TECHNO ECONOMIC FEASIBILITY REPORT FOR DEVELOPMENT OF PORT AT BELEKERI

Techno-Economic Feasibility Report for Development of Port at Belekeri

Prepared for

Ministry of Shipping / Indian Ports Association

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EXECUTIVE SUMMARY

Introduction

To make best use of economies of scale, increased global trade and to achieve efficient management of supply chain, larger sized ships are being built (cape size vessels for moving bulk cargoes) to ply on international routes and as well as Coastal shipping lines. This benefits the cargo owners who have to bear lower freight costs which eventually lead to low cost of final product for the end user. This trend is seen globally and it is envisaged by Ministry of Shipping that all major ports in India shall have infrastructure and equipment's that will be at par with their global peer group.

New Mangalore Port being only deep draft port in the state of Karnataka, shares primary hinterland with surroundings of Dakshina Kannada District and secondary hinterland with districts of North & Central Karnataka mainly where the boom of coal requiring industries viz., power plants and steel & Cement Industries exist. Due to its location, rising environmental concerns and lack of proper connectivity to the secondary hinterland, Mormugao port, Krishnapatnam port, Kamarajar port and Chennai port have been the natural competitors for the cargoes in this region.

To accommodate the deep draft vessels in the port, New Mangalore Port initially had plans to deepen its channel and inner harbour. However due to involvement of rock dredging and associated blasting which involves high cost and interrupts with port activities, there is no plan to deepen the harbour. Therefore, the concept of satellite port for NMP has emerged, which aims at proposal of a Greenfield port along the Karnataka coast that serve the requirements of secondary hinterland cargo of NMP and also over coming constraints of deepening harbour. The development of satellite port in the northern costal Karnataka would be a catalyst in aiding for speeding development of the region by providing the employment opportunities, industrialisation, cheaper end products to user etc.,

Based on the Origin–Destination studies carried out under Sagarmala assignment, it has been assessed that there is a good potential of about 37 MTPA of traffic for coastal movement of thermal coal from eastern region to power plants and steel industries located in the North & Central Karnataka. These industries can be better served by setting up a port on the coastline of north Karnataka. In addition to diversion of traffic, Belekeri port can also build upon the industrial growth of Karnataka, which is considered one of India's most industrialised states, comprising large public sector industrial undertakings as well as privately-owned industries, e.g., steel, sugar and textiles. The state has also evolved as the manufacturing hub for some of the largest public sector industries in India.

It is assessed that the proposed port shall cater to the total traffic volumes of 18 MTPA in Phase 1 and increasing upto 37 MTPA in Master Plan phase (year 2036).

Port Development Plan

It is proposed that the port facilities shall be developed in the phased manner commensurate with traffic growth. Considering that the coal would be the key commodity for the port, it is proposed that port facilities will be able to handle capsize vessels upto 200,000 DWT so as to be in competitive position over Krishnapatnam and Mormugao ports. However the initial phase development is proposed to be limited for Panamax vessels to minimise the initial capital investment and the deepening shall be carried out in for cape size ships in later stages of development.

The proposed port layout comprised of one south breakwater of 4780 m. In Phase 1 development of the port it is proposed to provide 2 Coal berths and 1 Multipurpose berth and the estimated capital dredging for phase 1 development is about 16.4 Mcum and the reclamation quantity is 8.6Mcum. The stacking area for the bulk cargoes has been proposed in the reclaimed area.

State of the art material handling system shall be provided to ensure faster turnaround of ships. The bulk import system shall comprise of four ship unloaders with design capacity of 2,200 TPH, one conveyor stream of 4,400 TPH, four stacker cum reclaimer units and one in motion wagon loader.

Additional berths, equipment and other infrastructure shall be in staged manner till the ultimate stage development added.

The estimated capital cost of Phase 1 port development is Rs. 2,595 crores and additional Rs. 225 crores would be needed for the rail/road connectivity to the port. Phase 1 of port development would have an implementation time of about 4 years.

Assessment and Recommendations

The viability analysis for the project has been carried out considering three alternative models for port development i.e. development by project proponents, by full-fledged concession to private operators and landlord model.

In the project proponent model the project shall be executed by a Special Purpose Vehicle (SPV), which may include NMPT and other government entities. SPV shall arrange funds, manage and operate the port. The IRR for project proponent model works out to 11.5%.

In the second model in which the entire project is given to private developer and costs towards external rail/road connectivity, land acquisition for connectivity and port facilities shall be taken up by the government entities. The project cost of Rs. 2,595 Crores is considered and the IRR works out to 12.4% considering the private entity does not do the revenue sharing with the government.

