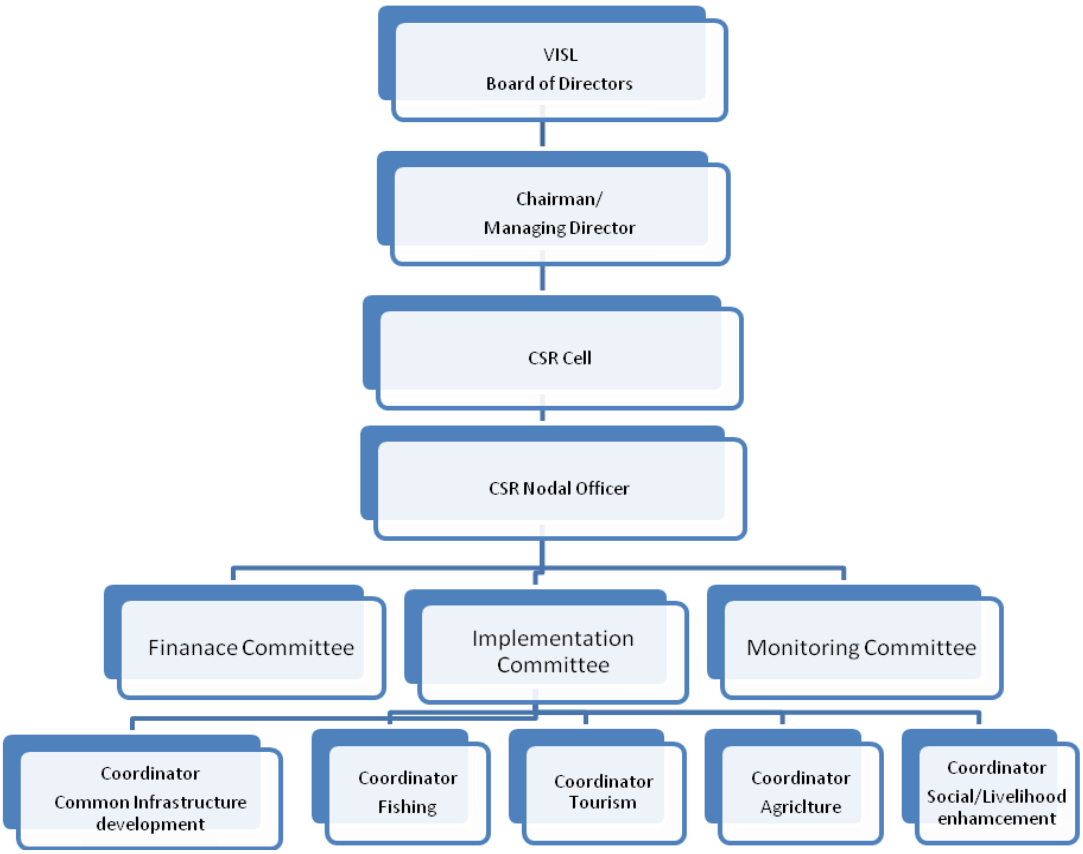


Figure 8-1: Proposed Organizational Structure of CSR Cell

Association with local authorities, business associations and civil society/non-government organizations are important for effective implementation as they also influence the supply chain for CSR initiative and motivate employees for voluntary effort for social development.

The specific amount in budgets for CSR activities shall be allocated.

The VISL shall disseminate information on CSR policy, activities and progress in a structured manner to all their stakeholders and the public at large through their website, annual reports, and other communication media.

The generalized strategic implementation framework that may be used for VISL CSR plan is as shown in **Figure 8-2**. As shown in the figure effective implementation is an integrated approach starting with planning for CSR projects followed by implementation on ground which shall be followed by check for adequacy and effectiveness of the CSR project and shall be followed by improvement in CSR activity.

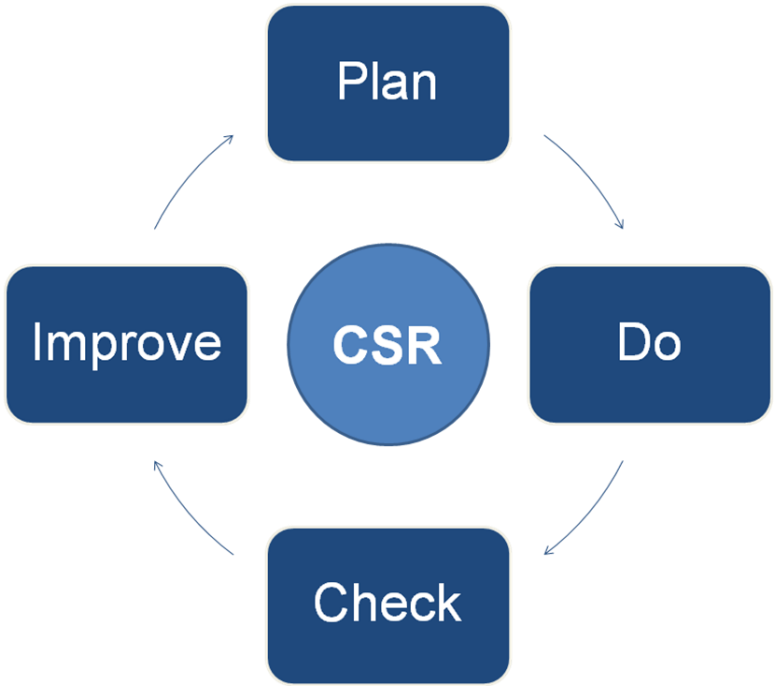


Figure 8-2: Implementation Framework

8.7.10 Monitoring Mechanism

Monitoring of CSR project goes concurrently with implementation, and is as important. Monitoring is essential to assess if the progress is on expected lines in terms of timelines, budgetary expenditure and achievement of physical targets. Monitoring should be done periodically with the help of identified key performance indicators; the periodicity being determined largely by the nature of performance indicators. Like implementation, monitoring too should be done in project mode with continuous feedback mechanism, and recourse always available for mid-course correction in implementation, whenever required.

A robust monitoring mechanism will also be developed to meet the required standards and targets on time. In order to have non biased monitoring, independent consultants may be hired by VISL. It is proposed to include CSR report a part of the Environmental monitoring report. Proponent will make sure that following monitoring activities are done periodically

- Monthly monitoring of Projects by CSR Cell
- Quarterly monitoring by Board Level Committee
- CSR Progress reported to the Board bi-annually
- Two social audits every year

8.8 Project Benefits due to Revenue Generation

The exposure of economies to trade and its related activities gave prominence to the development of ports. Ports and shipping can be considered as the engines of growth for any country. The importance of ports and its related infrastructure plays a vital role in the growth of a Nation and its economy.

The project construction and operation will generate revenue for the State and Central Government by way of payment of royalty, tax and sharing of port revenue. In addition to the above, port development will attract investments into the region and thereby contribute to economic growth of Thiruvananthapuram District, the State of Kerala and neighbouring Kanyakumari District. The importance of ports and its related infrastructure plays a vital role in the growth of a Nation and its economy.

8.9 Project Benefits to Local Economic Growth

The local economy is going to improve as part of the complete development of the port infrastructure. This cannot be quantified in real terms as it involves many levels of benefit. For example, lots of new people from other Indian States and from other countries may move into the region and newly arrived port related people (tourists, businessmen, truck drivers, etc.) that they may need vehicles, vehicle repair facilities, accommodation, etc. They need clothes and stitching facilities for that they need textile shops and garment stitching facilities. The people need to eat in restaurants of various types with various food and tastes. They also need leisure activities such as cinema and tourism. Therefore, the project is going to improve the number of various shops and facilities for the local communities. Positive impact will be felt on all aspects of development. All such chain reactions (Religious institutions, marriages, education, festivals, etc.) are part and parcel of local economy creating wealth as well as new employment opportunities.

8.9.1 Project benefits as per stake holders perceptions

The positive and negative perceptions of local stakeholders with respect to the Project, as heard in various public consultations, FGDs and from the household survey, are summarised below.

Perceived Benefits:

- An opportunity to develop the area and the quality of life of people.
- A great opportunity to increase the financial status of government.
- Development of institutions like schools, colleges and offices.
- Agricultural development through better irrigation facilities.
- Development of health care facilities.
- Better infrastructural development.
- Better road and transportation facility.
- Better property values.
- Better employment opportunities.
- Improvement of cultural and social affairs.
- Development of small scale industries.

- Development in accessibility like improvement of the local road and rail networks.
- Overall development of the economy and communication system.
- Increase in export and import business.
- Overall technological development in the area.

8.10 Strategic Defence Location

Over the last two years the project has evolved from a State project to a '**National Project"** with regards to safety and security of the country. Indian Ocean region being an international border, this port location as the southernmost port location is going to strategically boost our defence preparedness. This is more important due to the increasing presence and influence of the region by many countries like US and China. Moreover the recent developments in Sri Lanka and in Maldives are true international issues. As a result the Ministry of Defence has sought space in the berthing systems; the coast guard has already booked the berth. Accordingly these provisions have been integrated into the project design. Together with the road/rail/air connectivity, Thiruvanathapuram will become one of the most important strategic defence positions of the Country.

Both in the Indian Ocean and the Arabian Sea, defence vessels of all types can get into this area due to the very high draft in the region. The connectivity to the Vizhinjam port will greatly benefit the navy in terms of access to the defence vessels calling in at Vizhinjam port. The only amphibian unit of army at Thiruvanathapuram is stated to be using the Karwar port area in Karnataka for certain kind of Amphibian Operations which can now shift to Vizhinjam. This will help swift movement for timely actions.

8.11 Deep Sea Mining Possibilities

Polymetallic nodules, also called manganese nodules, are rock concretions at the bottom of the sea formed of concentric layers of iron and manganese hydroxides around a core. The core may be microscopically small and is sometimes completely transformed into manganese minerals by crystallization. When visible to the naked eye, it can be a small test (shell) of a microfossil (radiolarian or foraminifer), a phosphatized shark tooth, basalt debris or even fragments of earlier nodules. These deposits are actually **"common heritage of mankind"** and the profits needs to be shared with the international community.

There are chances to believe that mining of manganese nodules near Seychelles is going to be economical due to the reduction of bulk transportation cost of mined nodules from the island region to Vizhinjam. Therefore, Government of India (GoI) needs to think of setting up the robotic deep sea mining and the mineral and ore processing industries for the manganese nodules near Thiruvananthapuram, Tamil Nadu border region.

With a deepwater port in Thiruvananthapuram, the nodules can be transported in unimaginable quantities using the biggest ships ever available for mankind. So far this is the most expensive part of mining of deepwater mineral deposits from the Indian Ocean. GoI and GoK can work out an action plan for this offshore mining project. GoI got exclusive rights from the United Nations for mining of an area of 100 km^2 near Seychelles Island of the Indian Ocean. Although not envisaged in the near future it is a fact that the marine mining activities like mining of manganese nodule from Indian Ocean need a major port of Vizhinjam type before being supplied to the ore processing industrial units. Such mining activities will be highly economical if mined and transported in bulk quantities. Most of these activities will be coordinated by National Institute of Oceanography (NIO). Such activities will be more important in case of any war like situation along the borders.

Chapter 9
Environmental Cost Benefit Analysis

Chapter 9 Environmental Cost Benefit Analysis

9.1 Introduction

This chapter has been included to focus on the Environment cost benefit of the proposed Vizhinjam deep water port project as a feed back to the multiple stake holders based on the extensive consultations carried out for the project during the project cycle till today. Due to the proximity to the Kovalam tourism areas, CRZ areas and fishing harbour, all environmental decisions are stream lined to the design decisions; this has been made in a manner apparently consistent with the cost benefits. The engineering decisions have been systematically tuned and fine tuned to improve the quality of assets especially during the Operational phase. The possible impacts of the short term construction phase is also planned to address with all due care. However construction and operation of the project for major infrastructure assets of the country are definitely to have few potential impacts also. Therefore the Management decisions were also taken in consistent with the requirement to avoid, compensate, negate or enhance the environmental impacts. The two management action plans (RAP & EMP) formulated were highly satisfying for the general public (RAP in particular). As a result a project of local nature a decade ago has become a State project and then a National project and finally the people's project. These management action plans were formulated with care and the GOK is willing to improve further after listening to the public during public hearing and during the environmental appraisal at GoI-MoEF later.

9.1.1 Stakeholders and Their Concerns

The project has several stakeholders such as tourism communities, fishermen communities, NGOs, Government and the society in general. Normally as a usual practice the investor or project operator analyses the investment from a limited perceptive i.e. to know whether it will generate sufficient financial returns over the project term. However, this helps to generate direct and indirect effects for the economy of the region and the country as whole.

9.1.2 Design Decisions

All design decisions has been taken with utmost care to improve the quality of environmental assets. Based on regulators (MoEF, PCB, etc.) and stake holder concerns the design have been optimised by extensive marine side numerical modelling techniques to avoid any impact to marine ecology and for the existing fishing harbour.

<table>
<tr><td>To the interest of local fish folk and the Nation, the following berthing facilities provided in proposed port</td><td colspan="2">• Fish landing area
• Coastal Guard berths
• Navy berth</td></tr>
<tr><td rowspan="4">Port lay out has been optimised by</td><td colspan="2">Shifting the complete proposed port 80m south in addition to 220 m proposed at ToR stage</td></tr>
<tr><td rowspan="2">Shifting the container terminal</td><td>Towards the sea by 50m</td></tr>
<tr><td>South by 100m (creating a 100 m gap between the terminal and the breakwater)</td></tr>
<tr><td colspan="2">Optimisation of rail access to site</td></tr>
</table>

There are some items that can be viewed as an improvement of the design in terms of its social impact such as:

- Inclusion of significant fish landing facilities, improving current facilities
- Cruise terminal, leading to additional employment and economic growth
- Modification of the rail access to the site reducing impact on the local population
- Shifting of the port 80m south to improve tranquillity in the existing fishing port.
- Inclusion of industrial facilities as a shipyard, etc., leading to increased employment in the region.

On the other hand there are other items that require attention such as:

- Increase in raw material use due to the shifting of the container terminal to deeper water. This has a negative impact on the environment.
- However with further numerical modelling has removed the southern break water (considerable reduction in raw material) and part of Northern back water that share common with fish landing centre (again reduction in cost and resources)
- Development of proper Environmental Management in relation to additional services proposed as there is e.g. Solid waste management with **"zero tolerance**: limit

9.1.3 National Thinking

The National security with regards to the Indian Ocean region is a growing concern and is increasingly becoming an otherwise very favourable region to a very sensitive region. The Vizhinjam deep water port as explained in other chapters is very favourable for all swift marine and air operations for navy/air force and the only amphibian unit of Army located at about 17km away at Pangode from the project location. A defence berth has been provided in the phase 1 itself to cater to the countries security needs.

9.1.4 International Concerns

The impact to the Wadge bank an important fishing area is stated to be important as an ecological unit located in international waters. All literature and even the written stake holder representations has categorically stated that the distance to the international shipping route that caters to the movement of several 1000s of ship movement (both ways towards East and West) is located at just 18 km from the Vizhinjam deep water port. The distance to Wadge bank has been provided as 40 kms that clearly pointing out the ecologically safe location of Vizhinjam port with regards to the location of Wadge bank. This international transhipment container port is only dependent on the near transhipment route which separates the **Wadge bank** from Vizhinjam port. Although it is apparently clear and is a closed subject VISL and GOK will further listen to public and then EAC (at MOEF) and any "**potential**" impacts (No Impacts as on today) will be further looked in to for any possible mitigation and or avoidance measures.

9.1.5 Regulatory Compliance

Each and every regulation is meant to achieve certain level of minimum standards in our actions. The compliance of required regulation is one of the major objectives of the project. In this way project also will have to pass through Environmental appraisals at state and National level. Most important regulations are the September 14, 2006 MOEF EIA notification and January 6, 2011 CRZ notification. **Appendix 1.1** provides the list of national and international regulations that the project need to adhere

to achieve certain Standards. Benefits accruing out of such regulatory compliance are also project benefits especially from the Socio economic angle.

9.2 Economic Cost Benefit study

The main purpose of the project cost benefit analysis is help to design and select projects that contribute to the welfare of the country. A project may generate economic benefits in terms of:

- employment generation
- better quality products,
- time saving,
- fall an average price levels etc.

On the other hand, it may also generate economic costs such as

- pollution,
- increase in accidents,
- Displacement of people/ village etc.

Generally, when a project seeks public finding, it necessary to study the economic benefits and costs of the project and determine whether it is generating sufficient returns for the economy. Economic analysis is carried out in the “with project” and “without project” situation i.e., seeing the increment effect on the economy by the undertaking of the project. So, to study the financial viability of the project, VISL has appointed **Deloitte Touche Tohmastu India Private Limited**. Deloitte (May 2013) has prepared a report on Estimation of Economic Internal Rate of Return (EIRR) of the Vizhinjam port project This study is particularly important as this project is one of the most studied port project in terms of its completeness prior to construction phase. As listed in the project summary more than 20 agencies were directly involved in various capacities for the same reason ie, to develop a deep water sea port at Vizhinjam. These studies have helped **Deloitte** to come out with a relatively accurate picture on economic benefits (EIRR study Deloitte, May 2013).

9.2.1 The Economic Internal Rate of Return (EIRR)

The Economic Internal Rate of Return (EIRR) is the basis by which the High priority projects were selected for implementation. A 12% Internal Rate of Return or more is generally acceptable for international projects for implementation or for loan assistance from International banking institutions.

The Net Present Value (NPV) incorporates the total benefits discounted to the base Year. The minimum NPV/ cost ratio considered for the selection criteria is 1.

Economic internal rate of return (EIRR) is a criterion used for economic evaluation of projects such as the Vizhinjam Deep water port projects and is defined as the annual rate of return generated by the investment. It is calculated in terms of a base case and is a means of evaluating the economic benefits. The calculations depend on estimated costs net of taxes, duties and royalties. In this case the economic benefits that are normally considered in evaluating EIRR are:

- Savings in fuel costs;
- Time savings for passengers and goods; and
- Increase in spending of tourists
- Carbon emission reduction benefit
- Savings in National security

The EIRR depends on various factors including:

- Estimation of Benefits on account of water tankers
- Additional Employment generation

- Reduction in number of trucks to handle tankers
- Accident benefits
- Capital cost savings and accident benefits in inland transportation.

Anticipated improvements in these variables after the port and other infrastructure development

9.2.2 EIRR Study – Results and Discussion

Economic analysis of the costs and benefits of the project reveals that the project has a positive economic net present value and a high economic internal rate of return. The project generates substantial consumer surplus in terms of savings in ship and inland transportation costs. The Cruise terminal will attract more tourists to the region resulting in greater incomes for the local tourism industry. The Coast Guard and Navy will be able to save substantially on fuel costs on its surveillance trips to Vizhinjam area, by operating out of Vizhinjam instead of Cochin or Tuticorin. The local community will be provided water by the planned water supply project, which will result in savings of cost of water tankers. The project also generates environmental benefits such as reduction in carbon emissions.

There are several negative economic effects of the port project as well in terms of relocation of resorts, loss of jobs for people employed at these resorts and effects on the environment. However, the economic benefits outweigh the economic costs to generate a net economic surplus.

The financial and economic indicators are summarised in the Table 9-1.

Table 9-1: Financial and Economic NPV/EIRR after considering Environmental Benefits and cost

Indicators	Unit	Financial	Economic Internal Rate of return (EIRR)
NPV	INR crores	5187	303
IRR	%	2.54%	12.93%

(Source: Deloitte EIRR study May, 2013)

9.3 Management Action Plans to Negate Environmental Impacts

The Management Action Plans (MAP) encompasses both EMP and RAP to address all issues comprehensively. While RAP is the outcome of Social Impact Assessment (SIA) carried for all components of the port project, the EMP is the outcome of all EIA carried out for all components of the project. All social and environmental issues were addressed or will be addressed in a time bound manner.

9.4 Resettlement Action Plan (RAP)

As a part of mitigation work, VISL has already prepared a RAP defining the entitlement for all the losses to the local communities. As per this the entitlement framework were prepared for various type of Social impacts. The local communities are highly satisfied with the framework and steps taken for proper compensation of the PAPs. The entitlement Matrix for PAPs as per VISL/GoK policy for Vizhinjam Project is provided in **Chapter 10**.

9.5 Environmental Management Plan (EMP)

For the purpose of operational EMP and decentralised environmental management, the For the purpose of operational EMP and decentralised environmental management, the **Table 10-3** provides the delineated EMP zones for 10 sectors/zones identified. All operation environmental management aspects of these units will be treated separately.

Table 10-3: provides the delineated EMP zones for 10 sectors/zones identified. All operation environmental management aspects of these units will be treated separately.

Table 9-2: Areas/Zones Identified For Decentralised Environmental Management

Sector No	Identified Homogenous Zones /Sectors	Sector No	Identified Homogenous Zones/Sectors
1	Old/New Fish landing Centre	6	Rail Connectivity
2	Backup Areas (four sectors)	7	Port or Marine Side Activities
3	Entire Road Network of VISL	8	Port Operators Colony
4	Truck Terminal Area	9	Warehousing Area
5	Sub-station Area	10	Defence/Coast Guard/Cruise Berth

9.5.1 Contractors EMP

Contractor is to prepare an implementable contractor EMP to address all construction related environmental impacts. This has to be approved by VISL prior to implementation. Environmental monitoring consultant appointed by VISL for the implementation of EMP will ensure the finalisation of an implementable contactors EMP during construction phase. The same environmental consultant will supervise the implementation of the EMP as well. The major activities under the EMP are:

- Labour camp with basic amenities like water, power, sanitation and medical etc
- Dust suppression/pollution control measures
- Personal protective equipment (PPE)
- Health & safety measures
- Dredge Management Plan
- Quarry Management Plan
- Natural Resource Management Plan
- Transport Management Plan

9.6 Corporate Social Responsibility (CSR)

As a part of the Corporate Social Responsibility (CSR) a water supply scheme has been commissioned recently for the Vizhinjam fishing village. Further a fish landing centre that could be able to double the capacity of the fishing harbour is going to be implemented. This has already been included in the phase-I design and a realistic budget estimated.

Planned activities included in the CSR are the following:

- Seafood park
- Skill development centre for marine port and

- Upgradation of UP school in Mulloor to a High School
- Refurbishment of infrastructure facilities at Vizhinjam Fishing Harbour to International Standards
- Preparation of a "port city" area development plan to be integrated with Thiruvanathapuram city and Kovalam development plan
- Health clinic and Yoga centre (recreational facilities)
- Two types of Scholarship for meritorious students and poor students from the PIA panchayts

9.7 Adoption of Vizhinjam Fishing harbour

As a part of the CSR the consultants strongly recommend VISL and the Government for Kerala (GoK) to adopt the fishing harbour for the proper integration of the old and new establishment to happen without any environmental and social issues. This has the potential to holistically address all fishery sector specific impacts and issues. The master planning of the area with stringent environmental planning component need to be carried out as a priority for the actual old fishing harbour operation, maintenance and visual integration to other newly constructed infrastructure facilities to happen. Otherwise, the management of this area will be difficult. This alone could address all issues relating to the old fishing harbour.

9.7.1 Corporate Social Responsibility (CSR)

The estimated total project cost for phase-I is ₹ 4,110 crores (excluding the land & EMP/CSR costs), out of which ₹ 2803 crores is the expenditure by VISL and the rest by the operator). About 5% of the VISL expenses amounting to ₹ 140 crores is suggested to be set apart under the head of EMP (₹ 40 crores) & CSR (₹ 100 crores).

These budgets exclude the land cost.

Table 9-3: Identified Items under Corporate Social Responsibility

S. No.	Details of activity	Environment/ CSR	Cost(₹ Crores)	Cost in Million
1.	Water supply scheme for fishing village already commissioned	implemented	7.0	70
2.	New fish landing centre	Properly	16.0	160
3.	Balance budget for CSR activities as described in Chapter 8	General	77.0	770
Total			**100**	**1000**

9.7.2 Environmental Budget

Broadly Rs – Million (40 crores) have been earmarked for the EMP and Environmental Monitoring Plan to address all environmental management requirements.

- Environmental (terrestrial and marine) monitoring in both construction and operation phase
- Monitoring of Shoreline changes in Vizhinjam coast in both construction and operation phase
- Water & wastewater management
- Solid waste management
- Storm water management

- Tree plantation plan
- Environmental enhancement such as landscaping
- Focussed water supply augmentation study in the ten km study area

9.8 Environmental Cost Benefit Analysis - Conclusions

The project planning has taken in to consideration all aspects environmental and ecological concerns through systematic comprehensive studies based on regulatory and stake holders concerns.

- DELOITE economic cost benefit study has indeed considered on the environmental and social benefits accrued as result of CSR, environmental (EMP) and social impact mitigation (RAP), and other enhancement measures
- Project has stream lined all environmental requirements with that of engineering requirements and the design and layouts were fine tuned. In other words it is called main streaming of Environmental and social concerns in to design, construction and operational phases
- Further GOK/VISL is planning to revisit and if required is committed to address all potential issues precipitated during the public hearing
- Similarly VISL is also committed to address all issues and concerns of the regulatory body's particularly environmental appraisal by GoI-MoEF.

Chapter 10
Environmental Management Plan (EMP)

Chapter 10 Environmental Management Plan

10.1 Introduction

The Environmental Management Plan (EMP) has been prepared for all the components of the port (road/rail, ancillary sites) to address the potential environmental impacts. In this project both EMP measures and CSR measures are more or less identical and hence an appropriate institutional mechanism suggested. An appropriate budget of ₹ 1000 Million (₹ 100 Crores) as CSR and ₹ 400 Million (₹ 40 Crores) has been earmarked for EMP measures.

The region being a tourism area with Kovalam just 2.0 km away and Poovar about 9.0 km south from Vizhinjam, "*ZERO TOLERANCE FOR POLLUTION"* will be an institutional slogan during construction and operational phase of the project. This is basically to achieve to maximum possible success with regards to various environmental management measures. With this slogan in mind, several programmes are being planned and the VISL/GoK is also interested to develop innovative programmes and policies that could give value addition to this area; especially in terms of use of non-conventional energy resources such as solar energy, wind energy, wave energy and decentralised cost effective solid waste management programme. An elaborate decentralised solid waste management facility, rainwater harvesting programme and other water resources development initiative are also incorporated. Both CSR and EMP funds will not be used (***"No diversion, No Lapse funds"***) for any other purposes as to be declared by the VISL during the public hearing. The main decision to adopt the old fishing harbour is based on the commitment of VISL and GoK for the co-existence of proposed port, tourism and fishing harbour in the same region. The various facilities provided in the existing harbour are not being used for want of proper maintenance and some key areas are not being used because of religious issues. To integrate the old fishing harbour with the new fishing harbour a master plan with a core planning concept as the environmental management plan will be required. Additional government land already available in the nearby area can be explored for various environmental management facilities.

In this project both CSR and EMP activities and fund flow need to be through the EMP cell on account of maintenance of both new and old fishing harbours. This unit will be the starting point of recommendation to the management with regards to CSR and EMP activities. The transfer of funds to EMP and from EMP to CSR is always acceptable due to the similarity of objectives in this area of importance. All environmental management facilities are provided in **Table 10-1** and the locations in **Figure 10-1**.

Table 10-1: List of EMP and CSR Measures

S. No.	EMP and CSR measures	Classification	Remarks
1	Water Reservoir		
2	Rainwater harvesting	Mainly Fishing harbor	in all Ten EMP units
3	Open well Bore /well location /bathing ghat and rain water harvesting facility	Along a lineament – Vellayani lake connection	Believed to be Potential sites
4	Appropriate treatment location	River 1 & 2	Appropriate treatment method
5	Sewage treatment plant	Domestic Wastewater	
6	Composting facility for all ten	Along the road side	Although EMP is decentralized,

S. No.	EMP and CSR measures	Classification	Remarks
	units	surrounded by green belt	Composting is planned only at one place
7	Sea food park and agro park	Agri and fishing communities	Prefer employment for Livelihood issues
8	Recreational Area	Abandoned fish landing centre & Auction halls	Conversion of the proposed use to recreation
9	Scavenger boats	New fishing harbour	-
10	Greenbelt	Along the proposed road	-
11	Horticulture and other instrument store room	Backup area 2	-
12	Solid waste management facility at four locations	In all important units mainly fishing harbor and truck terminal area	/ Truck parking area /Port operators colony/Ware housing area
13	Water supply scheme for the fishing community/port	Already commissioned	Fully operational
14	Battery of toilets Location	For OLD / NEW fishing harbor	Conception lay out with message of maintenance and sustainable operation of the units without fail even for a day
15	Drainage improvement works	Gangayaar Domestic waste water	Along – Civil works STP for two highly polluted streams
16	Solid waste Disposal Site	Backup area 3	Low lying area

10.1.1 Contractors EMP

Contractor is to prepare an implementable contractors EMP to address all construction related environmental impacts. This has to be approved by VISL prior to implementation. Environmental monitoring consultant appointed by VISL for the implementation of EMP will ensure the finalisation of an implementable contactors EMP during construction phase. The same environmental consultant will supervise the implementation of the EMP as well. The major activities under the EMP are:

- Labour camp with water, power, sanitation and medical, etc.
- Waste Management Plan
- Dredge and Reclamation Area Management
- Quarry and transport management Plan
- Personal Protective Equipment
- Health, Safety & Hygiene Measures
- Community grievance management
- Local Employment Plan
- Water Management
- Air Quality and Dust Management Plan
- Natural Resource Management Plan
- Transport Management Plan

All contractors' related facilities are provided in **Table 10-2** and their locations in **Figure 10-1**.

Table 10-2: Phase-I Construction - Contractor's Facilities

S. No.	Construction phase establishment to be dismantled after construction	Proposed location	Remarks
A	Contractors labour camp	Truck parking area	Lay out approved

S. No.	Construction phase establishment to be dismantled after construction	Proposed location	Remarks
B	Material storage area	Along the acquired road side	
C	Contractors miscellaneous storage area	Port officers colony	PPE safety equipments & instruments
D	Water storage area	Truck parking area	-
E	Contractors vehicle parking area	Truck parking area	-
F	Manufacturing Fabrication Facility (MFF)	In front of backup area 4	Reclaimed land
G	Storage yard for MFF	In front of backup area 4	Reclaimed land
H	Contractors Camp and office facilities	In front of backup area 4	Reclaimed land
I	Sub contractors camp (Office/labour camp, etc.)	warehouse	-

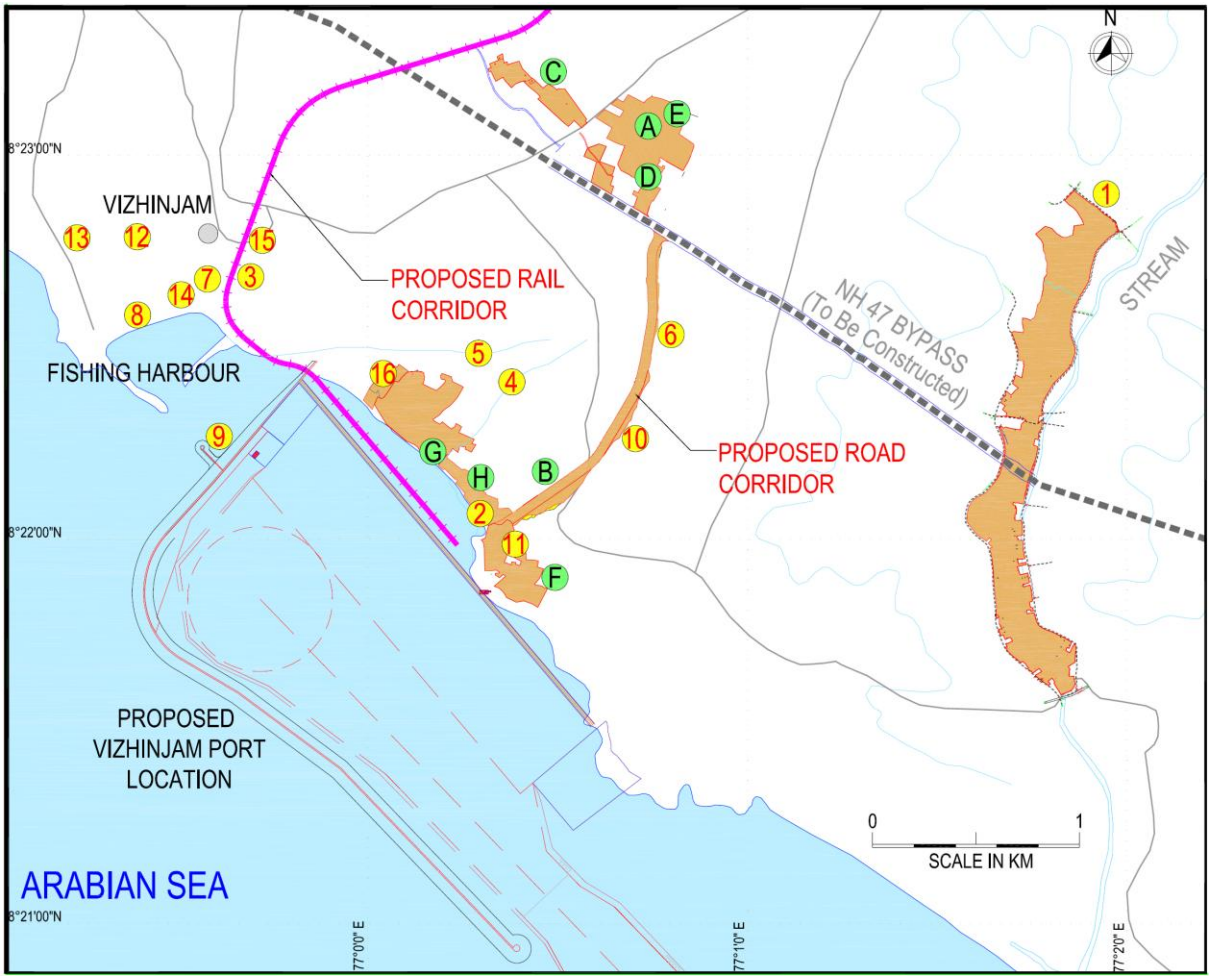


Figure 10-1: Proposed EMP/CSR and Contractors Facilities Locations

10.1.2 Dedicated Environmental Management Team

In order to achieve all set goals, a highly committed project management team will be required. The success of implementation of various EMP measures largely depends on the commitment of project management team with a clear vision. The dedicated environmental management team will drive the action with:

- Capital cost
- Adequate trained staff
- I T support facilities
- Clear lead role to main stream environment
- Contractor EMP for construction phase
- Recurring budget
- Vehicles on demand
- Adequate space and room
- For every activity to maintain tourist grade environment in the region
- Operational EMP for Vizhinjam port

The main objectives of Environmental Management are to:

- Accept the importance of the location and establish a clear environmental management vision for this important tourism region.
- Identify key environmental issues envisaged to be encountered during construction and operation phases of the project.
- Provide guidelines for appropriate mitigation measures.
- Establish systems and procedures for implementing mitigation measures.
- Ensure the mitigation measures are being implemented effectively.
- Monitor the effectiveness of mitigation measures.
- Take necessary prompt action when unforeseen impacts occur.
- And finally the **green stamp by Head of EMP/CSR cell** must be made mandatory for execution of all activities (civil/mechanical/electrical/administrative, etc.) with a clear logically correct **EMP/Sustainability note**.

10.1.3 Corporate Social Responsibility (CSR)

As a part of the Corporate Social Responsibility (CSR) a water supply scheme has been commissioned recently for the Vizhinjam fishing village. Further a fish landing centre that could be able to double the capacity of the fishing harbour is going to be implemented. This has already been included in the phase-I design and a realistic budget estimated.

Cruise terminal earlier envisaged in Phase II plan (Master Plan, November, 2012) has been brought in to Phase I as an outcome of the public consultations on the impacts on tourism, and its increased scope in the Kovalam - Poovar belt. As a result, VISL is investing in cruise terminal Phase I, rather than the earlier plan to invest in Phase II. Although this is as part of the corporate commitments of the company, the same has not been accounted in the CSR head, considering that it was a planned activity in the original master plan.

Planned activities included (but not limited to) in the CSR are the following:

- Creation of a new fishing harbour that could double the capacity of existing fishing harbour[28]
- Adoption/Refurbishment of infrastructure facilities at Vizhinjam Fishing Harbour to International Standards
- Seafood/agro park
- Skill development centre for marine port and
- Up-gradation of UP school in Mulloor to a High School
- Health clinic and Yoga centre (recreational facilities)
- Two types of scholarship for meritorious students and poor students
- Preparation of a “port city” area development plan to be integrated with Thiruvanathapuram city and Kovalam development plan

[28]Details are provided in the final port layout after detailed modelling studies.

10.1.3.1 Adoption of Vizhinjam Fishing harbour

As a part of the CSR, the consultants strongly recommend VISL and GoK to adopt the fishing harbour for the proper integration of the old and new establishment to happen without any environmental and social hitches. This has the potential to holistically address all fishery sector specific impacts and issues. The master planning of the area with stringent environmental planning component need to be carried out as a priority for the actual old fishing harbour operation, maintenance and visual integration to other newly constructed infrastructure facilities to happen. Otherwise, the management of this area will be difficult. This alone could address all issues relating to the old fishing harbour.

10.1.4 Institutional Setup of EMP and CSR Cell

The EMP cell needs to be a decision making unit of the entire management mechanism. Therefore (option -1) either to have full-fledged EMP cell with all staff or (Option 2) to have a lean unit with hired consultants fulltime on call. Of course the second option is expensive but efficient and the first option is dependent on the professional capability of the EMP team and also on the importance of the EMP cell in decision making.

Head of EMP and CSR cell also need to be at least on a third level of hierarchy:

- Chief Executive Officer (CEO)
- Chief Operating officer (COO) and Port Security Officer (PSO)
- HODs of all sections
- Within EMP cell both CSR section and EMP section. The CSR section need to have professional preferably an expert from the Social angle and the EMP cell must have a professional preferably a strong environmental management professional.
- There must be decentralised environmental managers that will have independent or composite charges of the decentralised units. The environmental CSR manager of the fishing harbour must have an independent charge as this work will be most challenging. In this way additional three managers can deal with situations of all other centralised units with combination of responsibilities.

Further, a building/facility, vehicles, communication systems and IT systems are all important for the unit.

10.1.5 Quarry Management Plan

Quarry material is required for the construction of Port breakwater. About 27,000 Ton/day is proposed to be transported in the construction period of phase I. Out of nine possible alternatives of quarry site, four (Karavaram, Kadavila, Malayan and Thakala) were shortlisted and assessed (Preliminary Project Plan Report, RH, 2010). Reference is made to **Chapter 4** for the discussion on the various alternatives and Chapter 5 for the Baseline information.

It is proposed that out of the aforementioned four shortlisted quarry sites, the Kadavila quarry and the Theviyodu quarry will be offered as alternative sources for quarry material. The final quarry location will be chosen by the Contractor depending upon the ease of transportation and cost effectiveness and anticipated environmental and social (E&S) risks and impacts as well as community health and safety potential risks.

A **Quarry Management Plan** should be developed by the contractor approved by the developer prior to port construction.

10.1.6 Administrative and Technical Setup for Environmental Management

A highly qualified and experienced people in the field of Environmental Management of port shall be considered for the position of Senior Manager for Environmental Management along with adequate supporting staff.

The responsibilities of the Environmental Management Team shall be as follows:

- Identify environmental aspects, normal, abnormal and emergency conditions
- Ensure implementation of standard operating procedures as updated from time to time
- Evaluate any non-conformity to the environmental standards, as stipulated by different regulatory agencies
- Ensure and implement necessary corrective actions
- Establish procedures for reporting, document and record control
- Establish and implement procedures for incident and near miss reporting, investigation and root cause analysis and prescribe corrective action

10.1.7 Institutional Mechanism for Implementation of Mitigation Measures

The effective implementation and close supervision of the environmental management to mitigate the environmental impacts, which are likely to arise due to the construction and operational phases of the project could be achieved through a suitable institutional mechanism. The proposed institutional mechanism recommended for the implementation of the mitigation measures is presented in **Figure 10-2**.

A proper institutional mechanism to understand and implement appropriate environmental management measures during various stages of the project is a pre requisite and has a strong bearing for the overall success of the project management. Implementation of the Environmental Management measures will become easy once a good project management team is in place.

10.1.8 Approach towards Voluntary Compliance

VISL can adopt Environment, Health & Safety Management System (EHS MS) based on recognized international standards for environmental and safety management systems (ISO 14001 – 2008; OHSAS 18001- 2007, 2008, Social Accountability (SA) 8000 and International Maritime Organisation (IMO)). The objective is to establish a system to assess, monitor and manage environmental performances, which can be used to promote continual environmental improvement and prevention of pollution. The typical procedure that can be adopted in formulating the EMS is presented below:

- Identify and list out environmental aspects due to the operation of the proposed project
- Determine the key operations that have significant environmental impacts
- Identify and track environmental legislations, policies, codes and other relevant requirements
- Establish objectives and targets (Environmental Management Plan)
- Formulate an Environmental Management System

For successful implementation of the formulated Environmental Management System, VISL shall ensure that the essential resources (with defined roles and responsibilities) are made available to implement, maintain and improve the Environmental Management System.

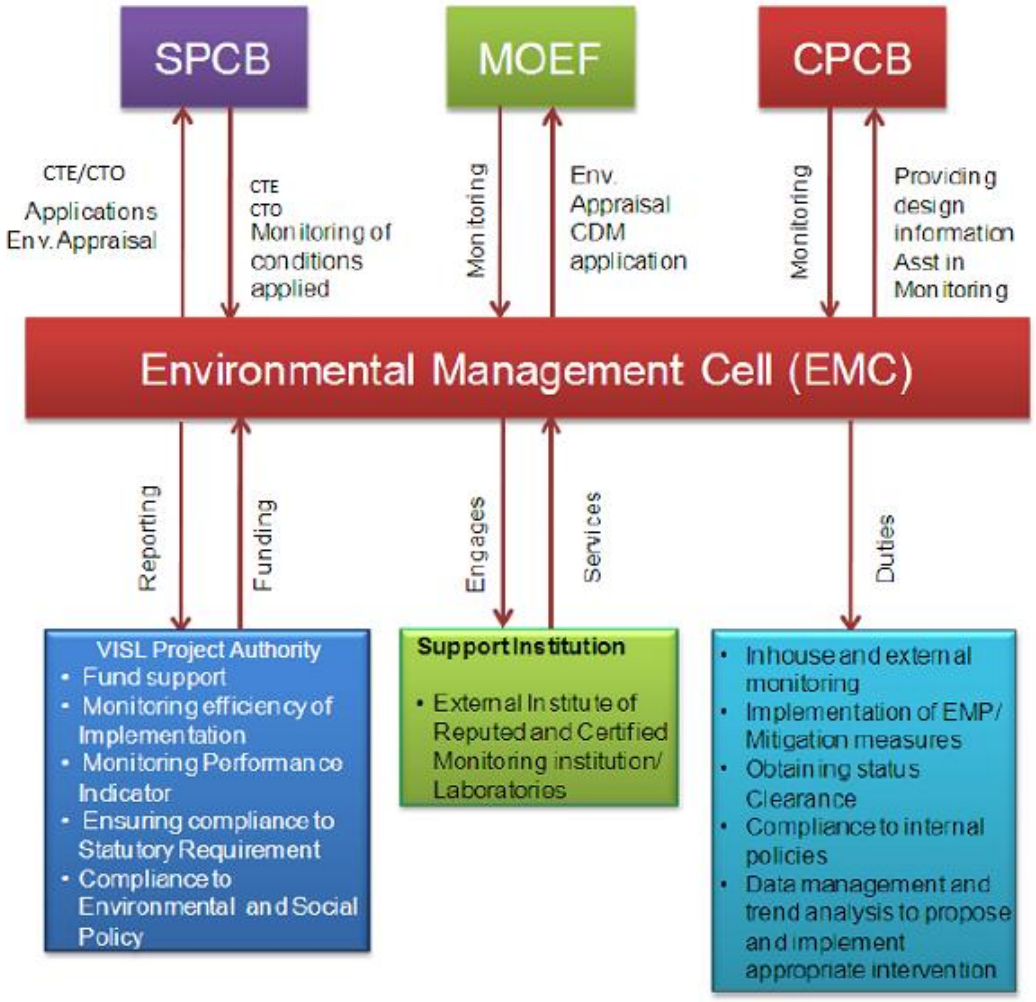


Figure 10-2: Institutional Mechanism for Implementing Mitigation Measures

10.2 Environmental Management Cell (EMC)

Apart from having an Environmental Management Plan, it is so also necessary to have a permanent organizational set up charged with the task of ensuring its effective implementation of mitigation measures and to conduct environmental monitoring. VISL shall have a well-structured Environmental Monitoring Cell (EMC), staffed with qualified manpower and a well-equipped laboratory. The EMC is responsible for overall environmental activities of the Port and implementation of the Environmental Management Plan (EMP). The EMC's responsibility for implementing the EMP also requires regular interaction with the environment regulatory authorities such as KSPCB, MoEF and the Indian Coast Guard. The major duties and responsibilities of Environment Management Cell are:

- To implement the environmental management plan
- Risk identification and control of environmental problems
- Evaluating the efficacy of the EIA, mitigation measures, as stipulated in the EMP.
- Coordination with MoEF and other central/state pollution control boards for prevention and control of pollution.
- To assure regulatory compliance with all relevant rules and regulations
- To ensure regular operation and maintenance of pollution control devices
- To minimize environmental impacts of operations by strict adherence to the EMP
- To initiate environmental monitoring as per approved schedule

- Review and interpretation of monitoring as per approved schedule
- Review and interpretation of monitoring results and corrective measures in case of monitored results are above the specified limit
- Maintain documentation of good environmental practices and applicable environmental laws as ready reference
- Maintain environmental related records
- Coordination with regulatory agencies, external consultant, monitoring laboratories
- Maintain log of public complaints regarding environmental issues and the action taken
- Plantation/green belt development and monitoring.