In the third financial model, SPV shall be responsible for providing the entire basic infrastructure for the port including the external connectivity and land acquisition to the port. The cargo handling terminals and associated facilities shall be developed by PPP operator, who shall be responsible terminal operations & maintenance and also sharing the revenue with the SPV. Limiting the project IRR to 15% for the PPP operator, he can share about 36% of the revenue with the SPV which is overall IRR of 9.9% for SPV. Though the estimated IRR for SPV is low, it can be managed if SPV can manage debt from the international funding agencies. Further if the external rail and road connectivity to the port could be undertaken by NHAI, Railways and IPRCL, the burden on SPV shall reduce.

The thorough analysis of the development of port at Belekeri, it can be concluded that the port has a great potential and can be developed under Landlord model. However, the entire development of port is dependent on the completion of Hubali – Ankola rail line and the current road blocks on its completion need to be removed with active participation from State and Central government. It is also suggested that the proposed Hubli Ankola Rail link be extended till Belekeri as a single project to get synergy and also provide competitive multi-modal transport to the destination.

1.0 INTRODUCTION

1.1 Background

The Sagarmala initiative is one of the most important strategic imperatives to realize India's economic aspirations. The overall objective of the project is to evolve a model of port-led development, whereby Indian ports become a major contributor to the country's GDP.

As shown in **Figure 1.1**, the Sagarmala project envisages transforming existing ports into modern world-class ports, and developing new top notch ports based on the requirement. It also aspires to efficiently integrate ports with industrial clusters, the hinterland and the evacuation systems, through road, rail, inland and coastal waterways. This would enable ports to drive economic activity in coastal areas. Further, Sagarmala aims to develop coastal and inland shipping as a major mode of transport for the carriage of goods along the coastal and riverine economic centres.

As an outcome, it would offer efficient and seamless evacuation of cargo for both the EXIM and domestic sectors, thereby reducing logistics costs with ports becoming a larger economy.