The environmental management cell shall have all basic record keeping facilities such as hard ware/software facilities, adequate space, vehicle (transport) and basic furniture and all simple instruments such as GPS, Digital camera, Hand held noise metre etc. The cell shall have all basic environmental management data of the project that includes but not limited to the following:

- Environmental Impact Assessment Reports (both well preserved soft and hard copy) the master copy with CEO seal and signature shall not be removed from the office (Not to lose)
- All valid and up to date environmental clearances papers (both soft and hard copy)
- All latest Environmental legislations, standards, policies, codes and manuals for ready references (both soft and hard copy)
- A list of consultants on environmental management need to be kept with yearly revision of the list. This will help to receive proper advice in case of an emergency or a requirement and also to implement day to day environmental management activities

Over a period of time a system to understand and absorb the new revisions and changes in the environmental requirements and practices are to be established. This can only be achieved by regular training and genuine capacity building initiatives. All this require a sound positive attitude of top level management towards environmental management.

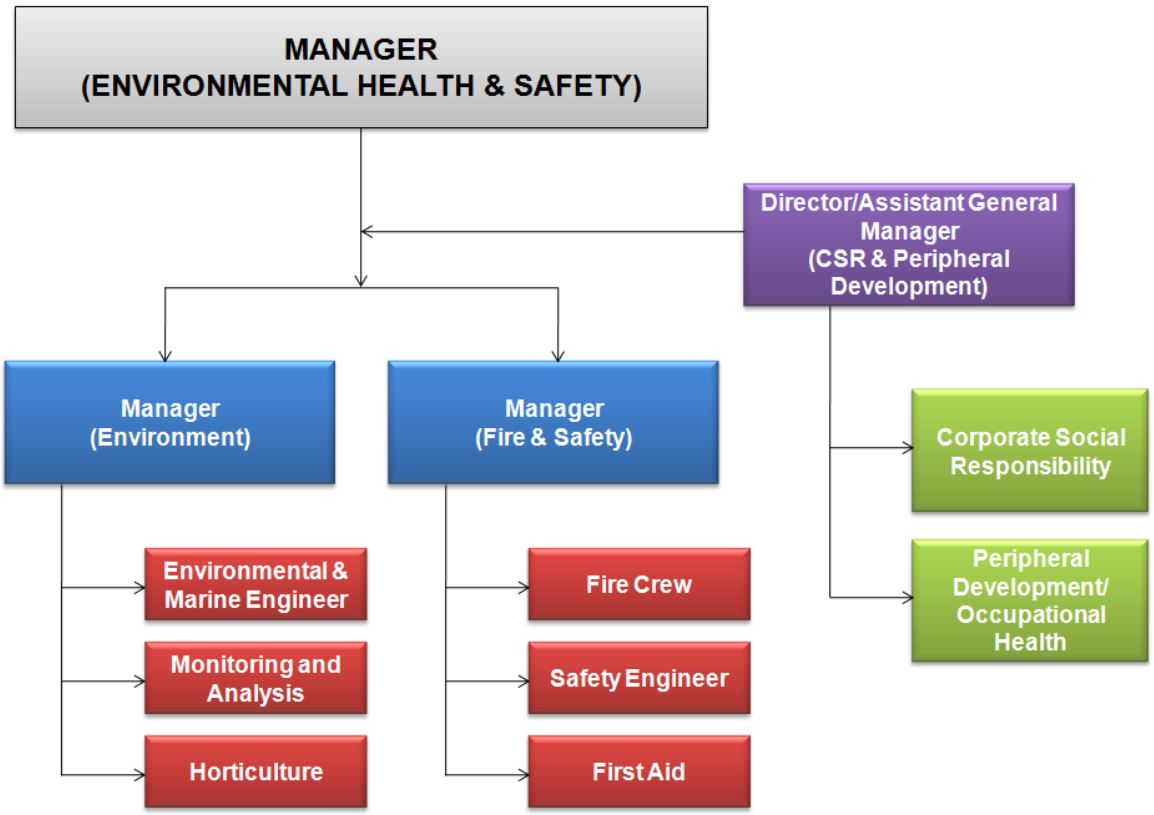


Figure 10-3: Organizational Setup for Environmental Management Cell

10.3 Audits and Inspections

In addition, the EHS Department shall be responsible for implementing Compliance Assurance activities, namely environmental audits. Internal audits and reviews of environmental procedures shall be conducted annually. The EHS Steering Committee, made up of Management Team members, shall conduct quarterly EHS performance reviews. Any change to the environment wholly or partial is identified, evaluated and equally corrective actions are taken to better the environmental performance.

A vital part of EHS practice is to learn from experience, using it as basis to improve the system. To this effect, periodic inspections and record keeping provides a measure of how effective programs are and facilitates identification of areas where improvement will be necessary. Environmental inspections consist of examining all activities and documenting those actions that are carried out in compliance with environmental permits, specifications relating to environmental protection, and mitigation plans approved for SPCB/ MoEF.

10.3.1 Environmental Supervising Engineer (ESE)

It is advised that during construction works the environmental supervision of the works will be contracted to a third party (environmental consultants), an Environmental Supervising Engineer (ESE), independent of the Contractor. The ESE would preferably be an accredited consultant, since the works are complex and will probably be carried out by different National and international Contractors. The quantity of works to be carried out calls for a team of supervisors (international and National), each dedicated to a specific region/project component and /or kind of work. It is recommended that an ESE is involved full time during the entire construction period. The ESE will assist the EMC in the environmental supervision of the works.

10.3.2 Decentralised EMP and CSR Approach

For the purpose of operational EMP and decentralised environmental management, the **Table 10-3** provides the delineated EMP zones for 10 sectors/zones identified. All operation environmental management aspects of these units will be treated separately.

Table 10-3: Areas/Zones Identified For Decentralised Environmental Management

Sector No	Identified Homogenous Zones /Sectors	Sector No	Identified Homogenous Zones/Sectors
1	Old/New Fish landing Centre	6	Rail Connectivity
2	Backup Areas (four sectors)	7	Port or Marine Side Activities
3	Entire Road Network of VISL	8	Port Operators Colony
4	Truck Terminal Area	9	Warehousing Area
5	Sub-station Area	10	Defence/Coast Guard/Cruise Berth

The idea is simple; for an area like the fishing harbour, 24 hours a day and seven days a week EMP measures are required. At the same time, substation area requires once in six months EMP measures (excluding gardening). In the case inside the port area, especially for defence, coast guard and cruise berth, security being a major concern, the EMP approach must be altogether different.

10.4 Components of EMP and CSR

The environmental impact mitigation and avoidance measures for each likely impact on the prevailing environment have been discussed in detail at the respective sections in **Chapter 5**. The Environmental Monitoring Programme has been discussed in **Chapter 6**. Various project activities, associated impacts and mitigation measures are summarised in **Table 10-4**. There are three important components with regards to EMP implementation during all phases of the project these are:

- **Construction Phase Contractor Selection:** Contractors will be selected with proven ability and experience in environmental management and compliances. Specific estimated budget will be included for labour colony and Personal Protective Equipment (PPE). This budget will be separately provided/accounted after acceptable compliances and standards.
- **Instrument/Equipment/Vehicle Procurement and Selection:** One of the main criteria for procurement of machineries equipment and vehicles will be Environmental criteria with regards to energy efficiency and pollution control including use of battery operated vehicles.
- **Institutional Framework, Capacity Building Training and Logistics:** There will be proper budgetary provision on these entire aspects. For example, an environmental manger that has to move around the port premises must have vehicles on demand from a pool of centralised vehicles. There must be sufficient trained staff with good experience and knowledge available to execute EMP with its entirety of spirit and scope.

The Management Action Plans (MAP) encompasses both EMP and CSR plans to address all issues comprehensively.

Table 10-4: Potential Impacts and Mitigation Measures of Various Project Activities

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
Construction Phase					
1.	Capital dredging	Marine water quality	– Increase in turbidity – Change in marine water quality due to aqueous discharges (oily waste, sanitary wastes) from dredgers, barges and workboats	– Check turbidity levels with baseline levels as reference during entire monitoring programme – Preparation of Dredge/reclamation Management plan – Discharge of waste into sea will be prohibited – Oil Spill control measures will be adopted – Ensure that slop tanks will be provided to barges/ workboats for collection of liquid/ solid waste – Marine environmental monitoring as per environmental monitoring programme	Construction Contractor/VISL/GoK
		Marine ecology	– Decrease in DO levels – Increase in noise levels – Removal of benthic communities – Increase in species diversity and density in areas adjoining dredging site – Smothering or blanketing of sub-tidal communities		
2	Material transport and construction activities	Air Quality	– Exhaust emissions from vehicles – Windblown dust during material movement – Fugitive dust during material unloading – Dust suspension during site preparation, construction	– Most of the Breakwater stones will be transported from the quarries to the nearest harbour. From there through Barges it will be transported through Project site. This is will avoid substantiate flow of Heavy Vehicles during construction Phase thereby minimising impact on Air Quality in the project region. – To reduce impacts from exhausts, emission control norms will be enforced / adhered. – All the vehicles and construction machinery will be periodically checked to ensure compliance to the emission standards – Construction equipment and transport vehicles will be periodically washed to remove accumulated dirt	Construction Contractor/ VISL/GoK

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				– Providing adequately sized construction yard for storage of construction materials, equipment tools, earthmoving equipment, etc – Provide enclosures on all sides of construction site – Movement of material will be mostly during non-peak hours. – On-site vehicle speeds will be controlled to reduce excessive dust suspension in air and dispersion by traffic – Water sprinkling will be carried out to suppress fugitive dust – Environmental awareness program will be provided to the personnel involved in developmental works – Use of tarpaulin covers and speed regulations for vehicles engaged in transportation	
		Noise	Noise from following activities – Vehicles transporting construction material – Diesel run engines of construction machinery and dredgers – Pile driving activities during construction of cargo berths	– Noise levels will be maintained below threshold levels stipulated by Central/Kerala State Pollution Control Board (CPCB)/KSPCB – Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A) – Well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used – Any equipment emitting high noise, wherever possible, will be oriented so that the noise is directed away from sensitive receptors – Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers – High noise generating activities such as piling and drilling will be scheduled at daytime (6.00 am to 10 pm) to minimise noise impacts – Personnel exposed to noise levels beyond threshold limits will be provided with protective gear like earplugs, muffs, etc. – Ambient noise levels will be monitored at regular intervals	-

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
		Disturbance to Natural Drainage pattern	– Impact to natural flow of runoff due to blockage and change of drainage course	– Port development is mostly on reclamation – Rain water/surface water harvesting pond included in design – Existing drainage near port boundary (backup area) will be integrated with port storm water drainage & management plan – Existing drains Streams that are passing in ware house area will not be closed/ diverted. And these streams will be desilted and enhanced to improve their carrying capacities	
		Vegetation and Strain on existing infrastructure	– Loss of vegetation and strain on existing infrastructure.	– Port development is planned mostly on reclaimed land; – Land use at backup area, PAF Zone and warehouse area will be mostly coconut plantation and low mixed plantation – Adequate green belt will be developed in port and its associated (backup area, PAF, warehouse and road & rail connectivity). – Temporary workers camp with self sufficient infrastructure facilities.	-
		Existing Traffic	– Traffic addition	– NH-47 bypass under construction around 2.0 km m from the proposed Port site and the Transportation of construction materials will be carried out during non- peak hours. Hence a dedicated road of 45 M RoW is proposed to connect site with NH Bypass – Regularization of truck movement – Majority of rock for breakwater construction will be transported through sea route via barges from nearby quarry sites – A dedicated rail network of approximately 15 km is proposed from port to Nemom railway station	–
3.	Land Reclamation	Existing Water Resources like Groundwater and surface water	– The area along the coast is partly intertidal land, rocky cliff	– Land to be reclaimed will be separated from adjoining land by creating containment bund. – Return sea water will be sent back to sea through appropriate channels.	VISL/Construction Contractor
4.	Solid Waste Management	Soil quality	– Impacts due to disposal of solid waste on	– Construction waste will be used within port site for filling of low lying areas.	VISL/Construction Contractor

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
			ground without treatment	– Composted bio-degradable waste will be used as manure in greenbelt. Other recyclable wastes will be sold. – Excavated soil at backup, PAF Zone and ware house area will be stockpiled in a corner of the site in bunded area to avoid run off with storm water. – General refuse generated on-site will be collected in waste skips and separated from construction waste. – Burning of refuse at construction sites will be prohibited. – All control measure will taken to avoid the contamination of ground water during construction phase	
5.	Handling of hazardous wastes	Human safety and property loss	– Fire accidents due to hazardous material handling	– Adequate safety measures as per OSHA standards will be adopted – Construction site will be secured by fencing with controlled/limited entry points. – Hazardous materials such as lubricants, paints, compressed gases, and varnishes etc., will be stored as per the prescribed/approved safety norms. – Construction site will be secured by fencing with controlled/ limited entry points – Medical facilities including first aid will be available for attending to injured workers. – Handling and storage as per statutory guidelines. – Positive isolation procedures will be adhered – Hazardous wastes will be disposed through approved KSPCB/CPCB vendors.	VISL/Contractor/GoK
6.	Water Resources	Water scarcity /Pollution	– Impacts to the surface water body	– Water requirement during the construction is expected to be around 0.10 MLD – Water will be sourced from Vellayani lake – Avoid/minimise the loss during conveyance – Optimized utilization of the water – Care will be taken to prevent the runoff from the construction site	VISL/GoK

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				to the nearby natural streams, if any	
7.	Fishing	Fishermen and fishing villages	– Impact on fishing due to Construction works	– Signboards will be placed at the construction activities in order to make fishermen aware of the ongoing construction activities – Necessary marker buoys will be installed – Interactions will be initiated with the fishing community before commencement of construction works	VISL/Contractor/GoK
8	Tourism	Affect on tourism	Loss of Pocket beach/access/expose to beach / loss of resorts and other tourist facilities in the acquired area	Tourism activity is observed at Kovalam located about 2.0 km towards the North of Proposed Port. Mathematical Modelling studies on shoreline changes show the insignificant impact due to the port development on the existing coastline. However, the Shoreline monitoring during construction as well as operation Phases were proposed. A cruise terminal and related facilities is part and parcel of the project. This is to largely compensate the losses made For all acquired properties and land adequate compensation will be provided based on legally valid documents	VISL/GoK
9	Breakwater	Change in shoreline	Erosion and accretion of along the coast	– Shoreline monitoring shall be carried – Suitable Shoreline protection measures will be implemented based on the observations	VISL/GoK
10	Effect on existing fishing harbour	Movement of fishing boats	Restriction on free movement of fishing boats to/ from fishing harbour Tranquillity in fishing harbour Loss of livelihood	– A detailed modelling study has been carried out tranquillity conditions in the fishing harbour with port development. The study reveals that the tranquillity conditions will be improved in fishing harbour with construction of the port minor accretion happening within the fishing harbour will be arrested – Traffic of Marine vessel/ fishing boats will be planned without affecting each other – Adoption of fishing harbour to manage it to perform as per International standard – A new fishing harbour provided under CSR initiatives – Loss of livelihood will be either take care of in the new port premises or adequately compensated mostly in the form of	VISL/GoK

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				employment	
Operation Phase					
1.	Cargo handling and Inland Cargo movement and storage areas	Air Quality	– Emissions from DG sets (during Power failure), RTGCs vehicular emissions	– Use of Multi Purpose Cranes such as RTGs with provision of electric RTGs in future. – Use of low sulphur diesel fuel is proposed – Regularization of truck movement – Periodic cleaning of cargo spills, – Use of tarpaulin covers and speed regulations for vehicles engaged in transportation – Greenbelt Development	VISL/Port operator to provide regulations to vessel operators/GoK
		Noise	– Due to equipment handling and vehicular movement	– Acoustic Barriers and Enclosures – Personal Protecting Equipment (PPE) – Greenbelt Development – Counselling and traffic regulation	
		Traffic Addition	– Cargo movement from/to port	– A dedicated road network of approximately 2.0 km is proposed from port to NH -47 bypass. – Regularization of truck movement – A dedicated rail network of approximately 15 km is proposed from port to Nemom railway station	
2.	Aqueous discharges in harbour basin	Marine water quality and ecology	– Change in marine water quality/ecology due to discharge ship wastes (spillage), sewage, bilge water, solid waste etc.	– Ships are prohibited from discharging wastewater, bilge, oil wastes, etc. into the near-shore as well as harbour waters. – Ships would also comply with the **MARPOL convention**. – As a mitigation measure for spillages an **Oil spill contingency plan** will be prepared and implemented. – Provision of waste reception facility	VISL/Port operator to provide regulations to vessel operators/GoK
3.	Cargo and Oil spills	Marine water quality and ecology	– Change in marine water quality	– In case of any cargo spillage during transfer from/to ships, it will be attempted to recover the spills. – Oil spill control equipment such as booms / barriers will be provided for containment and skimmers will be provided for recovery.	VISL/Port operator to provide regulations to vessel operators

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				– Response time for shutting down the fuelling, containment and recovery will be quicker.	
4.	Maintenance dredging	Marine water quality	– Increase in turbidity	– As per design, bathymetry, oceanographic conditions and modelling results quantity of dredge negligible. Maintenance dredged material will be dumped at the identified offshore disposal area for capital dredged material.. – Additional Environmental Monitoring Programme comprising of monitoring of marine water quality, marine sediment quality and marine ecology will be initiated one week prior to commencement of dredging and will be carried out during the dredging period.	Dredging Contractor/VISL/GoK
		Marine Ecology	– Due to decrease in DO levels which effect marine ecology and disturbance to benthic communities.		
5.	Water Supply	Water resources	– Impact on existing water resources	– Water requirement 0.5 MLD during Phase 1 and this water will be met from Vellayani lake – Water treatment plant, storage and distribution network developed.	VISL/Port operator
6.	Wastewater Discharge	Water Quality	– Impact due to discharge of runoff from container storage and sewage from port and port colony premises	– Separate Collection and treatment for oil and grease for runoff from workshop area, truck parking etc – **Sewage treatment plant** will be constructed within port area and port colony area – Treated wastewater from STP will be used for irrigating the greenbelt	VISL/Port operator /GoK
7.	Solid Waste Management	Groundwater and Soil quality	– Impact due to disposal of solid waste on ground without treatment	– An integrated **solid waste management plan** is proposed for port and associated facilities – Composted bio-degradable waste will be used as manure in greenbelt. – Other recyclable wastes will be sold.	VISL/Port operator /GoK
8.	Handling of hazardous wastes	Fire accidents due to products handling	– Human life and loss of property	– Hazardous materials like FRM will be stored as per the prescribed/approved safety norms. – Hazardous wastes (used oil & used battery) will be sent to KSPCB/CPCB approved recyclers. – Medical facilities including first aid will be available for attending to injured workers	VISL/Port operator/GoK

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				– Emergency alarms, provision of fire hydrant system and fire station. – Effective Disaster Management Plan (DMP) which covers onsite and offsite emergency plans. – Recovery of spills to the extent possible.	
9.	Fishing activity	Fishermen livelihood	– Impact on fishing due to vessel movement	– Educating the fishermen about the orientation of approach channel and movement of ships – Regular Interactions will be initiated with the fishing community – Conflicts if any with fishing community will be amicably resolved in all cases – A fishing harbour with all the required infrastructural facilities (i.e., landing terminals, road network, fish processing as well as auction area, ice plant, transportation facilities, drainage and solid waste management facilities) shall be constructed. – Fishermen using the beaches of Mulloor for mussel collection and nellikkunnu for shore seine in the project footprint area will be compensated with either alternate employment or to be suitably integrated to the new fishing harbour /port activities	VISL/GoK
10.	Tourism	Tourism	Effect on tourism	– Tourism activity is observed at Kovalam located about 2.0 km towards the North of Proposed Port. Mathematical Modelling studies on shoreline changes show the insignificant impact due to the port development on the existing coastline. However, the Shoreline monitoring during construction as well as operation Phases were proposed. – Since cruise terminal is planned at port, tourism sector in this regions will be enhanced – An appropriate tourism management plan will be prepared and implemented	VISL/GoK
11.	Breakwaters	Shoreline	– Shoreline adjacent to Port – Mathematical model	– Shoreline monitoring shall be carried – Suitable Shoreline protection measures will be implemented based on the observations	VISL/GoK

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
			study to predict the shoreline changes due to the presence of breakwaters is carried out		
12.	Operation of port	Socio-economic conditions of the region	During construction phase, the employment potential is estimated at about 2300 persons (including road/rail connectivity). During operational phase, the port is likely to generate direct employment **of 650 and nearly 200 indirect** employment opportunities. Local people will be given preference based on their qualification and skill set. Together with this employment potential, project will help to enhance the socio economic conditions of the area with better schooling, communication and transport facilities that will be developed/ triggered as a part of overall economic development of the region. Further a project of this size could trigger multitude of opportunities and such employment generations cannot be estimated at this juncture.		
		Natural Hazards	Disaster Management Plan (DMP) will be prepared; Manager (EHS) will act as the overall in-charge of the control of educative, protective and rehabilitation activities to ensure least damage to life and property.		
		Induced Development	Offers an efficient and cost effective supply chain/ value proposition to the local importers and exporters in states of Kerala, Tamil Nadu and Karnataka.		

Table 10-5-Environmental Management Plan Matrix (Road/Rail Corridors)

Environmental Impacts and Issues	Mitigation Measures	Time Frame	Implementing Organisation	Responsible Organisation	Contractual Clause
Construction Phase					
Environmental Management and Monitoring Facility Equipment for EMP (Meters, Vehicles and Buildings)	This will include institutional requirements, training, environmental management and monitoring. Provision for purchasing required equipment.	During and after construction (Five Years)	Government of Kerala (GoK)	VISL / Consultants	As a Project specific action this will have to be incorporated.
Altered Road embankments	Retaining walls and gabions should be provided	During construction	GoK	VISL / Consultants	Design standard requirement
Dust	• Water should be sprayed during the construction phase, at mixing sites, and temporary roads. • In laying sub-base, water spraying is needed to aid compaction of the material. After the compaction, water spraying should be	During the Construction phase	GoK	VISL / Consultants	Design standard requirement

Environmental Impacts and Issues	Mitigation Measures	Time Frame	Implementing Organisation	Responsible Organisation	Contractual Clause
	carried out at regular intervals to prevent dust. • Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.				
Air Pollution	• Vehicles and machinery are to be maintained so that emissions conform to National and State standards. • All vehicles and machineries should obtain Pollution Under Control Certificates (PUC).	Beginning with and continuing throughout construction phase	GoK	VISL / Consultants	MORTH's Specifications
Noise	• Machinery and vehicles will be maintained to keep their noise to a minimum. • Construction of noise barriers of an average length of 100m and eight feet height where ever necessary. • Proper maintenance of the rail track and rail wagon, by frequent lubrication to avoid frictional noise. • Regular monitoring shall be carried out as per the Environmental Monitoring Plan.	Beginning and throughout construction phase	GoK	VISL /Consultants	MORTH's Specifications
Loss of low lying land and ponds	• Impacted ponds can be enhanced by constructing bridged structures like Gabions to avoid plugging of springs. • Mitigation/Compensation shall be affected for the completely impacted ponds. • Filling of low lying areas like paddy fields shall be done • At Chainage km 6.500 the Railway alignment goes below the Existing NH and then at km 6.600 it will hit pond. The pond will be excavated partially and the soil material shall be used to fill in the western part and an equivalent area lost may be excavated to compensate the loss of effective pond area.	During Construction phase	GoK	VISL / Consultants	MORTH's Specifications
Flood Impacts and Cross Drainage Structures	Formation level should be raised according to the design and the cross drainage structures suitably planned for the flood events.	During construction phase	GoK	VISL / Consultants	MORTH's Specifications
Alteration of drainage	• In sections along watercourses, earth and stone will be properly disposed of so as not to block rivers and streams, thereby preventing any adverse impact on water quality. • All necessary measures shall be taken to prevent earthworks and stone works from impeding cross drainage at streams and canals or existing irrigation and drainage systems in conformity to the Contractors visual integration and management plan and EMP.	During construction phase	GoK	VISL / Consultants	MORTH's Specifications
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced during construction from entering directly into rivers and irrigation systems	Throughout construction phase	GoK	VISL / Consultants	MORTH's Specifications
Borrow pits	• Borrow pits are to be identified, opened and closed after	During construction	GoK	VISL	MORTH's

Environmental Impacts and Issues	Mitigation Measures	Time Frame	Implementing Organisation	Responsible Organisation	Contractual Clause
	consultations and proper documentation	phase		/Consultants	Specifications
Quarrying and Material sources	• Quarrying will be carried out at approved and licensed quarries only. • Details of Quarrying material sources are given in Chapter 4.	During construction phase	GoK	VISL / Consultants	MORTH's Specifications
Soil Erosion and Soil Conservation	• On slopes and other suitable places along the two proposed corridors, trees and grass should be planted. • On sections with filling and deep cutting their slopes should be covered by sod, or planted with grass, etc. • If existing irrigation and drainage system, ponds are damaged, they will be suitably repaired. • Retaining walls and gabions shall be suitably provided.	During construction and upon completion of construction activities at these sites.	GoK	VISL / Consultants	MORTH's Specifications
Loss of agricultural topsoil	• Arable land should not be used for topsoil borrowing. • Topsoil will be kept and reused after excavation is over. • Any surplus to be used on productive agricultural land.	During construction phase	GoK	VISL / Consultants	MORTH's Specifications
Compaction of Soil and Damage to Vegetation	Construction vehicles should operate within the Corridor of Impact avoiding damage to soil and vegetation.	During construction	GoK	VISL / Consultants	MORTH's Specifications
Loss of trees and Avenue Planting	• Areas of trees cleared will be replaced according to Compensatory Afforestation Policy under the Forest Conservation Act - 1980. • Two trees will be planted for each tree cut down. • Landscaping shall be done at major junctions.	After completion of construction activities	GoK/ Forest Department	VISL / Consultants	MORTH's Specifications
Vegetation clearance	Tree clearing within the ROW should be avoided beyond that which is directly required for construction activities and / or to reduce accidents. Especially in plantation and house garden areas both along road and rail alignment.	During cleaning operations	GoK	VISL / Consultants	MORTH's Specifications
Fauna	Construction workers should protect natural resources and animals. Hunting of birds and other local animals is prohibited.	During construction phase	GoK	VISL / Consultants	MORTH's Specifications
Traffic Jams and congestion	If there is traffic congestion during construction, measures should be taken to relieve it as far as possible with the co-operation of the traffic police.	During construction phase	GoK	VISL / Consultants	MORTH's Specifications
Health and Safety	All contractors' staff and workers must wear high visibility purpose made overalls or trousers/a waist coat at all times All operators working with any materials above head height (even in trenches) must wear hard hats all at times on the worksite.	Health and Safety	GoK	VISL / Consultants	MORTH's Specifications
Pollution of Streams	Construction material / waste should be disposed of properly so as	During construction	GoK	VISL /	MORTH's

Environmental Impacts and Issues	Mitigation Measures	Time Frame	Implementing Organisation	Responsible Organisation	Contractual Clause
parallel or along the alignments	not to block or pollute streams or ponds with special attention to confining concrete work.	phase		Consultants	Specifications
Cultural Remains	• Construction should be stopped until authorised department assess the remains to preserve Archaeological relics and cultural structures like Temples, mosques and churches. • Archaeologists will supervise the excavation to avoid any damage in the relics.	Throughout Construction phase	GoK	VISL / Consultants Archaeology department	ASI Acts
Operation Phase					
Dust Generation	• Dust generation during operation of road and rail is expected to be minimal as the proposed corridors are dedicated to Port traffic. However precautionary measure shall be taken care whenever dust is generated like control of emissions from vehicles. • Monitoring of air pollution at critical points as per Environmental Management Plan.	During Operation phase	GoK	VISL / Consultants	Environmental Management Plan (EMP)
Information boards to promote tourism	Information boards as required showing name of rivers, pilgrim sites tourist locations as per the environmental enhancements	After completion of construction	GoK	VISL / Consultants	EMP
Noise	• Use of sound barriers or other measures should be considered. • Public will be informed about the regulations on noise of vehicles.	After completion of construction	GoK	VISL / Consultants	EMP
Contamination from spills due to traffic movement.	Proposed road and rail corridors are dedicated to Port traffic. Moreover, the type of cargo is container cargo only along the alignments. So no contamination from spills is anticipated from proposed alignments. In case of any contamination then the RA and DMP measures described in the PORT EIA will be triggered.	After completion	GoK	VISL	EMP
Maintenance of Storm Water Drainage System	Drainage systems will be maintained to accommodate storm water flow.	Especially at the beginning and end of monsoon	GoK	VISL / Consultants	EMP
Erosion of Altered Road embankments	Stabilisation of raised Paddy field areas by rip rap, Gabions, retaining walls, etc.	Immediately after construction	GoK	VISL / Consultants	As per design standards
Solid waste disposal	• Solid waste disposal comes from the road users. Water bodies need to be covered by side walls or screens. This will also mitigate the privacy issue of women bathing at Ponds or canals • Signboards shall be installed propagating that not to pollute environment and to keep neat and clean.	During Operation phase	GoK	VISL / Consultants	EMP
Loss of drinking water source (open/Bore wells)	• Bore wells shall be suitably replaced. Compensation shall be paid for the impacted open/bore wells • If the water supply disrupted alternative arrangements shall be	During Construction and Operation phase	GoK	VISL / Consultants	EMP

Environmental Impacts and Issues	Mitigation Measures	Time Frame	Implementing Organisation	Responsible Organisation	Contractual Clause
	made until the supply reinstated.				

Table 10-6: Project Activities, Associated Impacts and Mitigation Measures

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
WAREHOUSE AREAS						
Construction Phase						
Material transport and construction activities	Air Quality/Dust	– Exhaust emissions from vehicles – Windblown dust during material movement – Fugitive dust during material unloading – Dust suspension during site preparation, construction and trenching	• To reduce impacts from exhausts, emission control norms will be enforced / adhered. • All the vehicles and construction machinery will be periodically checked to ensure compliance to the emission standards. • Construction equipment and transport vehicles will be periodically washed to remove accumulated dirt. • Providing adequately sized construction yard for storage of construction materials, equipment tools, earthmoving equipment, etc. • Provide enclosures on all sides of construction site • Movement of material will be mostly during non-peak hours. • On-site vehicle speeds will be controlled to reduce excessive dust suspension in air and dispersion by traffic • Water should be sprayed during the construction phase, at mixing sites, and temporary roads. • In laying sub-base, water spraying is needed to aid compaction of the material. After the compaction, water spraying should be carried out at regular intervals to prevent dust. • Vehicles delivering materials should be covered to reduce spills and dust blowing off the load. • Environmental awareness program will be provided to the personnel involved in developmental works. • Use of tarpaulin covers and speed regulations for vehicles engaged in transportation.	Contractor	VISL	Consultant
	Noise	Noise from following activities	• Noise levels will be maintained below threshold levels		VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
		– Vehicles transporting construction material – Diesel run engines of construction machinery	stipulated by Central/Kerala State Pollution Control Board (CPCB)/KSPCB. • Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A). • Well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used • Any equipment emitting high noise, wherever possible, will be oriented so that the noise is directed away from sensitive receptors. • Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers. • High noise generating activities such as piling and drilling will be scheduled at daytime (6.00 am to 10 pm) to minimise noise impacts. • Personnel exposed to noise levels beyond threshold limits will be provided with protective gear like earplugs, muffs, etc. • Ambient noise levels will be monitored at regular intervals			
Construction of Buildings, Roads, Sheds, etc.	Vegetation and Strain on existing infrastructure	– Loss of vegetation and strain on existing infrastructure.	Most of the land is covered with coconut trees and few other trees. Trees that are cut down will be accounted for and the same no. of trees of the same or some other species will be replanted at another location to compensate for the loss of greenery.	Contractor	VISL	Consultant
	Water Environment	– There are several streams that pass through the warehouse area and will be affected with the construction of new infrastructure on the land	• The streams 1 and 2 will be made to avoid entering the warehouse area by diverging them into the Karaichal River. • A tunnel like arrangement with RCC structures will be used so as to not affect the streams (3 and 4) that will go through the warehouse area. The streams will be made to go under the warehouse areas through the tunnel. Another option is to divert through the boundary wall- an application was filed with the irrigation dept. • Another option is to divert the stream through the boundary – An application has been filed with the irrigation department for permission.	Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
		– Loss of low lying area	• The low lying area in the areas is already made use by the local people, and has been degraded. There are no active ecological systems in the area. As far as possible, during operation phase the network of streams that add to the low lying area area of the region will be diverted or channelled under the constructed buildings to avoid impact to the low lying area. • Filling of low lying areas (if required) shall be done			
		– Impact to the downstream due to pollution of the streams	• Construction waste such as cement, paint, and other construction waste will flow into the downstream parts of the streams and Karichal River. Construction will be avoided during rainy season. Good housekeeping practices, such as cement being stored in dry areas will be taken care of. Labour camps will be provided with proper support services.	Contractor	VISL	Consultant
	Disturbance to Natural Drainage pattern	– Impact to natural flow of runoff due to blockage and change of drainage course	• As mentioned above, formidable measurements will be taken to avoid the disturbance to the natural flow of water. If some structure or building will come in the way of the existing flow of water, the flow will be redirected to the closest stream in the drainage pattern. • In sections along watercourses, earth and stone will be properly disposed of so as not to block rivers and streams, thereby preventing any adverse impact on water quality. • All necessary measures shall be taken to prevent earthworks and stone works from impeding cross drainage at streams and canals or existing irrigation and drainage systems in conformity to the Contractors visual integration and management plan and EMP.	Contractor	VISL	Consultant
	Existing Traffic	– Traffic addition	• Transportation of construction materials will be carried out during non- peak hours. • Regularization of truck movement. • The existing roads shall be strengthened and shall be used for the construction material transportation.		VISL	Consultant
Solid Waste Management	Soil quality	– Impacts due to disposal of solid waste on ground	• Construction waste will be used within warehouse site for filling of low lying areas. • Composted bio-degradable waste will be used as manure	VISL/ Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
		without treatment	in greenbelt. Other recyclable wastes will be sold. • Excavated soil will be stockpiled in a corner of the site in bunded area to avoid run off with storm water. • General refuse generated on-site will be collected in waste skips and separated from construction waste. • Burning of refuse at construction sites will be prohibited.			
Operation Phase						
Truck Movement	Traffic Management and road safety	– Traffic addition – Linings – Sign boards – Information boards and – Traffic police	• The consultants have envisaged a plan for the movement of trucks and other vehicular traffic related to the warehouse area so as not to avoid existing traffic in the road network and also proposed traffic that would be operation on the NH 47 bypass. • A flyover is proposed at the crossing of the internal roads for the warehouse area, the existing road network and the NH 47 bypass. Service roads will also be available for the easy movement of traffic around the congested area and to avoid disturbances to the free flow of traffic on the NH 47 bypass. Trucks going to the warehouse areas can get off the NH 47 bypass onto the service roads and under the flyover before turning left or right into the warehouse areas.	NHAI	VISL	Consultant
	Accidents Management	– Loss of life and Property and damage to Vehicles/Trucks	In case of accidents in the vicinity, list of ambulance services and the nearest clinic/hospitals will be notified for quick ambulance service and hospitalisation. Police will also be informed accordingly. There will be clinic and service doctor available in the truck terminal with round the clock availability on call either full time or part time.		VISL	Consultant
Operation of warehouse area	Solid Waste Management	– Impact to Groundwater and Soil quality due to disposal of solid waste on ground without treatment	• Some portions of the warehouse area can be utilised for greenbelt development. There will also be a residential block in the warehouse area. Solid waste emerging from the warehouse and residential areas will be composted and bio-degradable waste will be used as manure in greenbelt. • Other recyclable wastes will be sold to approved PCB vendors. • Solid waste will be managed as per PCB standards	Contractor	VISL	Consultant
	Handling of hazardous	– Fire accidents due to products	• Hazardous materials will be stored as per the prescribed/approved safety norms.	Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
	wastes	handling resulting in loss of Human life and loss of property	• Construction site will be secured by fencing with controlled/limited entry points. • Truck parking will also be located next to each warehouse as the truck will stand by while loading and unloading and hazardous wastes such as used oil & used battery will be sent to KSPCB/CPCB approved recyclers. • Medical facilities including first aid will be available for attending to injured workers • Emergency alarms, provision of fire hydrant system and fire station. • Effective Disaster Management Plan (DMP) which covers onsite and offsite emergency plans. • Recovery of spills to the extent possible.			
	Water Quality	– Impact to the downstream side due to pollution during construction phase	• During the operation stage, petroleum oil and lubricants (POL) from the workshop and all the vehicles coming and going out of the warehouse area will be reaching the Karichal River, especially during the rainy season. Further the effluents from the residential areas also will be drained. • The warehouse will be operated on a concrete base such that all liquids, oil and other lubricants will be collected in one area and sold to PCB approved vendors.	Contractor	VISL	Consultant
Operation of warehouse area	Socio-economic conditions of the region	Impact to the socio-economic conditions of the region The fishing village of Adamalathura which is downstream of the warehouse area will be affected in ways that the pollutants from the warehouse area might reach there and affect the fishing community.	During operational phase, the warehouse area for the Vizhinjam port is likely to employee a few people. Local people will be given preference based on their qualification and skill set. Together with this employment potential, project will help to enhance the socio economic conditions of the area with better schooling, communication and transport facilities that will be developed/ triggered as a part of overall economic development of the region. Careful measures will be taken to make sure that no effluents enter into the stream without treatment. The fishing activities in the village will not be affected in any way.	Contractor	VISL	Consultant
	Natural Hazards	Extensive loss of life and property	Disaster Management Plan (DMP) will be prepared; Manager (EHS) will act as the overall in-charge of the control of	Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
			educative, protective and rehabilitation activities to ensure least damage to life and property.			
	Induced Development	Absence of the warehouse area may add more strain on the whole port infrastructure and result in less productivity of the port operations.	The warehouse will be used as a part of the overall Vizhinjam port infrastructure and will accompany the port with serving the purpose of storage and warehousing which will benefit the port operations.	Contractor	VISL	Consultant
PAF Zone						
Construction Phase						
Material transport and construction activities	Air Quality/Dust	– Exhaust emissions from vehicles – Windblown dust during material movement – Fugitive dust during material unloading – Dust suspension during site preparation, construction and trenching	• To reduce impacts from exhausts, emission control norms will be enforced / adhered. • All the vehicles and construction machinery will be periodically checked to ensure compliance to the emission standards. • Construction equipment and transport vehicles will be periodically washed to remove accumulated dirt. • Providing adequately sized construction yard for storage of construction materials, equipment tools, earthmoving equipment, etc. • Provide enclosures on all sides of construction site • Movement of material will be mostly during non-peak hours. • On-site vehicle speeds will be controlled to reduce excessive dust suspension in air and dispersion by traffic • Water should be sprayed during the construction phase, at mixing sites, and temporary roads • In laying sub-base, water spraying is needed to aid compaction of the material. After the compaction, water spraying should be carried out at regular intervals to prevent dust. • Vehicles delivering materials should be covered to reduce spills and dust blowing off the load. • Environmental awareness program will be provided to the	Construction Contractor/ VISL	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
			personnel involved in developmental works. • Use of tarpaulin covers and speed regulations for vehicles engaged in transportation.			
	Noise	Noise from following activities – Vehicles transporting construction material – Diesel run engines of construction machinery	• Noise levels will be maintained below threshold levels stipulated by Central/Kerala State Pollution Control Board (CPCB)/KSPCB. • Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A). • Well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used • Any equipment emitting high noise, wherever possible, will be oriented so that the noise is directed away from sensitive receptors. • Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers. • High noise generating activities such as piling and drilling will be scheduled at daytime (6.00 am to 10 pm) to minimise noise impacts. • Personnel exposed to noise levels beyond threshold limits will be provided with protective gear like earplugs, muffs, etc. • Ambient noise levels will be monitored at regular intervals	Construction Contractor/ VISL	VISL	Consultant
Construction of Buildings, Roads, Parking features, etc.	Vegetation and Strain on existing infrastructure	– Loss of vegetation and strain on existing infrastructure.	• Most of the land is covered with coconut trees and few other trees. Trees that are cut down will be accounted for and the same no. of trees of the same or some other species will be replanted at another location to compensate for the loss of greenery. • There are very few existing buildings and infrastructure on the PAF zone area land which will be acquired and people in that area will be rehabilitated. As much as possible the major buildings are avoided and skirt around the boundary wall of the PAF zone.	VISL/ Contractor	VISL	Consultant
	Existing Traffic	– Traffic addition	• Transportation of construction materials will be carried out during non- peak hours.	VISL/ Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
			• Regularization of truck movement. • The existing roads shall be strengthened and shall be used for the construction material transportation.			
	Solid Waste Management	– Impacts to Soil quality due to disposal of solid waste on ground without treatment	• Construction waste will be used within port site for filling of low lying areas. • Composted bio-degradable waste will be used as manure in greenbelt. Other recyclable wastes will be sold. • Excavated soil will be stockpiled in a corner of the site in bunded area to avoid run off with storm water. • General refuse generated on-site will be collected in waste skips and separated from construction waste. • Burning of refuse at construction sites will be prohibited.	VISL/ Contractor	VISL	Consultant
Operation Phase						
Truck Movements	Traffic Management	– Traffic addition	• The consultants have envisaged a plan for the movement of trucks and other vehicular traffic related to the truck terminals area so as to not avoid existing traffic in the road network and also proposed traffic that would be operation on the NH 47 bypass • Use of NH bypass flyover to avoid the truck movement across the two warehouse areas.	Contractor in Association with NHAI	VISL	Consultant
	Accidents Management	– Loss of life and Property and damage to Vehicles/Trucks	In case of accidents in the vicinity, list of ambulance services and the nearest clinic/hospitals will be notified for quick ambulance service and hospitalisation. Police will also be informed accordingly. There will be clinic and service doctor available in the truck terminal with round the clock availability on call either full time or part time.		VISL	Consultant
	Road Safety	– Possibility of accidents along the roads	Lining, Signing, Information boards, Traffic Signals, Direction boards, etc. to ensure the road is safe for free movement of vehicles. Ensure comprehensive (third party) insurance package for all the port related trucks and other vehicles. These will be checked at all entry gates.		VISL	Consultant
Operation of warehouse area	Socio-economic conditions of the region	The local people may complain regarding the operation of the PAF zone without involving them and no benefits	During operational phase, the PAF zone for the Vizhinjam port is likely to employee a few people. Local people will be given preference based on their qualification and skill set. Together with this employment potential, project will help to enhance the socio economic conditions of the area with better schooling,	VISL/ Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
		coming out of the PAF zone. There may be the possibility of truck drivers staying in the truck terminal areas to look out of the area and glare into the nearby buildings.	communication and transport facilities that will be developed/ triggered as a part of overall economic development of the region. There will be a 2 m wall constructed all around the PAF zone to safeguard the neighbouring buildings which happens to be schools and hostels, etc.			
	Natural Hazards	In case of any natural hazard, the general people may not know what to do and what order to do them which may add more problems to the situation.	Disaster Management Plan (DMP) will be prepared; Manager (EHS) will act as the overall in-charge of the control of educative, protective and rehabilitation activities to ensure least damage to life and property.	VISL/ Contractor	VISL	Consultant
	Induced Development	Absence of the PAF zone may add more strain on the whole port infrastructure and result in less productivity of the port operations.	The PAF zone will be used as a part of the overall Vizhinjam port infrastructure and will accompany the port with serving the purpose of storage and warehousing which will benefit the port operations.			
Backup Areas						
Construction Phase						
Material transport and construction activities	Air Quality	– Exhaust emissions from vehicles – Windblown dust during material movement – Fugitive dust during material unloading – Dust suspension during site	• To reduce impacts from exhausts, emission control norms will be enforced / adhered. • All the vehicles and construction machinery will be periodically checked to ensure compliance to the emission standards • Construction equipment and transport vehicles will be periodically washed to remove accumulated dirt • Providing adequately sized construction yard for storage of construction materials, equipment tools, earthmoving equipment, etc.	Construction Contractor/ VISL	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
		preparation, construction and trenching	• Provide enclosures on all sides of construction site • Movement of material will be mostly during non-peak hours. • On-site vehicle speeds will be controlled to reduce excessive dust suspension in air and dispersion by traffic • Water sprinkling will be carried out to suppress fugitive dust • Environmental awareness program will be provided to the personnel involved in developmental works • Use of tarpaulin covers and speed regulations for vehicles engaged in transportation			
	Noise	Noise from following activities – Vehicles transporting construction material – Diesel run engines of construction machinery	• Noise levels will be maintained below threshold levels stipulated by Central/Kerala State Pollution Control Board (CPCB)/KSPCB • Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A) • Well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used • Any equipment emitting high noise, wherever possible, will be oriented so that the noise is directed away from sensitive receptors • Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers • High noise generating activities such as piling and drilling will be scheduled at daytime (6.00 am to 10 pm) to minimise noise impacts • Personnel exposed to noise levels beyond threshold limits will be provided with protective gear like earplugs, muffs, etc. • Ambient noise levels will be monitored at regular intervals	VISL/ Contractor	VISL	Consultant
Construction Activities	Water Environment	Flood Impacts and Cross Drainage Structures	Formation level should be raised according to the design and the cross drainage structures suitably planned for the flood events.	VISL/ Consultants	VISL	Consultant
		Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced during construction from entering directly into the	VISL/ Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
			water bodies.			
	Land Environment	Soil Erosion and Soil Conservation	• On slopes and other suitable places along the two proposed corridors, trees and grass should be planted. • On sections with filling and deep cutting their slopes should be covered by sod, or planted with grass, etc. • If existing irrigation and drainage system, ponds are damaged, they will be suitably repaired. • Retaining walls and gabions shall be suitably provided.	VISL/ Contractor	VISL	Consultant
		Loss of agricultural topsoil	• Arable land should not be used for topsoil borrowing. • Topsoil will be kept and reused after excavation is over. • Any surplus to be used on productive agricultural land.	VISL/ Contractor	VISL	Consultant
		Compaction of Soil and Damage to Vegetation	Construction vehicles should operate within the Backup Areas avoiding damage to soil and vegetation.	VISL/ Contractor	VISL	Consultant
		Loss of trees and Avenue Planting	• Areas of trees cleared will be replaced according to Compensatory Afforestation Policy under the Forest Conservation Act - 1980. • Two trees will be planted for each tree cut down. • Landscaping shall be done at major junctions.	VISL/ Contractor	VISL	Consultant
		Vegetation clearance	Tree clearing within the backup areas should be avoided beyond that which is directly required for construction activities and / or to reduce accidents.	VISL/ Contractor	VISL	Consultant
Operation Phase						
Operation of Backup Areas	Air Environment	Dust Generation	• Dust generation during operation of backup areas is expected to be minimal as the proposed corridors are dedicated to Port traffic. However precautionary measure shall be taken care whenever dust is generated like control of emissions from vehicles. • Monitoring of air pollution at critical points as per Environmental Management Plan.	VISL/ Contractor	VISL	Consultant
	Tourism	Loss of resorts and access to beaches	Appropriate compensation to the affected resorts and introduction of a cruise terminal in phase I. Since the backup areas are close to the coast and are close to the beach sites, tourists might come around looking for places to visit. Good information must be provided to the people so	Contractor	VISL	Consultant