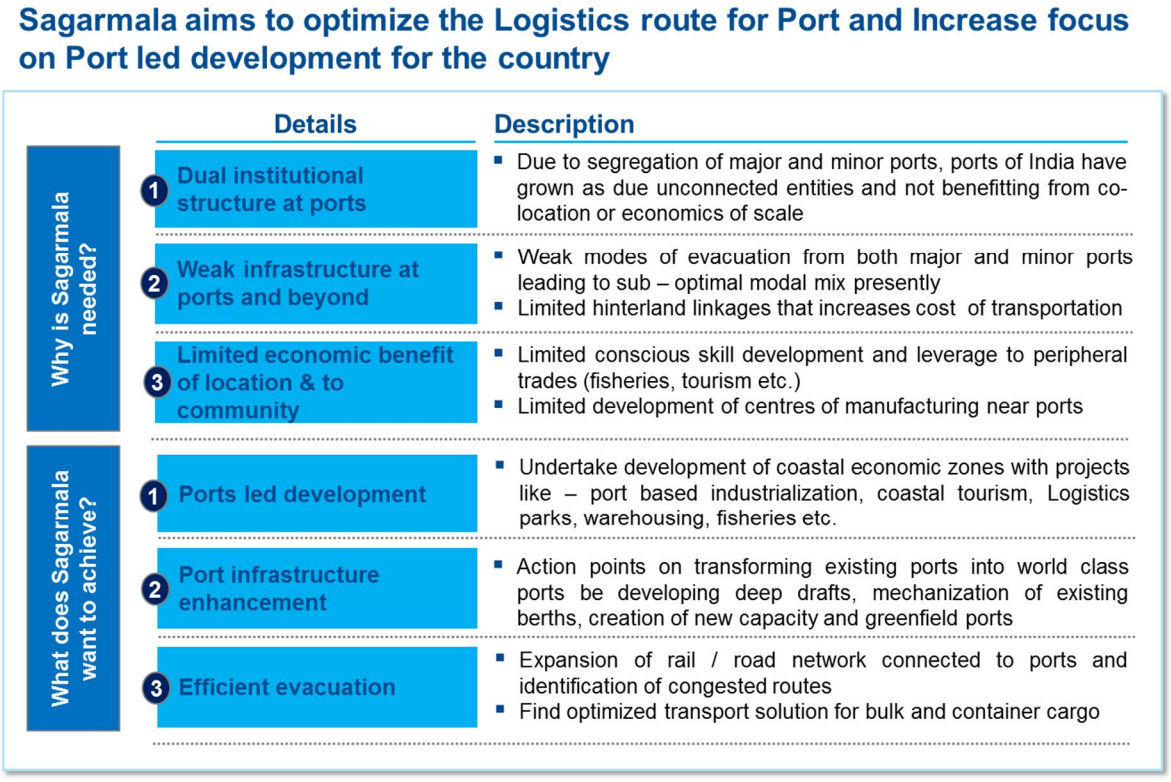


Figure 1.1 Aim of Sagarmala Development

In order to meet the objectives, Indian Port Association (IPA) appointed the consortium of McKinsey and AECOM as Consultant to prepare the National Perspective Plan as part of the Sagarmala Programme.

1.2 Scope of Work

Based on the experience in port-led development, the major engagement challenge to develop a set of governing principles for our approach is shown in **Figure 1.2**:

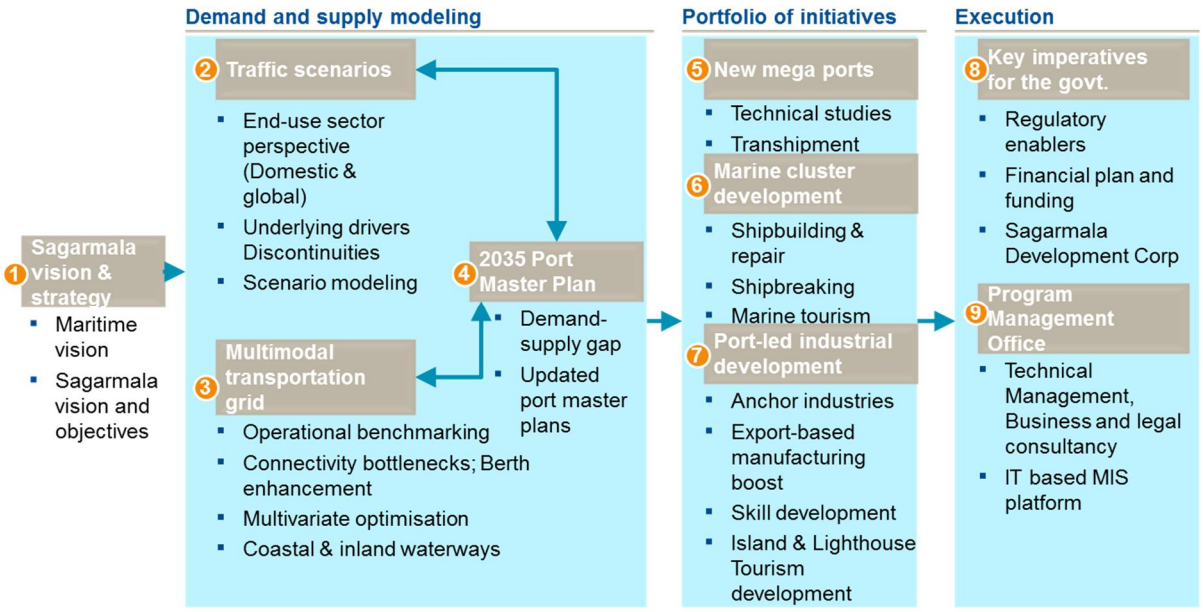


Figure 1.2 Governing Principles of Our Approach

As indicated above, the origin-destination of key cargo (accounting for greater than 85% of the total traffic) in Indian ports shall be mapped to develop traffic scenarios for a period of next 20 years. The forces and developments that will drive change in the cargo flows shall also be identified. This would lead to the identification of regions along the coastline where the potential for the development of Greenfield port or expansion of existing port exists. These regions shall be further evaluated based on the technical, socio-economic and environmental aspects to arrive at the suitable location of a major port.

The scope of the assignment includes the preparation of development/investment plan for at least 5 mega ports sites based on the technical study, traffic scenarios and constraints in existing ports.

1.3 Need for the New Port at Belekeri

As part of the OD study carried out under Sagarmala assignment, it has been assessed that there is a good potential for coastal movement of thermal coal from the mines located in the eastern region (i.e. Mahanadi Coal fields, Talcher, IB Valley etc.) to the power plants located in the western region.

At Central Karnataka power and steel plants have been set up at Kudgi, Bellary etc. which can be best served by a port located along the coastline of north Karnataka. This is however subject to the timely completion of Hubli - Ankola rail line, which will act as a catalyst for the proposed port and the development of the region.