Activity	Relevant Environmental & Social components likely to be impacted	Likely Impacts and their Significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Implementing Agency	Responsible Agency	Supervising Agency
			that they can catch the places of interest they wish to visit.			
	Noise Environment	Noise	• Use of sound barriers or other measures should be considered. • Public will be informed about the regulations on noise of vehicles.	VISL/ Contractor	VISL	Consultant
	Water Environment	Maintenance of Storm Water Drainage System	Drainage systems will be maintained to accommodate storm water flow.	VISL/ Contractor	VISL	Consultant
	Solid waste	Solid waste disposal	Signboards shall be installed propagating that not to pollute environment and to keep neat and clean.	VISL/ Contractor	VISL	Consultant
	Natural Hazards	In case of any natural hazard, the general people may not know what to do and what order to do them which may add more problems to the situation.	Disaster Management Plan (DMP) will be prepared; Manager (EHS) will act as the overall in-charge of the control of educative, protective and rehabilitation activities to ensure least damage to life and property.	VISL/ Contractor	VISL	Consultant
	Induced Development	Absence of the backup areas may add more strain on the whole port infrastructure and result in less productivity of the port operations.	The backup areas will be used as a part of the overall Vizhinjam port infrastructure and will accompany the port with serving the purpose of temporary storage and any other additional building and infrastructure, which will benefit the port operations.	VISL	VISL	Consultant
Fishing	Loss of fishing areas and livelihood	The mussel and lobster collection in the footprint of the port and impact to the existing fishing harbour.	Mussel and lobster related fishermen will be properly rehabilitated with alternative employment or will be relocated in the new fishing harbour. New fishing harbour doubling the capacity is part of new phase I layout. The adoption of the existing fishing harbour to improve the existing fishing harbour and livelihood of the villages Sea food/agro park will be developed.	VISL	VISL/GoK	GoK

10.5 Dredging and Dredge Disposal Management Plan

The proposed construction of the Vizhinjam port envisages capital dredging in its construction and maintenance dredging later during operation phases. The project components of the port, which require dredging, are the berthing area, turning circle and approach channel. **The capital dredging in phase-I of the proposed project will be 7.6 MCM**.

This outline of a Dredge Management Plan is based on the Revised OSPAR Guidelines for the Management of Dredged Material (Reference number: 2004-08). As the dredged material will be mainly used for the reclamation purpose in berthing area, the adverse impact on the disposal of dredged material elsewhere is reduced. The material suitability, the potential impacts and mitigation measures related to reclamation and disposal are discussed in **Chapter 5**.

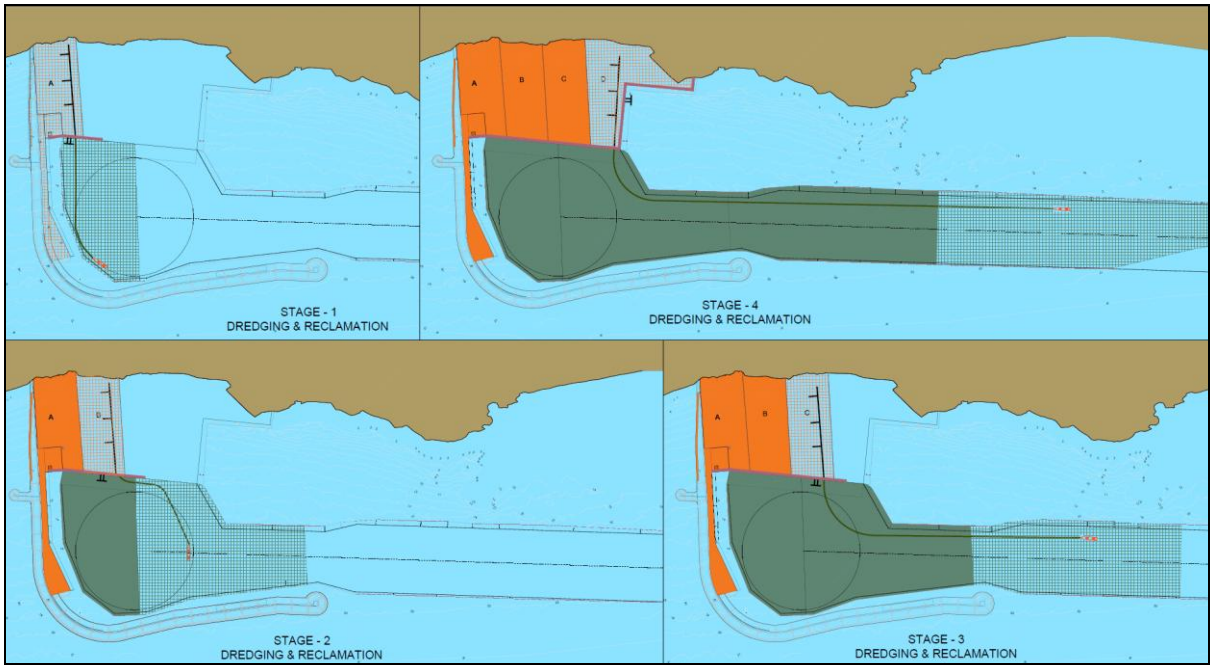


Figure 10-4: Stagewise Dredging and Reclamation

10.5.1 Dredging Methodology

10.5.1.1 General

This method statement is prepared based on the information available at this stage the aim of not to freeze the methodology but to consider possible alternatives and feasibility of the dredging and shall be modified /revised by the specialised dredging contractor to be appointed through EPC tendering process. The final approach has to be developed by the contractors who are experienced and innovative in the field of marine dredging operations.

10.5.1.2 Work Method

The prevailing site conditions and equipment properties dominate the selection of the equipment and work method and this largely EPC contractors choice with the approval of VISL. The materials to be dredged consist of layers varying from coarse sand to silty clay at the top. Separate dredging of

suitable and unsuitable materials will be carried out. The suitable sandy and gravel material will be placed in the reclamation area for container yard construction. The unsuitable material, such as slity clay, will be dredged and discharged to the designated offshore disposal area. Considering the variety of soils (soft and hard) in combination with a limited pumping distance between the dredging- and reclamation areas, the work method utilizes a **large Cutter Suction Dredger (CSD)**.

A **large Cutter Suction Dredger** will be deployed to dredge the materials and hydraulically transport these to the required reclamation areas. The dredged suitable materials will be pumped ashore by means of a system of onboard dredging pumps in combination with floating, submerged and land lines. The suitable materials will be pumped ashore into the reclamation areas A, B, C & D. All the dredged unsuitable materials will be discharged into a split bottom barge and transported and dumped to the designated offshore disposal area. The suitable and unsuitable soil layers will be placed in a soil model which will be loaded into the onboard dredge computer. The dredging will take place in several cuts. Based on this plan the dredge master can determine his dredging strategy and synchronize this with the reclamation crew.

Dredging by Cutter Suction Dredger (CSD): The CSD is deployed for dredging and pumping materials directly into the reclamation area. The pipeline may consist of a combination of floating, submerged and shore lines. In this particular situation, the CSD is connected directly to a shore connection point by means of a floating pipelines where required in combination with a submerged line and there off to the reclamation area, by means of a shore pipeline. As the reclamation progresses, the shoreline will be extended. Two different pipeline configurations are schematized in the **Figures 2-2** and **Figure 2-3** in **Chapter 2**.

Depending on the layer thickness to be dredged and the characteristic of the materials, the CSD will cut and dredge the material in one and more layers. On an average 0.5 m vertical over depth will be dredged by the CSD. The dredging will be carried out by using the box-cut method and slopes will be allowed to fall to natural angle of repose. The example of box-cut cross section is as shown in **Figure 10-5**.

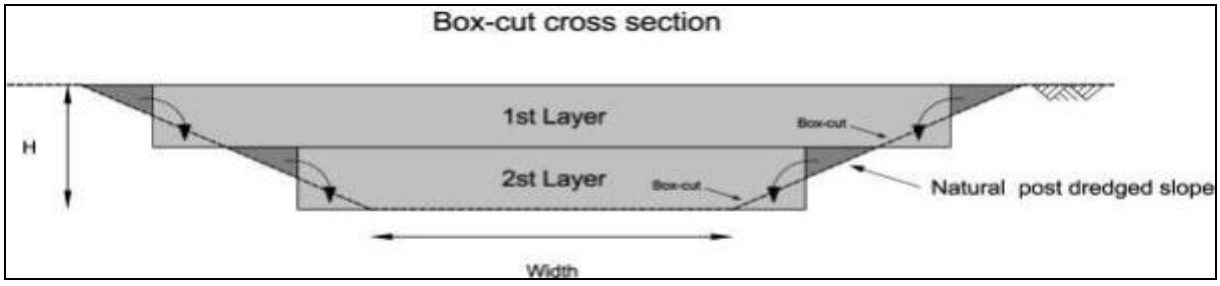


Figure 10-5: Principal of Box Cut Method

10.5.2 Reclamation Works

It is estimated that around **6.9 MCM** of material will be required for reclamation. This would require total dredging to be of the order of around **7.6 MCM**. This additional dredging of around 2.56 MCM may be obtained by over-dredging the navigational channel. The suitable dredged materials will be discharged by the CSD into one of the reclamation areas.

Prior to commencement of the dredging and reclamation works, land based equipment will be used to install water boxes in between the sea and reclamation bunds (where deemed necessary). Bunds will be constructed around each of the reclamation areas prior to start filling.

Permanent bund will be constructed partly by dredged materials and armour stones. The borders/edges (temporary bunds) of the various reclamation areas between A to D are pumped in by using hydraulic filling methods. As a result the reclamation slopes will become natural angle of repose and will be in the order of approximately 1:7 in steepness.

After preparation of the reclamation area, the CSD will be connected to the shore connection point by means of a floating pipeline where required in combination with a submerged line. The shore connection point is installed as close as possible to the reclamation area. From this point, shore pipelines will transport the soil/water mixture to the reclamation area. The layout of the total pipeline trajectory will depend on the location of the shore connection, the local circumstances, the number of earth moving equipment available.

The reclamation areas to be filled in maximum two layers to final fill level (+3.50 m CD near the berth increasing to +5.3 m CD to the shore). Land-based equipment will be used to spread and level the delivered materials. During the progress of the reclamation works the shore pipeline will be extended as the reclamation area is being filled with material and bunds will be raised. A cross-section for the raising of bunds is given in **Figure 10-6**.



Figure 10-6: Typical Cross section of Raising of the Bunds by using Bulldozers/ Excavator

On reaching the design fill level of +3.50 m CD, vibrating roller compaction is applied before placing of the surcharge loads (if requires). This is in order to reach the required **95% MDD (Maximum Dry Density)** for the top 1.5 m of the fill. After a fill area is completed, parts of the shore pipeline can be disconnected and used at the next fill area.

In order to ensure continuity of dredging and reclamation process, the reclamation area is generally laid out in such a way that there are always different discharge points available. The pipeline trajectory is arranged in such a way that switching from the suitable to unsuitable reclamation area can be made quickly by the use of valves system. This will create certain flexibility and provide the ability to respond to external factors.



Exhibit 10-1: Splitting of Shore Pipeline to Different Areas



Exhibit 10-2: Extension of pipeline at Reclamation Area

The transport water will be guided through the reclamation area and in order to control the outflow of transport water from the reclamation area, Weir Box (or water boxes) is installed. With Weir boxes, the water level inside the reclamation areas can be controlled by means of changing the elevation of the weir box boards **Figure 10-7**. By adjusting the weir level, the outflow of fines into the sea can be controlled. As a result, significantly more fines can be retained. A cross section of a weir box is shown below. This will also control the turbidity level of the sea water.

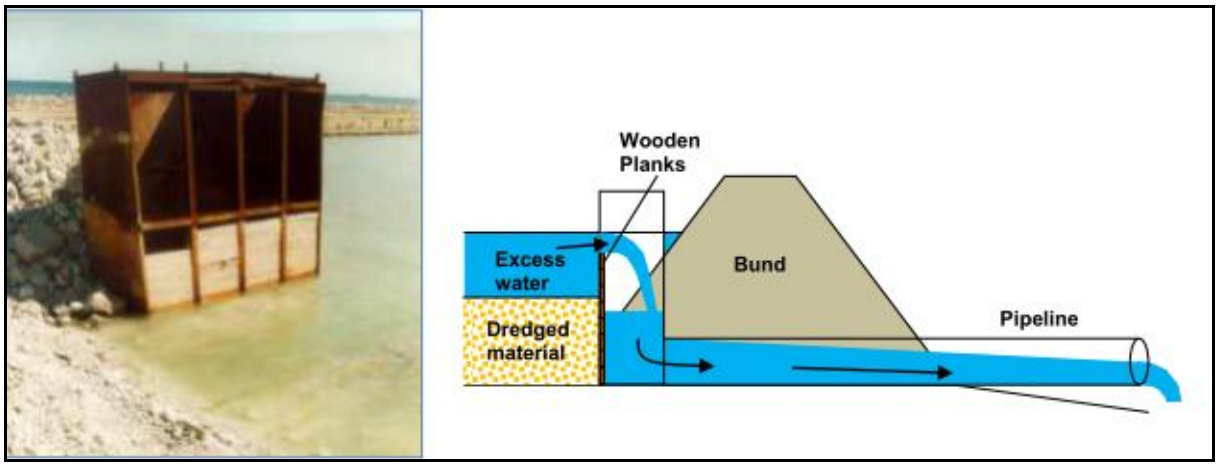


Figure 10-7: Weir Box and Cross Section of Weir Box

The selection of the disposal site in sea depends on several factors, which can be broadly classified into environmental and economical considerations. The major economic factors are volume of dredged material and distance of the disposal site. The environmental considerations are the characteristics of the material, short-term fate of the dredged material and the initial deposition pattern of the material in the bottom. These factors in turn determine the long-term movement of the disposed material from the disposal site. Generally, coarse material quickly settles to the bottom, while fine material is removed during its descendent to the bottom and transported by currents to adjoining areas. The disposed material will settle down depending on its own bulk size and grain size with different settling velocity. Hence, the environmental conditions at the location of the disposal site should be such that it is not subjected to high near-bottom current velocities which would cause the disposed material to return to areas of interest like the approach channel. Moreover, the shuttle distance between the disposal site and the areas of dredging should not be too large, as this would increase cost of disposal and consequently the dredging cost. Hence, the selection of the disposal site has to be the result of a balance between the environmental factors and economy of cost. The dredge spoils will be disposed through a hopper or suitable dredger at the disposal site. The impacts due to disposal of dredged material such as the spreading of turbidity at disposal location, suspension and re-suspension of sediment in the bulk of water column, settlement on the bed after a certain residence time have been assessed by conducting detailed mathematical modelling studies.

Dredge Material Quality: Marine soil quality analysis of the material to be dredged has been carried out. Analysis was done to study the quality of the dredged material in terms of its toxic metals. Results of the analysis show that the concentration of the toxic metals in the material to be dredged is within the acceptable concentration limits. Hence, based on this analysis, the dredged material can be suitably used for reclamation and any excess material can be disposed in selected offshore location.

Mathematical Model Study for Identification of Suitable Disposal Location: The fate of dredge spoil dumped offshore depends on a number of parameters like prevailing ocean currents, wind, characteristics of dumped materials, dumping method and location, seasonal variations, frequency of

dumping, environmental conditions at the time of individual dumping, total dumped quantity, etc. The dredge disposal modelling has been carried out for selecting suitable disposal sites and it is discussed in Chapter 5.

Sediment Characteristics: The grain size distribution of sediment and its settling velocity influence the plume dispersion. A part of the dredged material from the capital dredging will be used for reclamation purpose and the remaining will be disposed off at the suitable dumping location. Impacts are also discussed in Chapter 5.

The following measures are to be adopted to mitigate the potential impacts from dredging and when reusing the dredge material:

- Dredging to be carried out using suitable dredgers only, depending upon the terrain of the area to be dredged.
- Use techniques (e.g. silt curtains), to minimise adverse impacts on aquatic life from the re-suspension of sediments.
- Potential pollutants in the dredged material should be analysed for their physical, chemical, biological, and engineering properties prior to material dredging and reuse. (as per Technical Annex II of the Revised OSPAR Guidelines for Management of Dredged Material) shall be applied before using that material for reclamation.
- Reclamation with the dredged material should be conducted in a way that no negative impacts may occur, meaning not discharge of polluted excess water, no discharge of fines, etc.
- As the dredging techniques and reclamation activities are not yet defined it is advised to require the dredging contractor to develop a proper Dredging and Dredge Disposal EHS Management Plan following the appropriate standards (IFC, OSPAR and Indian) and PS 2, 3 and 4.

This **Dredging and Dredge Disposal Plan** should be developed by the Contractor and approved by the Developer prior to commencement of dredging works.

10.6 Water Management Plan

The water resource at Vellayani Lake is the source of water to meet the demand during construction and operation phases. A **Water Management Plan** will be developed taking into account the future needs of the region and the available resources and distribution potential. The water demand for Vizhinjam Port for phase 1 has been provided in the **Table 10-7**.

Table 10-7: Water Requirements

A.		B.	
Raw Water	KLD	Potable Water	KLD
Greenery and Landscape	120	Port Personnel, Users & Misc.	64
Reefer Wash and Misc	24	Township	250
Total Raw Water (A)	**144**	Cruise Terminal	40
		Ship Supply	-
		Total Potable Water (B)	**354**
Total (A + B) = 498			

The Water Management Plan has the following objectives:

- Monitor water use: the Plan will set procedures for estimating water used by the Project, identifying activities that use this resource and following a reporting procedure for registering used volumes of water.
- Minimise water use: the Plan will provide a series of measures to be considered for minimising the use of water.

- Document water sources and extraction locations: water sources to be used will be agreed with the relevant local authorities. Sources of water will be identified and registered in the Plan, together with the GPS coordinates and the maximum water volumes allowed from the source.

The **Water Management Plan** will be developed following Indian policies. The plan will include provisions for the training of all workers on how to minimise the use of water and how to respond in the case of spills, and will include procedures providing information regarding internal and external communications during an Emergency Response. The proposed port is planned to have its own storm water runoff collection system by providing renewable system to collect and treat the storm water. It will treat oil contaminated rainwater (run-off) from impervious areas, e.g. Roads, yard areas and will be spread throughout the port area. Most powered vehicles will be fuelled at the Fuel Station in the parking area and the water from this area will be treated separately. Therefore, the pavement in these areas shall be graded so that spills are contained and flow to special drains and/or sumps provided with oil-water separators and drain shut-off valves.

10.6.1 Rainwater Harvesting System

Kerala is known for its torrential rains during SW monsoon and also has the bequest of NE monsoon. The water scarcity scenario in and around the project site can be solved by rainwater harvesting (RWH). Therefore, rainwater harvesting units are suggested to construct at strategic locations along with storm water drainage system. Rainwater harvesting has been planned in all EMP units (landward side)

A typical RWH unit (injection type) consists of pipes, filtration system and injection well. In this method rainwater is allowed to percolate through a percolation pit or filter bed, which comprises of sand and gravel. Rain water drained from roads and car parking/ servicing area/ area near fuel and lubricant storage need to have oil and grease separator before leading to a RWH unit. A typical RWH system is given in **Figure 10-8**. The dimension and location of the rainwater harvesting system will be finalised during engineering phase. This Water Management Plan should be approved by the Developer prior to construction.

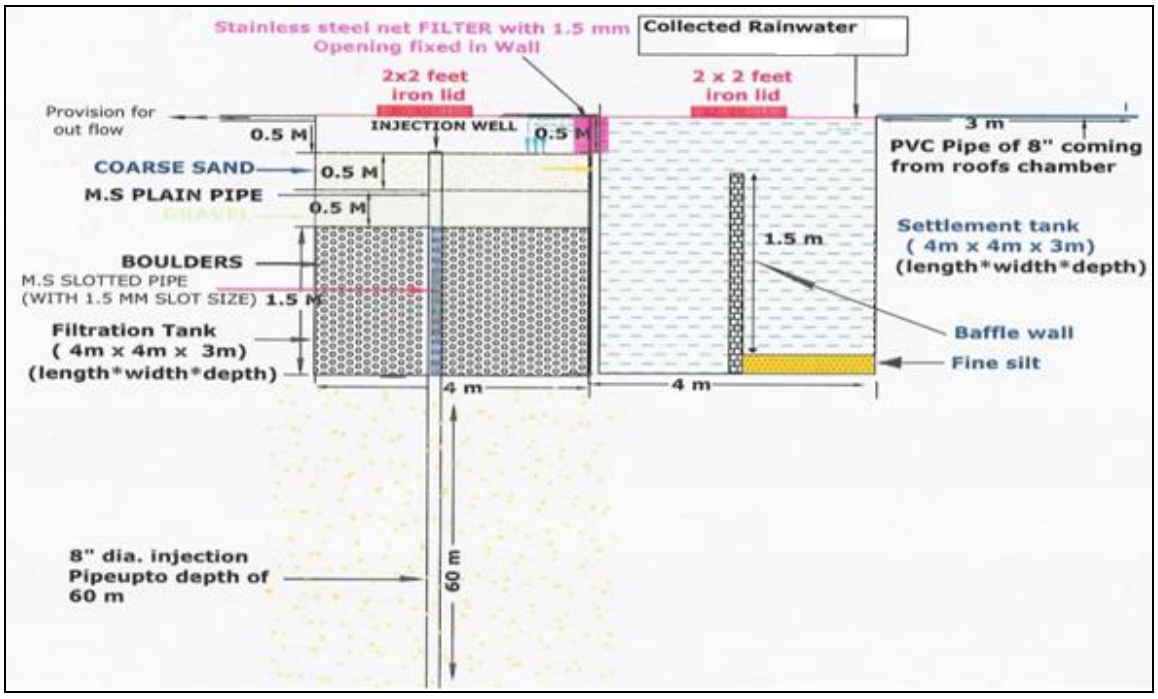


Figure 10-8: Typical Rainwater Harvesting System

10.6.2 Drainage System

For phase-I, the port land is about 500 m wide and about 800 m in length along the coastline and a hilly area in the rear of the proposed port. The drainage system needs to be designed to minimize the potential pollution in the port basin. The rainy season persists during the Southwest and the northeast monsoon. May to November is the wettest months of the year with an average rainfall in excess of 220 mm per month, with a maximum of 356 mm in June. The average annual rainfall is around 3000 mm. The average number of rainy days per year is 132 days. The maximum rainfall intensity has been taken as 30 mm/hr.

It is proposed to lay the trench drain parallel to the proposed internal road. These drains are connected through various cross drains bringing the water from the different areas of the terminals covering the port operational buildings. All the drains will be of Random Rubble (RR) stone pitched and grouted with cement mortar of 1:4.

A drainage system will be provided below the stacking area, with buried perforated drain lines. An impervious layer will be placed in the ground below these transverse drain lines. The storm water runoff from the yard area and adjacent roads will be collected, via trenches and buried pipelines. **Figure 10-9** shows a typical arrangement for drainage system over gravel bed container pavement.

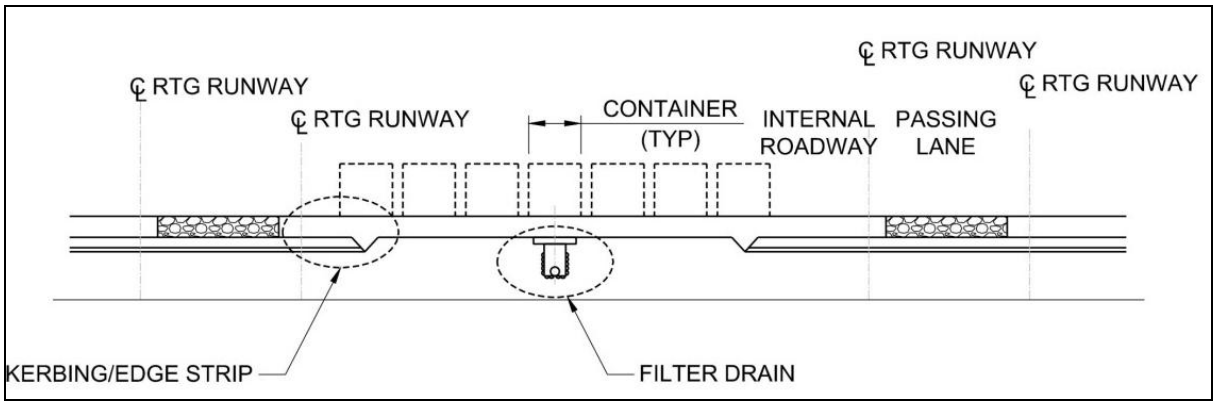


Figure 10-9: Typical Representation of Drainage for Gravel Bed Pavement in Container Yard

The storm water from the administrative offices, transit sheds and all other buildings will also be connected to the storm water drain. The storm water collected from the workshop will be treated in an oil skimmer before disposing off to the storm water drain.

A **storm water drainage system** has been proposed by VISL and will be through a system of underground covered drains provided to discharge the collected runoff from port surfaces. An oil /sediment in-line unit is recommended to provide basic treatment to the storm water before discharging through outfalls. A gravity drainage system with outfalls would be required for the proposed port.

10.7 Solid Waste Management Plan

The solid waste generated by humans during the initial phase is expected to be of the order of **1000 kg/day**. During the construction phase the EPC contractor will be responsible for collection, transport and disposal and during operation phase, VISL can prepare an Integrated Solid Waste Management Plan (IWMP) shall:

- Be compliant with Indian Regulations,
- Outline waste characteristics and sufficient capacity for managing waste: environmental/ ecological sustainable management options

This plan shall be developed to manage solid and liquid wastes and to avoid any discharges into the soil or water. It establishes procedures for the storage, collection and disposal of waste, including liquid and solid waste and hazardous and non-hazardous waste. The overall objective is to minimise impact of waste generated during the construction phase through the following:

- Minimise the amount of waste that is generated;
- Maximise the amount of waste that is recovered for recycling – including segregation of recyclable wastes at source;
- Minimise the amount of waste that is deposited at landfill;
- Ensure any hazardous wastes (e.g. used oils, lead-acid batteries) are securely stored and transferred to appropriate facilities;
- Ensure all wastes are properly contained, labelled and disposed of in accordance with National/local regulations; and
- Ensure waste is disposed of in accordance with the waste management hierarchy.
- The following items constitute the IWMP, based on international best practices in waste management, and in compliance with IFC guidelines and the Indian legislation.

10.7.1 Waste Minimisation Principles

An inventory will identify the consumption of products, ensuring waste's traceability, and identifying potential wastage and overconsumption. An inventory of all waste generated and disposed of will be retained (type and volume) and VISL will develop goals for reducing the quantities of waste generated, based on periodic review inventory. The list of identified homogeneous zones/sectors is given in **Table 10-3**. These zones acts individually and hence the waste should be collected to a common collection area and then it should be segregated as mentioned.

10.7.2 Separation of Solid Waste According to Established Classification

Waste generated during construction is likely to be classified into four categories for disposal: inert (earth, building rubble, unused construction material, etc.), domestic, oily & hazardous and liquid. Container/skips will be associated to waste types (cardboard, plastic, metal scrap, oily waste, hazardous if any, etc.), in order to permit the separation/segregation. This segregation will take place from the initial point of waste generation. Waste generated in each identified zones are segregated as Biodegradable and Non-biodegradable. Non-biodegradable waste will be further segregated into hazardous, non hazardous/recyclable. The Flow Diagram showing the general segregation classification is given in **Figure 10-10**. **Table 10-8** explains about various types of wastes that are possibly generated in the port site and their treatment methods.

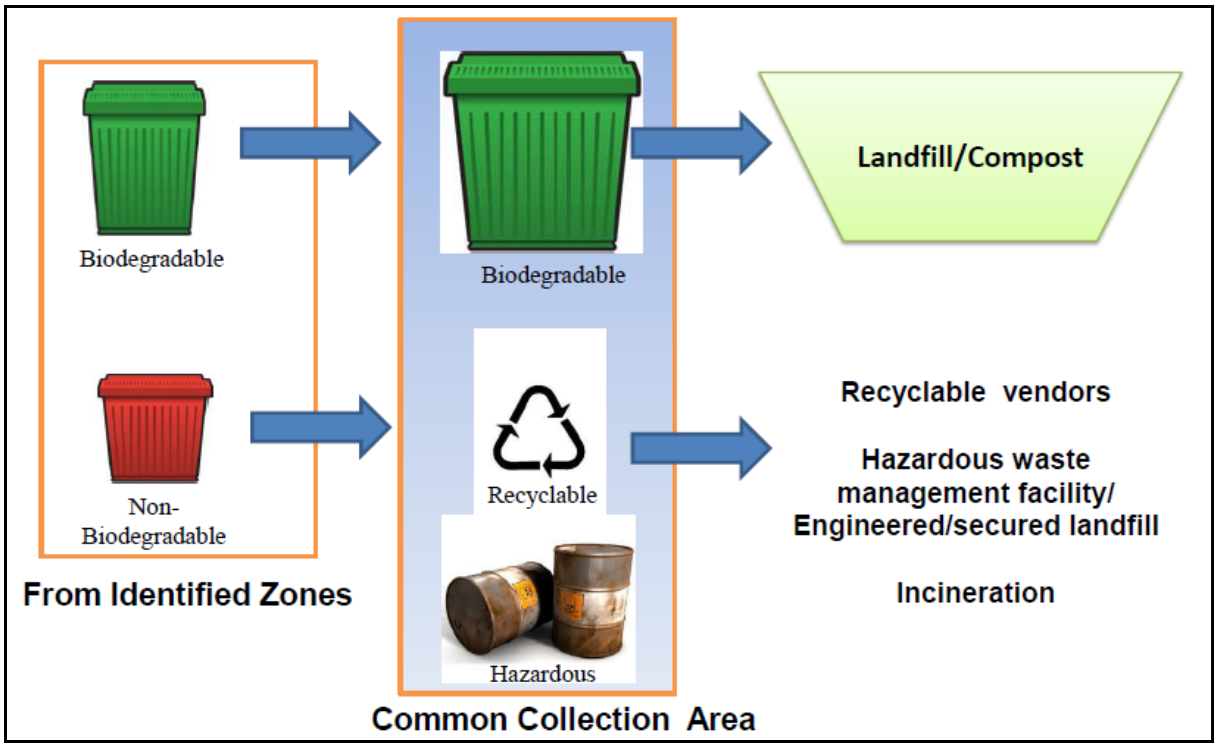


Figure 10-10: Segregation Process from Identified Zones

Table 10-8: Type of Waste and Treatment Methods

S. No	Type of waste	Treatment method	Disposal methods	Compliance
1	Paper, plastic, glass, metal, etc.	Recycle	Approved recycle vendors	Meet KSPCB /CPCB norms of waste management
2	Street/ garden littering	Compost	Compost / land fill	
3	Inert waste	Land fill	Secured landfill	
4	Kitchen waste, domestic waste	Compost	Compost / land fill	
5	Batteries	Recycle	Approved recycle vendors	
6	Electronic goods	Recycle	Approved recycle vendors	
7	Hazardous waste if any	Hazardous waste management facility	It will be sent to nearby approved HWMF/Incinerator	
8	Medical waste if any	Hazardous waste management facility	It will be sent to nearby approved HWMF/Incinerator	

Since the quantities of type of waste mentioned in 5, 6, 7 & 8 are less, it is environmentally/ economically not viable to set disposal systems for these types of waste at port premises. Details of typical compost yard and landfill details are given in subsequent sections

10.7.3 Solid Waste Collection & Storage

Collection of Solid waste from homogeneous zones is the important part of solid waste management. A common place has to be identified in such a way that the place should be easily accessible without disturbing activities of other zones. Mobile services for collecting floating wastes will also be used for this purpose. A daily waste storage area comprising containers/skips shall be kept at the site. Storage should be partly roofed. Waste skips for oil wastes or other hazardous wastes should be water proof. Procedures for filling fuel tanks of machines and handling of hazardous wastes/materials shall be

established prior to the start of construction. End of the day waste will be collected together from the storage area.

10.7.4 Waste Reuse/Recycle Opportunities

Wastes shall be separated according to local regulations and the recycling materials that are dealt with in India. Recycling materials shall be regularly collected to be recycled by local companies certified by the relevant authorities.

10.7.5 Waste Transfer

Waste transfer shall be carried out by certified companies; vehicles shall be fully equipped, considering the type of waste transported. Since the entire solid waste management system is targeting a decentralised using Kudumbasri units (Women self help groups) approach no exporting of waste is anticipated.

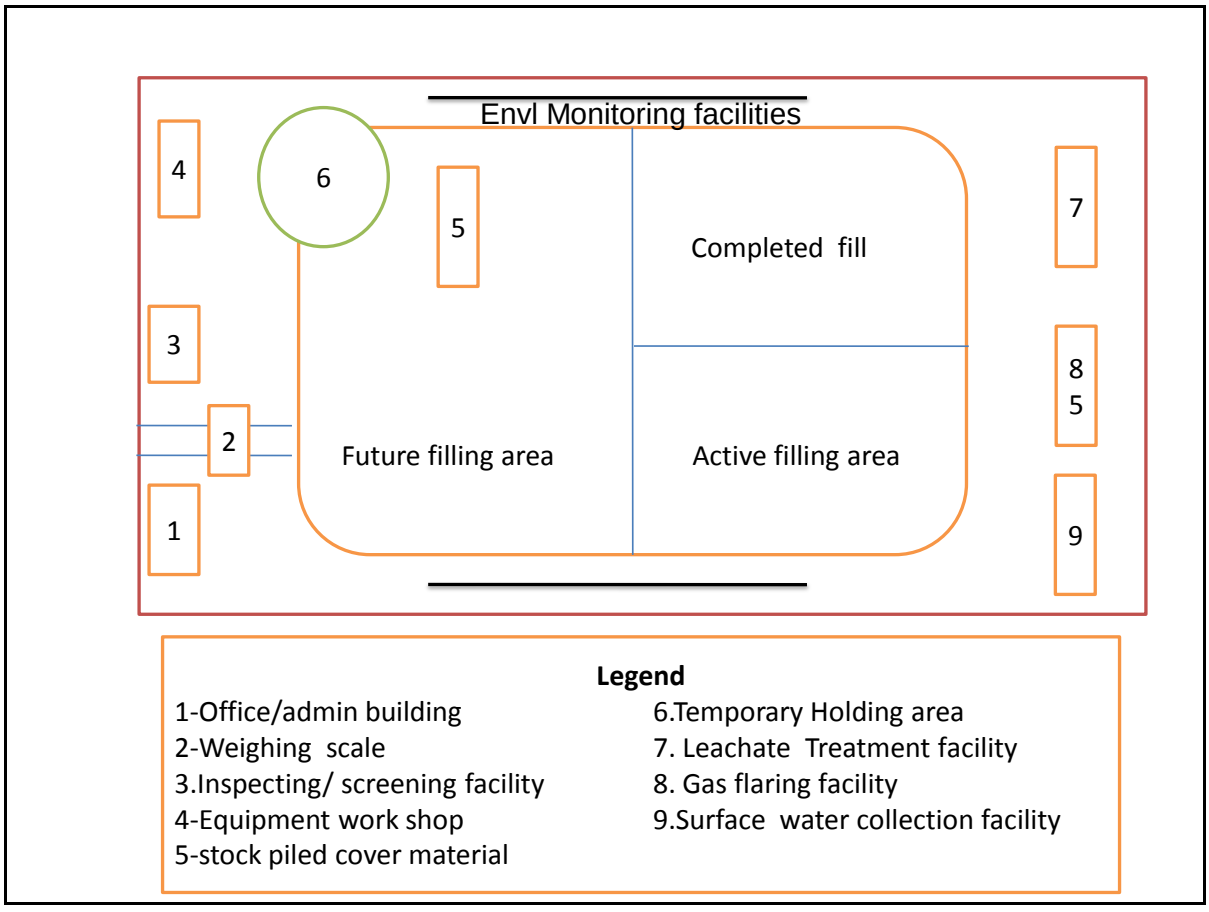


Figure 10-11: Typical Compost Yard Details

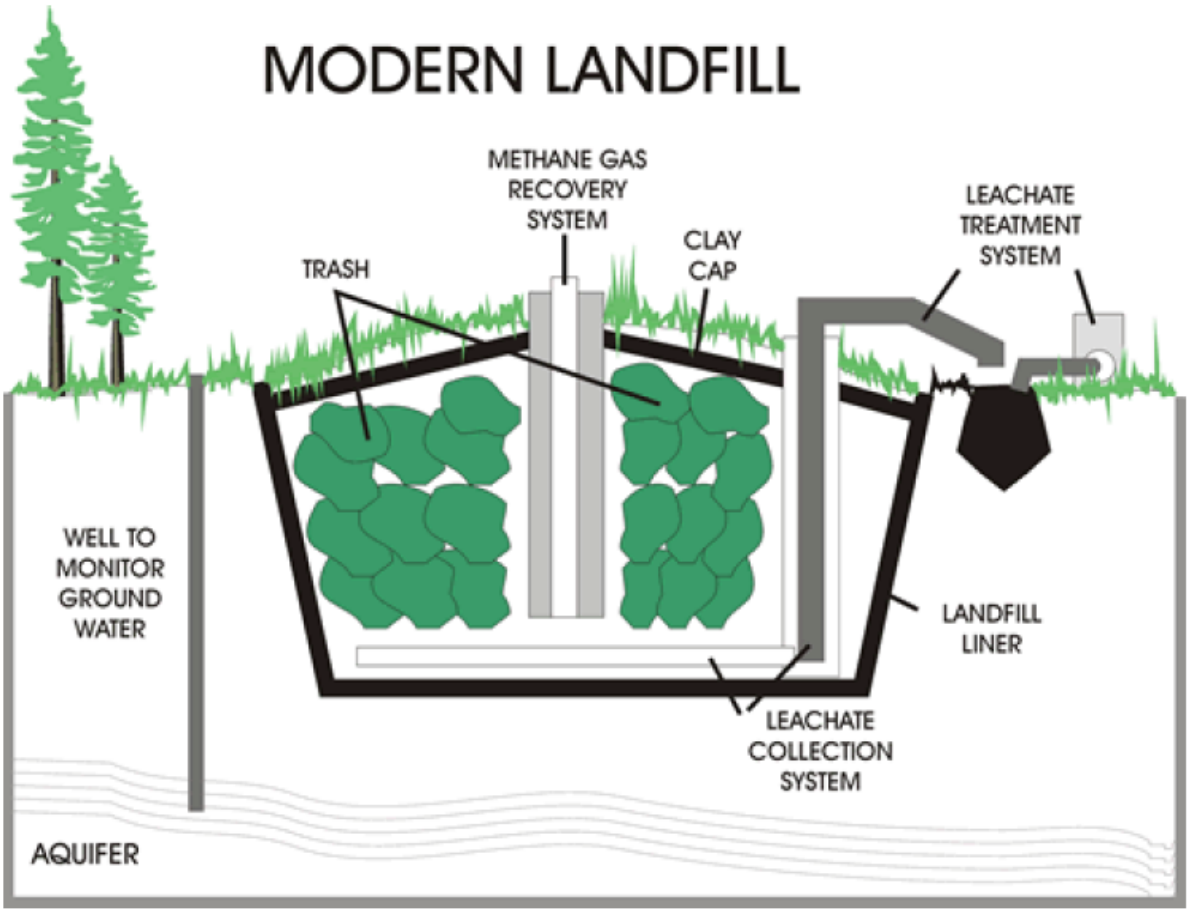


Figure 10-12: Typical Modern Landfill Site

10.7.6 Final Disposal of waste

The domestic waste will be transported to the composting unit or to the controlled municipal waste disposal site, as per the KSPCB /CPCB norms of waste management.

10.7.7 Training

Wastes should be separated by site staff, and staff dealing with wastes should be trained. Handling of wastes on-site will be instructed through “procedures”. Service companies go through a qualification process and will be audited during the service period.

10.7.8 Specificities of Hazardous Waste Management

In order to provide protection for the environment and human health, collection, transport and storage of hazardous waste shall include action to ensure traceability from the production area (mainly on construction site) to final disposal site. Oily and hazardous wastes shall be disposed by specialist contractors at sites that are equipped and approved for such wastes. The transport to hazardous waste shall only be undertaken in vehicles that:

- are suitably equipped for the type and quantity of hazardous waste to be transported,
- are of a roadworthy standard and
- Have been previously registered for this purpose with the relevant authorities.

10.7.9 Waste Recording Process

All waste shall be registered after every phase of the WMP: separation/segregation, storage, transfer and reception to the disposal. This inventory will ensure the traceability, particularly for the hazardous waste. Optimisation of waste management is a continuous process, and this plan must be periodically reviewed all through the construction phase and operation phase. Finally, the plan should include provisions for the training of all workers on how to use the WMP, and will include procedures related to communication to stakeholders and community improvement opportunities. The solid waste generated from the labour colony from construction phase, will be about **500 kg/day**. During port operation phase it was preliminary estimated that in phase-I port facility would generate **1000 kg/day**.

This **Solid Waste Management Plan** should be developed by the contractor and approved by the developer prior to construction. The Solid Waste Management Plan for the operational phase should be developed by the operators and approved by the local authorities prior to start of operations.

10.7.10 Wastewater Management Plan

The sewerage system is limited to the areas wherever office buildings, canteens, and other operational buildings are constructed. For the isolated buildings where the quantity is negligible, it is proposed to construct septic tanks with soak pit disposal.

Near the location of port buildings and township, it is proposed to provide a **Sewage Treatment Plant** (STP) of **100 KLD** and **350 KLD** capacities respectively. Appropriate stream sanitation measures will be sorted out for the two highly polluted streams entering the location of proposed new fishing harbour at the north and south. Both the streams have got bathing ghats where women especially fisher women are taking bath. The treated sewage shall be used for green belt development and washing. In rainy season, the treated sewage will be discharged into the main drainage system of the port after conforming to the marine discharge standards. The sludge from the treatment plant will be processed and used as manure.

In addition the STP will contain sewerage system comprising of sub-systems consisting of sewage collection pipe network, lifting stations (LS), terminal sewage pumping stations (TSPS) and main sewage treatment components. All the treated water will be used for greenbelt development. The following planning criteria shall be adopted for the designing the proposed sewerage system:

Sewage Flow: 80% of water supply shall be considered as sewage inflow.
Peak Factor: Design peak flow shall be two times the average flow.
Discharge Capacity: The sewers shall be designed for the discharge capacity of Qc to cater adequately for the estimated peak run off using Manning's formula: Qc = 1/n.A.R (2/3) S1/2 (m^3/sec), Where,

A = Flow area of sewer (m^2)
R = Hydraulic mean radius (m)
S = Bed gradient
n = roughness coefficient, (assume n=0.015 for reinforced concrete pipes)

The STP maybe built in modular and expandable manner. The STP may involve the following steps:

Sewage will pass through a screen chamber to remove floating solids. The floating solids collected will be removed and disposed off through Government authorised disposal agencies/ landfill site proposed for the port.
After grit chamber the sewage will be collected in an equalisation tank to control the flow rate and pH.

After equalisation tank, high efficiency aerobic treatment schemes based on extended aeration system using fine bubble diffused aeration (Activated sludge process) will be provided. Activated sludge process is an aerobic treatment of sewage in which aerobic bacteria thrive in presence of oxygen and bring about oxidation of the sewage. In this system, certain amount of oxidised or activated sludge is intimately mixed with the sewage, which greatly hastens the process of oxidation of organic matter. Aeration and activation is done through compressed air, which is introduced through diffusers into the sewage as it flows through tanks. Air is supplied through vertical pipes, which run longitudinally along the tank. Waste or excess sludge from the liquid stream is removed in the form of flocculent sludge in settling tanks.
Sludge from the activated sludge process will be collected/dried and used as manure for landscaping in and around the Port area.
Effluent (after its compliance with the 'General Standards for Discharge of Environmental Pollutants Part-A: Effluents': Schedule – VI of the Environment (Protection) Rules, 1986, pertaining to irrigation) will be re-used for landscaping purpose.

10.8 Greenbelt Development Plan

The entire back up area is already green and cutting for construction of buildings will be planted at the rate two to one. Trees function as sinks of air pollutants, besides their bio-aesthetical values, owing to its large surface area. Presence of a green belt means conserving the biological diversity thus retaining of soil moisture, recharge of ground water also self-control of micro- climate of that area. It also improves the aesthetic value of the area later on it becomes the natural habitat of various bird species. Development of a green belt around the Project area will also help to contain noise generated during construction and operational phase.

From land use plan, it is found that water bodies covers 54.8%, vegetation 33.58%, built up area 10.87% and coastal sand 0.74%. This means that 74% study area in land side is covered with vegetation. So back ground vegetation/ green belt will help in reducing the noise and air pollution levels in addition to protect soil erosion and fertility.

Greenbelt development will be carried along road & rail corridor and on the vacant areas to reduce pollution as well as to improve aesthetic value. Species recommended by horticulturists will be selected on the basis of air pollution tolerance index of tree. Selection of the plant species will be based on their adaptability to the existing geographical conditions and the vegetation composition of the forest type of the region. Regular watering will be undertaken. Soil conditioning and fertiliser application will be undertaken. If required, suitable soil treatment will be provided to ensure good growth of tree cover.

During the development of the green belt within the project area, it has to be emphasized that those native plant species shall be planted which are good ornamental values and are fast growing with excellent canopy cover. The general considerations involved while developing the green belt are:

- Generally local/native fast growing trees should be planted around various Project facilities
- Planting of trees should be undertaken in appropriate encircling rows around the Project site.
- Trees should be protected by plantation of non-palatable shrub species to avoid browsing by animals.

10.8.1 Objectives of Greenbelt Plan

The Greenbelt Development has the following objectives:

- Enhancement of the overall environmental quality.

- Compliance of the conditions stipulated in the environment clearance
- Improve ambient air quality.
- Conserve soil and moisture and provide healthy climatic conditions.
- Increase aesthetic value.
- Create awareness for environmental conservation and tree planting.
- Provide adequate shelter and habitat to the local fauna.
- Generate employment for the local people.
- Protect human health and prevent pollution.

10.8.2 Choice of Species

The selection of plant species for the development depends on various factors such as climate, elevation and soil. The plant species should exhibit the following desirable characteristic in order to be selected for plantation.

- Should be fast growing and providing optimum penetrability.
- Should be wind-firm and deep-rooted.
- Should form a dense canopy.
- Should have least economic value.
- As far as possible, the species should be indigenous and locally available.
- Should be permeable to help create air turbulence and mixing within the belt.
- Introduction of monocultures and alien plant species would be avoided Plants shall:
- Be fast growing and attaining a height of 5.0 m or more in three to four years
- Have thick canopy cover
- Be preferably evergreen
- Have large leaf area index
- Be resistant to specific air pollutants
- Maintain species diversity
- Be able to attenuate noise generated within the area
- Be well adapted to the existing soil conditions

As per the stipulations of MoEF, greenbelt will be provided all along road & rail corridor and around the landward side of port boundary. Greenbelt will be developed around administration buildings. A Greenbelt Development Plan will be implemented around the various project components of Vizhinjam port. This will help to achieve environmental protection and mitigation of pollution levels in the area. The general considerations for the development of greenbelt in Vizhinjam port are:

Trees growing up to 10 m or above in height with perennial foliage will be planted around the perimeter of Vizhinjam port area and on both sides of the Port Access Road.
Planting of trees will be done in appropriate encircling rows around Vizhinjam port site.
Trees will also be planted along the road side in such a way that there is dust control against the vehicular movement.
Generally fast growing trees will be planted.
Since the tree trunk area is normally devoid of foliage up to a height of 3 m, it will be useful to have shrubbery in front of the trees so as to give coverage to this portion.

10.8.3 Species for Plantation

A list of indigenous tree, shrubs and herbs was made after identification of species suitable for raising in nurseries and for development of green belt around the project area. An elaborate survey was carried out to observe the vegetation type and density along with the soil characteristics. Based on the

survey and environmental conditions suitable plant species for the green belt development was suggested. Around 1600 species per hectare of land is suggested for green belt development.

Table 10-9: List of Plant Species for Greenbelt Development

S. No.	Scientific Name of Species	Common Name
1.	*Dalbergiasissoo*	Indian Rosewood
2.	*Cocosnucifera*	Coconut
3.	*Terminaliacatappa*	
4.	*Syzygiumcumini*	Jamun
5.	*FicusReligiosa*	
6.	*Phyllanthusemblica*	Amla
7.	*Cassia fistula*	Amaltash
8.	*Salvadorapersica*	Jhak, Kharjal
9.	*Acacia mangium*	Acacia
10.	*Musa acuminata*	Banana
11.	*Moringaoleifera*	Drumstick
12.	*Achrassapota*	Sapota
13.	*Wrightiatinctoria*	Dhudi
14.	*Ziziphusmauritianalamk*	Ber
15.	*Delonixregia*	Gulmohar
16.	*Azadirachtaindica*	Neem
17.	*Mangiferaindica*	Mango
18.	*Bougainvillea sp.*	

Greenbelt Development Planned: The project proponent shall develop a green belt in a chosen area of 25 Ha, which is equivalent to the area where the tree cover will be lost. In addition to this 10 m thick green belt is planned all along the road & rail corridor. The maintenance of the green belt area will be monitored by the Environmental Cell of Vizhinjam port. Greenbelt development should will be developed by the Developer and approved by the local authorities prior to start of construction.

Chapter 11
Summary & Conclusion

Chapter 11 Summary and Conclusions

11.1 Introduction

The Government of Kerala (GoK) is planning to develop various port projects for the overall improvement of the economy of the State. The State of Kerala, located along the West coast of India, is endowed with a coastline of 580 km. Along this coast, there are 14 minor ports, three intermediate ports and one major port i.e. Cochin. The minor ports and the intermediate ports come under the jurisdiction of Department of Ports, GoK and the Cochin port is under the jurisdiction of Ministry of Shipping, Government of India (GoI). Out of the minor/intermediate ports, Vizhinjam harbour is one which has been accorded minor port status in 1977. Since then, a fishing harbour and a custom port has been developed with limited facilities like a wharf and transit shed.

GoK is now going to develop a full-fledged container transhipment Greenfield port adjoining the Vizhinjam Harbour; complete with cruise, coast guard and navy terminals. **Vizhinjam International Deepwater Multipurpose Seaport**, herein after referred to as **'Vizhinjam Deepwater Port'** or simply **'Vizhinjam Port'**, has become a dream project for the people of Kerala and therefore the entire GoK machinery is overwhelmingly supporting it. Due to its strategic location facing the Indian Ocean, its proximity to the International Shipping Route, Tamil Nadu and Sri Lanka give it a special stature making it a ***'National project'*** rather than a ***'State project'***.

The port is envisaged to be developed through Public Private Partnership (PPP) with VISL as a Landlord of the Port, in which the construction and operation of the port terminal will be on Build, Operate and Transfer (BOT) basis. The GoK is supposed to develop port associated infrastructural facilities like the breakwater, quay wall, dredging, reclamation, utilities (drinking water, power supply to the terminal, etc.) and infrastructure connectivity (rail and road). The port operations and superstructure development are proposed to be the responsibility of the private operator.

As the development of the proposed port attracts EIA Notification 2006 (as amended), Comprehensive Environmental Impact Assessment (CEIA) has been carried out and just concluded during May 2013 for the project. This is the summary and conclusions derived from the Comprehensive EIA. The document is to comply with all National Environmental regulatory requirements and National environmental standards for sustainable development. The CEIA report is prepared as per the format prescribed by MoEF in the Guidance Manual for Ports and Harbours and presented under the following heads:

Chapter 1	:	Introduction
Chapter 2	:	Project Description
Chapter 3	:	Analysis of Alternatives
Chapter 4	:	Description of Environment
Chapter 5	:	Anticipated Environmental Impacts and Mitigation Measures
Chapter 6	:	Environmental Monitoring Programme
Chapter 7	:	Additional Studies
Chapter 8	:	Project Benefits
Chapter 9	:	Environmental Cost Benefit Analysis
Chapter 10	:	Environment Management Plan (EMP)
Chapter 11	:	Summary and Conclusions
Chapter 12	:	Disclosure of Consultants Engaged

11.2 Project Description

Vizhinjam is selected as the prime location for the development of Greenfield port, as it has a natural bay region consisting of rocky outcrops, significant water depth of 18-20 m within a distance of one nautical mile into the sea and is located relatively close (10 nautical miles approximately) to the international shipping route, which connects the United Kingdom, West Asia and the Far East.

All the port facilities are proposed to be developed entirely on reclaimed land whereas all the infrastructure facilities like back up areas, warehouse, PAF zone, administrative buildings, etc. are planned to be developed on the landward side in area of 140.42 Ha, part of which i.e. around 48.2 Ha is owned by VISL. The port facilities which are planned to develop on reclaimed land comprises an area of approximately 66.00 Ha. Cargo traffic forecast expected to be handled at Vizhinjam port is 822, 256 TEU container, 107,000 Ton of mutli purpose cargo (timber and cashew) and cruise of 1200 passenger capacity per annum.

A dedicated rail/road corridor is planned for Vizhinjam port to cater the port traffic. The length of 14.725 km will be developed for the railway link. This will connect the Vizhinjam to the existing southern railway line from Thiruvananthapuram Central Station (TVC) to Nagercoil Junction (NCJ) at Nemom (NEM). The road length of 1.964 km will be developed up to NH 47 bypass, start at port and end at NH bypass. The NH 47 bypass starting from Kazhakootam at existing NH 47 (North side) up to Kovalam junction is complete with all planned components including the avenue plantation. The NH 47 bypass is still under construction from Kottukal (end of Vizhinjam village) to Kaliyikkavila at existing NH 47 (South of Neyyattinkara).

As a part of port development, several infrastructure facilities have to be developed in addition to road and rail connectivity. Most of these infrastructure facilities are developed close to the port. Therefore adequate backup area and other land resources have been acquired in the vicinity of proposed port. These are together termed as ancillary sites which will be a part of the overall port infrastructure. These ancillary sites and facilities are for developing (1) **warehouse area** (2) **Port Annex Facility** (PAF) zone which includes (a) truck terminal, (b) a 220/66 KV sub-station & (c) **port operator's colony** and (3) **port backup areas** for administrative and other utility and infrastructure requirements for phase-I/II/III for port, navy & coast guard and fish landing centre..

The salient features of the development of proposed port in phase-I are:

Fish landing center with a total berth length of 500 m
Northern break water length of 3180 m
Container berth length of 800 m
Cruise berth/ multipurpose cargo berth length of 300 m
Port craft berth length of 100 m and coast guard berth length of 120 m
Berthing, storage and operational facilities for Indian Navy with berth length of 500 m

The combined layout of the project and developmental plan is discussed in detail in **Chapter 2**.

11.3 Description of Environment

The EIA is prepared with three seasons primary data (comprehensive EIA) and the entire study took more than 18 months due to the elaborate stakeholder consultation to meet both GoI and IFC requirements.

The current state of the environment was studied (primarily for bench marking) in the project area and within a radius of 10 km from the project site (further referred to as the study area). The baseline environmental studies are carried out for marine and terrestrial environments by covering land, air, noise, water and biological environment.

11.3.1 Marine Environment

Existing marine environmental conditions in study area were established through collection and analysis of water and sediment samples at selected locations. Parameters monitored include physical parameters, chemical parameters and biological parameters.

- Results of marine water quality are within permissible limits of Water Quality Standards for Coastal Waters (Annexure 5 of EIA guidance manual for Ports and Harbours, MoEF, 2010)
- The pH, salinity and dissolved oxygen concentration in the marine water were in the range of 8.0 to 8.2, 34.0 to 35.5 ppt and 3.8 to 6.9 mg/l respectively.
- Concentration of chlorophyll in pre-monsoon, post-monsoon and monsoon seasons were in the range of 2.01 to 3.51 mg chlorophyll/m³, 2.045 to 2.946 mg chlorophyll/m³ and 1.983 to 3.84 mg chlorophyll/m³ respectively.
- Phytoplankton density ranged between 347218 Nos./m^3 at Mulloor during pre-monsoon season to 6591580 Nos./m^3 at Puthiyathura during monsoon season.
- Zooplankton density ranged between 5114 Nos./100m^3 at Mulloor during post-monsoon season to 69415 Nos./100m^3 at Kovalam during monsoon season.
- Results of marine sediment quality indicate that it is free from any significant pollution.

11.3.2 Terrestrial Environment

Existing terrestrial environmental conditions in the study area were established through collection and analysis of air, noise, groundwater, surface water, soil and ecology (flora and fauna) samples at selected locations.

- Topography of the port site is mostly plain as it is a coastal area and other area (road & rail and ancillary sites) are plan and undulating
- Total area considered for land use study is 31324 ha (~10 km radius). Of this 54.81% of the study area is covered by water (mainly Sea). The "**Built up Area**" and "**Coastal Sand**" (beach area) respectively constitute about 10.87% and 0.74% of the total area. The remaining area of 33.58% is covered by vegetation
- As per the project site specific meteorological data is collected from March, 2011 to February, 2012.
- During summer, the wind was blowing predominantly from the north-east direction. It reached a maximum speed of about 3.6 – 5.7 m/s. The average wind speed for this season was 0.56 m/s. In summer, almost 61.75% of the wind was calm less than 2 m/s.
- Monsoon season has two predominant wind directions, south-west and north-east, which depicts the two different seasons of monsoon (south-west monsoon and north-east monsoon). The average wind speed of this season was recorded at 0.51 m/s and 60.36% of the total wind in that region was calm. Higher wind speeds were recorded in the range of 2.1 – 3.6 m/s.
- In the winter season, the wind was blowing from north-east direction predominately. The wind speed was in the range of 3.6 – 5.7 m/s. The average wind speed was recorded at 0.58 m/s.
- Soil texture of the area varied from sandy clay loamy to loamy and soil samples are neutral to slightly alkaline in nature.
- All the parameters of groundwater and surface water are well within the limits As per the standards prescribed in Criteria for Raw Water Used for Organised Community Water

Supplies (Surface and Ground Water) Primary Parameters as per Annexure 4 of MoEF EIA guidance manual for Ports and Harbours, MoEF, 2010, the water is suitable for community use after conventional treatment (Sedimentation, Filtration, Coagulation and Chlorination).

- Ambient air quality parameters like Coarse Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Oxides of Sulphur (SO_2), Oxides of Nitrogen (NO_2) and Carbon Mono Oxide (CO) were monitored and found to be within limits prescribed by NAAQS.
- Noise levels were monitored as per CPCB guidelines and are found to be well within the limits except Balaramapuram and Punnamoodu.
- None of the plant species recorded either from the core area or Project influence area belongs to the Rare/Endangered / Endemic / Threatened category.
- No declared eco-sensitive zones like a National Park, a Wildlife Sanctuary or Wetlands are present within a 15 km radius of the project site.

11.3.3 Socio-Economic Environment

Socio-Economic baseline description consists of 10 km radius around the project stretch and also coastal villages present between 25 km to 15 km distance from the project stretch in the Northern and Southern directions respectively. Social survey was carried out which include Focussed Group Discussions (FGD) and Stakeholder Consultations.

- 43 FGDs were conducted to create public awareness about the project and to understand the apprehension of the local people. Fishermen and people involved in tourism related activities in the shadow area of the project have been identified.
- Large proportion of population was found directly or indirectly involved in fishing or fishing related activities in the study area.
- 28 FGDs for fishermen population were conducted in 22 coastal villages (located between 25 km to 15 km distance from the project stretch scattered with fishermen settlements in the Northern and Southern directions, respectively). The remaining 15 FGDs and other consultations were conducted related to tourism and other allied activities.
- Main occupation of the local people is fishing and fishing-related activities. Apart from fishing, tourism and agriculture are also important economic activities in the study area. There were no major industries in the study area.
- Total population count in the surveyed study area was 440,180
- Surveyed households had an average of 4.2 members. In the surveyed settlements, about 53% of respondents were from rural areas, 29% were from semi-urban and the rest (18%) were from urban areas. The surveyed area was a medium (42.3%) to high (53.4%) densely populated region. The average gender ratio of the surveyed population was 935 (Male: Female).
- In the study area, 77.16% of the people were literate, which is lower than the average literacy rate of the State (93.91%) and PIA District (92.66%) for the year 2011. Moreover, Christianity, Islamism and Hinduism are the three major religions prevalent in the study area.

11.4 Environmental Impacts and Mitigation/Avoidance Measures

The port activities and their impacts on the environmental and social attributes during the development and operation phase have been discussed in **Chapter 5**. Mathematical modelling studies have been carried out to evaluate the impacts due to disposal of dredge material, sediment transport and shoreline changes in and around existing fishing harbour as well as at the proposed Vizhinjam port. The following potential impact categories are taken into account:

- Land Environment
- Flora and Fauna

- Water Environment
- Marine Environment
- Air Environment
- Noise Pollution
- Climate Change
- Solid Waste Management
- Marine Ecology
- Raw Materials
- Visual Amenities
- Occupational Health and Safety
- Community Health and Safety

The impacts have been summarised, evaluated and suitable mitigation measures proposed to negate the likely impacts are presented in **Chapter 5**.

11.5 Environmental Monitoring Programme

The environmental attributes to be monitored during construction and operation phase of the project, specific description along with technical details of environmental monitoring including the monitoring parameters, methodology, sampling locations and frequency of monitoring are presented in **Chapter 6**. Environmental Management cost for establishment of environmental control equipment, including green belt development and annual recurring cost details are provided.

11.6 Additional Studies

11.6.1 Preliminary Risk Analysis

This section addresses proposed project actions related risks associated with explosion, fire, or release of hazardous materials in the event of accident or a natural disaster with the construction and operation of the proposed port in terms of identifying the hazards and suggesting the suitable mitigation measures.

The Preliminary Risk Analysis carried out also provided inputs for formulating the onsite Disaster Management Plan (DMP). Preliminary risk analysis was carried out under the following heads:

- Hazard identification including potential release events
- Enumeration of potential accidents and typical failure frequencies
- Risk reducing measures

11.6.2 Disaster Management Plan

A framework for Disaster Management Plan was prepared to minimise damages in the event of a disaster. An On-Site Emergency Preparedness Plan and Off-Site Emergency Preparedness Plan were broadly prepared to deal with emergencies and prevent disasters. An institutional framework with clear assignment of roles and responsibilities was broadly prepared with which location of Emergency Control Centre and Assembly Points will be identified. Communication system and alarm systems for effective communication in the event of a disaster are broadly identified. Disaster Management Plan (DMP) for natural hazards such as cyclones, tsunami was broadly prepared. Mutual aid scheme, composition of District Level Emergency Committee and aspects relating to community involvement for dealing with off-site disasters were broadly prepared.

11.6.3 Oil Spill Contingency Plan

An oil spill contingency plan for Tier -1 is prepared and this plan will be finalised and approved by the Indian Coast Guard. It describes about the different organisation/ teams required and their responsibilities. It also covered Training, Inspection and Drill Schedule and equipment etc required effect function of contingency plan.

11.6.4 Social Impact Assessment

The activities during the construction phase might have potential impact on the socio-economic environment which includes dredging, reclamation, transportation of quarrying materials, construction of terminals and breakwater as well as establishment of labour camps. During the operation phase, the operation of terminals, marine traffic, road & rail traffic and establishment of labour/employee colony might have potential impact on the socio-economic environment of that region. However as the port is planned to be developed entirely on the reclaimed land, no land acquisition is envisaged for the port development. But the port requires infrastructure facilities railway yard, administrative buildings cruise and navy operations. Hence it requires back up areas in the immediate vicinity. In addition for developing other facilities like road/rail connectivity, warehouse, residential areas, truck parking areas etc require land in the vicinity. The total land requirement in phase-I is 206.42 Ha, with 66 Ha reclaimed land and 140.42 Ha dry land. Reclaimed land (66 Ha) is required for the marine facilities of port with 36 Ha for container yard & 30 Ha for rail/road & other yard infrastructure. The dry land for land side infrastructure facilities is 140.42 Ha, with 23.36 Ha for back up; 9.97 Ha for road; 19.87 Ha for truck terminal; 41.53 Ha for warehouse and 45.68 Ha for railway. The dry land for the land side infrastructure in phase-I, would cater to the needs of phase-II & phase-III as well.

The impacts on nearby settlements, Fishermen community, fishing activities and employment potential during construction and operation phases are briefly summarized in **Chapter 7.**

11.6.5 Corporate Social Responsibility

As a part of Corporate Social Responsibility (CSR), VISL proposes to take up following activities for improving the living standards and providing facilities to the people of Vizhinjam and other nearby areas; CSR is addressed in **Chapter 7**.

Planned activities included in the CSR are the following:

- A water supply scheme has been commissioned recently for the Vizhinjam fishing village.
- A fish landing centre that could be able to double the capacity of the fishing harbour is going to be implemented.
- Seafood/Agro park
- Skill development centre for marine, port and fisheries sector
- Up gradation of UP school in Mulloor to a High School
- Adoption and Refurbishment of infrastructure facilities at Vizhinjam Fishing Harbour to International Standards
- Preparation of a “port city” area development plan to be integrated with Thiruvanathapuram city and Kovalam development plan
- Health clinic and Yoga centre (recreational facilities)
- Sanitation ad solid waste management improvement
- Improvement/eco-restoration of natural steams
- Two types of Scholarship for meritorious students and poor students

The total budget allocated for CSR activities is around **₹ 100.00 Crores**.

11.7 Project Benefits

Development of Vizhinjam port offers an efficient and cost effective supply chain/value proposition to the local importers and exporters. This could trigger a new set of opportunities as induced developments. This will accomplish one of the main aims of the proposed port project; which is to bring significant socio-economic benefits to the local people and also to the region as a whole. These benefits include:

- Dedicated roadway and railway connectivity proposed for the Vizhinjam port will provide access to the major existing road and railway network which offers an efficient and cost effective supply chain/value proposition to the local importers and exporters in the State of Kerala.
- Employment opportunities to the local people for skilled, semi-skilled and unskilled work force during the construction and operation phases
- Construction phase is estimated to provide employment opportunity to about 2300 people; during operation phase, 650 direct employment opportunities can be estimated.
- Major boost to the tourism sector with the proposed Cruise Terminal at port and overall local economic development.
- Significant benefits to local people and to the region as a whole and positive impact on the socio-economic conditions of the project region
- As part of CSR, VISL planned to initiate many activities for improving the way of living of people of Vizhinjam and other nearby villages in 2.0 km radii area in sectors like fisheries, agriculture, tourism, common infrastructure facilities, educational & medical facilities, sanitation & wastewater treatment, solid waste management, etc.

11.8 Environmental Cost Benefit Analysis

Economic analysis of the costs and benefits of the project reveals that the project has a positive economic net present value and a high economic internal rate of return. The project generates substantial consumer surplus in terms of savings in ship and inland transportation costs. The Cruise terminal will attract more tourists to the region resulting in greater incomes for the local tourism industry. The Coast Guard and Navy will be able to save substantially on fuel costs on its surveillance trips to Vizhinjam area, by operating out of Vizhinjam instead of Cochin or Tuticorin. The project also generates environmental benefits such as reduction in carbon emissions. The Economic analysis and financial viability of the project is addressed in **Chapter 9**.

11.9 Environmental Management Plan (EMP)

The effective implementation and close supervision of the environmental management to mitigate the environmental impacts, which are likely to arise due to the construction and operation phases of the project could be achieved through a suitable institutional mechanism. Around **₹ 40.00 Crores** have been earmarked for the EMP and Environmental Monitoring Plan to address all environmental management requirements. The institutional mechanism responsible for the implementation of the mitigation measures is presented in the **Chapter 9**.

11.10 Disclosure of Consultants

The consultants engaged for this Comprehensive EIA study are provided in **Table 11-1**.

Table 11-1: List of Agencies Engaged So Far and Their Role

S. No.	Agency	Role/Study
21.	International Finance Corporation (IFC)	Transaction Advisor
22.	Royal Haskoning (RH)	Technical Consultant Hired by IFC
23.	AECOM	Technical Consultant for EPC contract/ Master Planning and DPR
24.	Royal Haskoning/Asian Consulting Engineers Pvt. Ltd. (ACE)	ESIA Consultant for the Port, contracted by IFC
25.	L&T-RAMBØLL Consulting Engineers Ltd. (LTR)	ESIA for Road & Rail Connectivity, other infrastructural facilities, associated studies, consolidating the ESIA report for obtaining the EC from MoEF, GoI
		(1) hydrodynamics study, (2) wave transformation study, (3) wave disturbance study within the fishing harbour, (4) sediment transport study to assess the changes and (5) dredge spoil disposal study to evaluate the impact of dredge spoil dumping
26.	Indian National centre for Ocean information system (INCOIS), GoI	Shoreline Change studies
27.	Centre for Earth Science Studies (CESS), GoK	HTL/LTL demarcation studies as per CRZ Notification 2011
28.	Public works Department Government of Kerala	Road component – Engineering and construction
29.	Drewry Shipping Pvt. Ltd.	Market Study and Marine Traffic Study
30.	Fugro Geotech Pvt. Ltd.	Geo Technical Study
31.	Allen Overy and Trilegal	Legal Consultant
32.	SBI (State Bank of India) Capital	Financial Advisor
33.	EGS Survey Pvt. Ltd.	Oceanographic surveys
34.	CEPT (Centre for Environmental Planning and Training) University Ahmedabad	Area Development Plan
35.	Deloitte	Economic Viability and EIRR
36.	BMT (British Maritime Technology)	Ship navigational studies

S. No.	Agency	Role/Study
37.	RVNL (Rail Vikas Nigam Limited)	DPR for railway connectivity and Report on the Alternative Railway Alignment for Vizhinjam Railway connectivity
38.	RITES (Rail India Technical and Economic Services)	Feasibility for Vizhinjam Port railway connectivity
39.	IL&FS (Infrastructure Leasing and Financial Services) & LTR	Techno-commercial feasibility report
40.	CMFRI (Central Marine Fisheries Research Institute)	Marine/Fisheries Studies
41.	Eko Pro Engineers Private Limited	Terrestrial surveys

Chapter 12
Disclosure of Consultants Engaged

Chapter 12 Disclosure of Consultants

Vizhinjam International Seaport Limited, VISL has engaged L&T-RAMBØLL Consulting Engineers Limited (L&T-RAMBØLL), Hyderabad to undertake EIA (Environmental Impact Assessment) study for Vizhinjam port. The role of L&T-RAMBØLL is as follows:

- Technical assistance during public hearing and for obtaining all regulatory approval and Environmental Clearance (EC) from Ministry of Environment and Forests (MoEF)
- EIA of road and rail connectivity to Vizhinjam port
- Social Impact Assessment (SIA) of road and rail connectivity to Vizhinjam port
- Environmental and Social Impact Assessment (ESIA) for Vizhinjam port ancillary sites; such as (1) backup areas (2) warehouse (3) Project Annex Facility zone (port operators colony, truck terminal and VISL substation)
- Resettlement Action Plan (RAP) for the entire port and other infrastructure facilities
- **Comprehensive EIA for Vizhinjam port project (this report)** including all other sub projects with consultancy services input from other consultants mainly Royal Haskoning/Asian Consulting Engineers
- All associated numerical modelling for the marine side facilities[29] including studies related to old fishing harbour

The nature of consultancy service rendered by all other organisations involved in this project is discussed in this section.

12.1 Brief Profile of L&T RAMBØLL

L&T-RAMBØLL Consulting Engineers Limited (L&T-RAMBØLL) is a leading multi- disciplinary Indian Consultancy firm formed in 1998 between Larsen & Toubro Limited (L&T – the largest Indian Engineering and Construction Conglomerate) and RAMBØLL (a leading firm of Consultants in Europe). Both L&T and RAMBØLL have over six decades of experience. Following the footsteps of such illustrious parents, L&T-RAMBØLL has made a distinctive mark by creating new standards in providing sustainable solutions. Today, L&T-RAMBØLL is distinguished from others not limited to its lineage but its relentless quest for quality - a unique tradition of placing client's needs above all.

L&T-RAMBØLL has complete access to the technology of RAMBØLL. This technology is customised by L&T-RAMBØLL to serve the needs of the developing world. We offer a diverse array of talents together with practical experience. We assure our clients a professional approach by innovation and evolving optimal solutions. At L&T-RAMBØLL, we recognise that human resources are the key to organisational success. L&T-RAMBØLL's expertise ranges across a broad spectrum of sectors with special forte in Infrastructure Projects and Industrial Parks/SEZs. L&T-RAMBØLL has expertise in carrying out Techno-Economic Feasibility Studies, Preparation of Master Plans & Detailed Project Reports and Bid Process Management. L&T-RAMBØLL is rendering the following services for Specialised Industrial Clusters/SEZs/Industrial Parks/Investment Regions:

- Environmental and Social Impact Assessment including assistance to Client in obtaining necessary clearances/approvals from various statutory authorities: State PCB's, Coastal Zone Management Authorities (CZMA's), MoEF (GoI)
- Field surveys (Terrestrial & Marine Environments) and investigations
- Numerical modelling especially for the marine projects

[29] Except few modeling for initial port layout

- Project formulation/conceptualisation & configuration
- Market study and demand assessment
- Master planning, Urban planning, Environmental planning and Tourism planning
- Infrastructure design and engineering
- Block cost estimation
- Economic and financial analysis
- Bid Process Management
- Assistance in domestic and international marketing including road shows / investors conference (or meet) for marketing the project.
- Assistance to Client in achieving technical and financial closures

Strengths of L&T RAMBØLL

L&T-RAMBØLL has a well-equipped Corporate Office at Chennai where RAMBØLL's Danish Experts are positioned permanently. L&T-RAMBØLL's staffs is replete with a wide range of professionals – Planners, Engineers, Designers, Environmental and Social Specialists, Financial Analysts, Project Structuring, Marketing and Privatisation Experts, Construction Supervision Managers – covering a wide spectrum of services. The skills of the Experts are continuously aligned to suit the changing Client requirements. L&T-RAMBØLL has strategic tie-ups with Associates for specialized services. Services of an eminent group of Expert Consultants are also available to L&T-RAMBØLL. Our clients value the highly motivated and dedicated team of professionals who assure them international quality service through focused and optimal solutions.

L&T- RAMBØLL provides a stimulating working environment. We have assembled a team of skilled, creative and dynamic professionals who strive to translate the organisational ethos into reality. We are supported by experts from RAMBØLL with proven expertise in various fields. To enhance the efficiency of the personnel and enable them to be updated with the latest developments in technology, we organise comprehensive technical training programmes and organisational development programmes at regular intervals. A creative work environment, motivated staff, structured training, latest methodologies and tools, continuous adherence to quality, adoption of best ethical standards and a keen client orientation are the factors that spur on L&T-RAMBØLL's journey into the future. Our driving philosophy is 'Client First'. We work towards complete satisfaction of our clients by adopting good work practices and meeting their requirements through timely delivery of appropriate solutions. Further for achieving this objective, we have acquired state-of-the-art IT facilities and software to ensure quality in all spheres of our activity.

L&T-RAMBØLL has modern fully computerized offices with latest computational and communication facilities. A large number of high-end computers are available and are connected by a network. Further, data one Internet connectivity enables fast exchange of information with the clients, as well as within the offices and the parent companies. These facilities help us to provide our clients high quality services within the shortest possible time.Besides several expert consultants hired regularly for various highly skilled expertise requirements, L&T-RAMBØLL has more than 350 regular employees at four offices with a leading consulting group with extensive operations at Chennai, Hyderabad, Delhi and Mumbai.

Quality Policy of L&T RAMBØLL

L&T-RAMBØLL is committed to achieve and sustain excellence in consultancy services to customers world-wide through an in-house Quality Management System that conforms to ISO 9001:2008. The commitment stated above will be fulfilled by:

- Working towards compete satisfaction of L&T-RAMBØLL's customers by adopting good work practices and meeting their requirements through timely delivery of appropriate solutions.
- Striving to achieve continual improvement of quality management system through periodic review of quality policy, processes and quality objectives.
- Striving to maintain well-qualified and motivated staff by empowering them and proving a stimulating work environment.
- Adhering to the best ethical standards for business behaviour by respecting the rules of law governing L&T-RAMBØLL's business and presenting a well-audited financial statement every year.
- Impelling employees at all levels in achieving the objectives of the organisation and ensuring that all employees are aware of and act within the policy framework of L&T-RAMBØLL.
- Propagating our quality policy and procedures to our sub-consultants and associates and ensuring adherence to the relevant components of the quality system.

QCI-NABET - EIA Accreditation

National Accreditation Board for Education & Training (NABET) is a constituent board of the Quality Council of India (QCI). QCI, NABET has accredited L&T-RAMBØLL Consulting Engineers Limited for carrying out EIA studies in the following five sectors:

Ports, Harbours, Jetties, Marine Terminals, Break Waters and Dredging
Thermal Power Plants
Highways, Railways, Transport Terminals, Mass Rapid Transport Systems

- River Valley, Hydel, Drainage and Irrigation Projects
- Industrial estates/ parks/ complexes/areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes

Further details may be seen on the following URL: www.ltramboll.com

12.2 Sub Consultants Engaged

The ESIA for proposed road/rail connectivity to Vizhinjam port at Thiruvananthapuram involves terrestrial environmental surveys. For these surveys, L&T-RAMBØLL appointed reputed institutions/agencies and coordinated the surveys as per the guidelines of statutory authorities.

This agency/organization has been identified based on the credentials, commitment to the quality of output and deliverables, relatively low price, flexibility in fee negotiations, etc.

12.2.1 Terrestrial Environmental Survey

M/s. Vitro Labs, Hyderabad: M/s. Vitro labs were set up in the year 1989. The agency is offering consultancy services in generation of baseline terrestrial environmental data for the detailed EIA studies. The organization has attained the recognition from the Ministry of Environment & Forests (MoEF), GoI (with vide Gazette Notification No. 774 (E), dated 07.06.2005). Vitro Labs is also an ISO 9001:2000 Certified agency in the fields of environmental monitoring and analytical chemistry and other similar services. Vitro labs carried out terrestrial surveys for the Vizhinjam Port EIA Study.

12.2.2 Flora and Fauna Survey

Prof. K. B. Reddy: A detailed survey of flora and fauna of proposed road/rail corridor for Vizhinjam port connectivity and its environs extending up to a radius of 10 km was carried out under the

supervision and guidance of Prof. K. B. Reddy, retired, Professor of Environmental Biology (S. G. H. R & M. C. M. R College of Post Graduate Studies, Malla Reddy Nagar, Guntur) and a senior consultant for flora, fauna and ecology for several major irrigation and hydroelectric projects and his team. Our in house team of experts has analysed the consultants reports and included in this EIA document.

12.3 Other Consultants Engaged By VISL (through IFC/RH)

12.3.1 Marine Environmental Surveys / Fisheries

Central Marine Fisheries Research Institute (CMFRI): A Detailed and marine environmental survey had been carried out by a team of Experts from the Central Marine Fisheries Research Institute for Vizhinjam International Seaport Limited. It was established by the Government of India under the Ministry of Agriculture in 1947 became a member of the Indian Council of Agricultural Research (ICAR) family in 1967. Over the period, the Institute has grown significantly in its size, stature & research infrastructure. With the fast changing marine fisheries scenario and emergence of mariculture as a viable proposition for enhancing the production, the Institute over the years has tuned its mandate in consonance with the needs of the time.

12.3.2 Baseline Terrestrial Environmental Surveys

Eko Pro Engineers Private Limited: Eko Pro Engineers based In Ghaziabad offering consultancy services in generation of baseline terrestrial environmental data for the detailed EIA studies. Eko pro Engineers is NABL Accredited Agency in the field of Biological testing vide Certificate no.T1419 and chemical testing vide certificate no. T1418. Both certifications are valid till November 19, 2014. Eko Pro Engineers carried out terrestrial surveys for VISL.

12.3.3 Geo Technical Study

Fugro Geotech: Fugro provides a wide range of engineering geology and geotechnical services for siting, development, construction, and assessment/stabilization of new and existing facilities. Fugro has performed studies for developers, architects, engineers, government agencies, electric and gas utilities, municipalities, insurance companies, attorneys, and private owners. Fugro Geotech carried out Geo Technical surveys for VISL.

12.3.4 ESIA & Technical Consultants

Royal Haskoning DHV: Royal Haskoning DHV is one of Europe's leading independent project management, engineering and consultancy service providers with its headquarters in Amersfoort, The Netherlands. The company carries out projects in planning and transport, infrastructure, water, maritime, aviation, industry, energy, mining and buildings. Royal Haskoning DHV carried out ESIA consultancy for VISL.

AECOM: AECOM provides services to transportation, facilities, environmental, energy, water and government. AECOM provided services as Technical Consultant for EPC contract/ Master Planning and DPR for VISL.

Asian Consulting Engineers Limited: Asian Consulting Engineers Pvt. Ltd. (ACE) is an independent consulting company working in the field of water and environment. ACE provides consulting services

and sustainable solutions for infrastructure projects, industrial projects and social development projects. ACE was the supporting consultant to Royal Haskoning.

12.3.5 Transaction Advisory Services

International Finance Corporation (IFC): IFC, a member of the World Bank Group, is the largest global development institution focused exclusively on the private sector in developing countries. Established in 1956, IFC is owned by 184 member countries, a group that collectively determines our policies. Its work in more than a 100 developing countries allows companies and financial institutions in emerging markets to create jobs, generate tax revenues, improve corporate governance and environmental performance, and contribute to their local communities. IFC provided services as Transaction Advisor for VISL.

12.3.6 Market Study and Marine Traffic Study

Drewry Shipping: Founded in 1970 to provide information and advice to the global maritime industry. The company has global presence supported by associates across the world, delivers world-class support. Drewry Shipping carried out Market Study and Marine Traffic Study for VISL.

12.3.7 Rail Connectivity Studies

Rail Vikas Nigam Limited: Rail Vikas Nigam Limited (RVNL) is a Special Purpose Vehicle created to undertake project development, mobilization of financial resources and implement projects pertaining to strengthening of Golden Quadrilateral and Port Connectivity. It is the first major non-budgetary initiative for creating rail transport capacity ahead of demand and on a commercial format. RVNL has been registered as a company under Companies Act 1956 on 24.1.2003. It is a wholly owned Government company under the provisions of Section 617 of Companies Act. Certificate of Incorporation was obtained on 24.1.2003. Rail Vikas Nigam Limited (RVNL) carried out DPR for railway connectivity and Report on the Alternative Railway Alignment for Vizhinjam Railway connectivity.

12.3.8 Legal Consultant

Allen & Overy-Trilegal (Defunct since 2012): It was a partnership between Allen & Overy, an international Law firm, and Trilegal, a law firm based in India. It provided legal advice for sectors such as, infrastructure, energy, technology and IT enabled services, M&A, Capital Markets, Private Equity, capital funds, corporate and commercial disputes, intellectual property and banking. The agreement between Allen & Overy and Trilegal was terminated in 2012. Allen & Overy and Trilegal provided services as Legal Consultant for VISL.

12.3.9 Financial Advisor

SBI Capital: SBI CAPITAL is India's leading investment bank and project advisor, assisting domestic companies fund-mobilisation efforts for last many years. Foreseeing the changing needs of clients in a rapidly opening economy, over the years, it evolved an array of advisory services in almost all sectors of the economy. It provides a full range of Investment, Advisory and Financial Services under one umbrella. A pioneer in privatisation in India, it has established itself as a leader in providing financial and advisory services in the core sector and infrastructure industries. SBI Capital is again a 'wholly owned subsidiary' of State Bank of India. SBI Capital provided services as Financial Advisor for VISL.

Deloitte: "Deloitte" provide audit, consulting, financial advisory, risk management, and tax services to selected clients. These firms are members of Deloitte Touche Tohmatsu Limited (DTTL), a UK private company limited by guarantee. In India, they offer a range of Audit & Enterprise risk, Tax, Consulting and advisory services. Deloitte India's Financial Services Industry (FSI) providing services to firms in Banking, Insurance, Securities, Asset Management, Alternative Investment, Financial Services support as well as Regulators. For the present project they provided Economic Viability and Estimation of Economic Internal Rate of Return (EIRR) for VISL.

BMT consultants BMT (British Maritime Technology): "BMT Consultants (India) Pvt. Ltd. is fully owned subsidiary of the United Kingdom based BMT Limited. BMT is the maritime technology consulting organization provides technical, management and operational services for the worldwide shipping and port industry. BMT Consultants (India) carried out the ship manoeuvring simulation studies to assess the navigational suitability of the proposed layout at Vizhinjam. The simulations took into account the currents, waves, wind and bathymetric data provided by VISL and various other consultants employed by VISL."

EGS Survey Private Limited: First established in the UK, in 1974, the group has set up independent local companies in various countries from Australia to the USA and has strategic alliances with partner companies in various countries. EGS Survey Private Limited (EGS India) is an Indian company, operating under Indian Economy, whose majority ownership rests with WNRT Holding Ltd, Mauritius, which is a part of the EGS Trust based out of the Bahamas. The company is accredited by BSI with Quality Management System standards ISO 9001:2008, ISO14001:2004, OHSAS 18001:2007 & ISO/TS 29001:2010. EGS India provides services in the fields of Hydrography Geophysics, Oceanography and Engineering aspects of Offshore Surveying. EGS India carried out Periodic Survey Report on Current, Wave and Tidal Observations for VISL.

CESS Centre for Earth Science Studies (CESS), GoK: Establishment of CESS in 1978 undertakes studies in the fields of geosciences, environmental sciences, marine sciences and atmospheric sciences. CESS offers consultancy and training service to provide knowledge based support in decision making and in training public about application of earth sciences. CESS efforts are aimed to provide positive choices and actions that will enrich lives and improve better utility of our natural resources and environment, at lowest costs and risks. CESS carried out HTL/LTL demarcation studies as per CRZ Notification 2011 for VISL.

Indian National centre for Ocean information system (INCOIS), GoI: INCOIS is an autonomous organization of the Government of India, under Ministry of Earth Sciences located in the core area of Hyderabad. It provides ocean information and advisory services to the society, industry, government and scientific community through sustained ocean observations and constant improvements through systematic and focused research. Indian Early Tsunami Warning System, Ocean state forecast, ocean modelling, data and web services management are the prime programmes initiated and carried out at INCOIS. INCOIS provide forecasts of Wave height and direction, Sea surface currents, Sea surface Temperature, Mixed Layer Depth, Depth of the 20 degree isotherm (as a measure of thermocline) in addition to value added services like Location Specific forecast, Coastal forecast, Regional forecast, Indian Ocean forecast, Global forecast and Value added services. INCOIS carried out Shoreline Change studies for VISL.



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