The existing New Mangalore port has draft limitations and also not suitably located to serve the north Karnataka hinterland. It is therefore proposed to develop a Port at Belekeri as a satellite port for NMPT. The present report has been prepared to assess its technical suitability and cost economics.

1.4 Present Submission

The present submission is the Final Techno-economic Feasibility Report for “Development of the port at Belekeri”, Karnataka. This report is organised in the following sections:

Section 1 : Introduction
Section 2 : Site Conditions
Section 3 : Traffic Projections
Section 4 : Design Ship Sizes
Section 5 : Port Facility Requirements
Section 6 : Preparation of Port Layout
Section 7 : Engineering Details
Section 8 : Environmental Settings and Impact Evaluation
Section 9 : Cost Estimates and Implementation Schedule
Section 10 : Financial Analysis and Alternative Means of Project Development
Section 11 : Way Forward

2.0 SITE CONDITIONS

2.1 Alternative Sites along the Coastline of Karnataka

Various alternative sites located between Mormugao port and New Mangalore Port were analysed as shown in **Figure 2.1**.

Figure 2.1 Alternative Sites for Location of Port

All sites have 10 m contour at about 4-5 km; 20 m contour at about 10 to 12 km. These sites were analyzed for the three main criteria comprising of:

- Habitation,
- Connectivity,
- Environmental Concerns

The location plan of each site and the preliminary assessment has been shown in **Figure 2.2** and **Figure 2.3**.

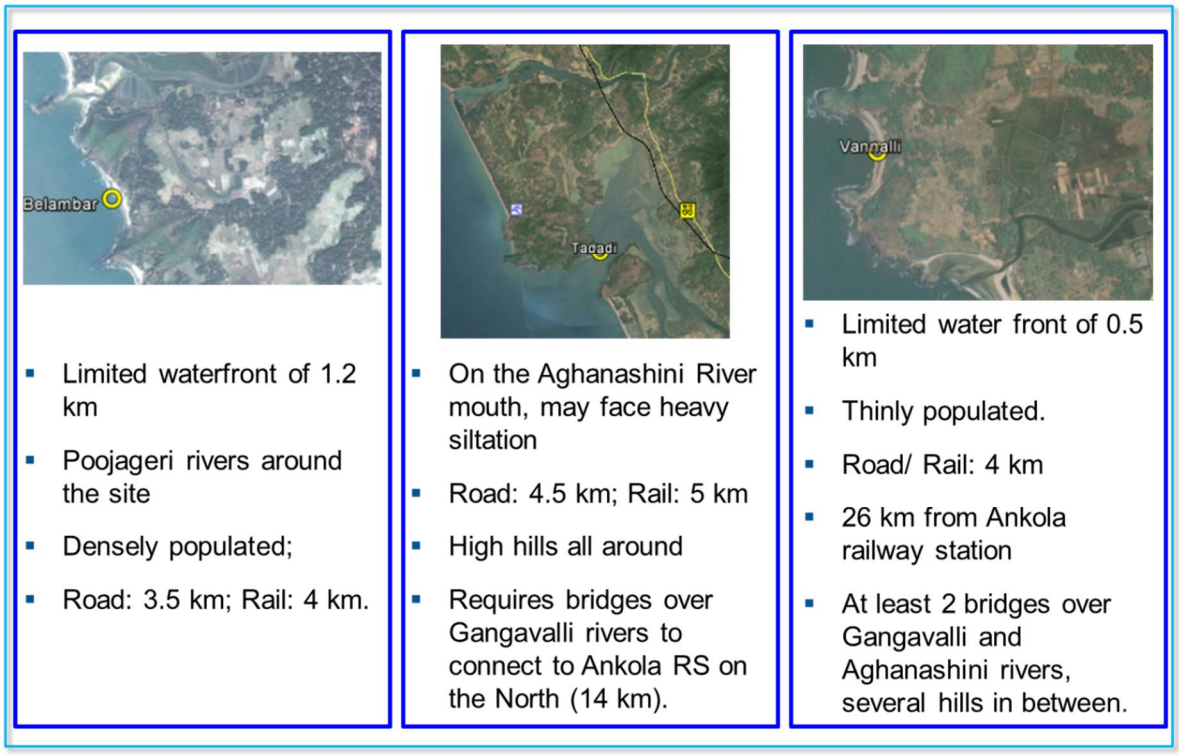


Figure 2.2 Evaluation of Sites (Belambar, Tadadi and Vannali)

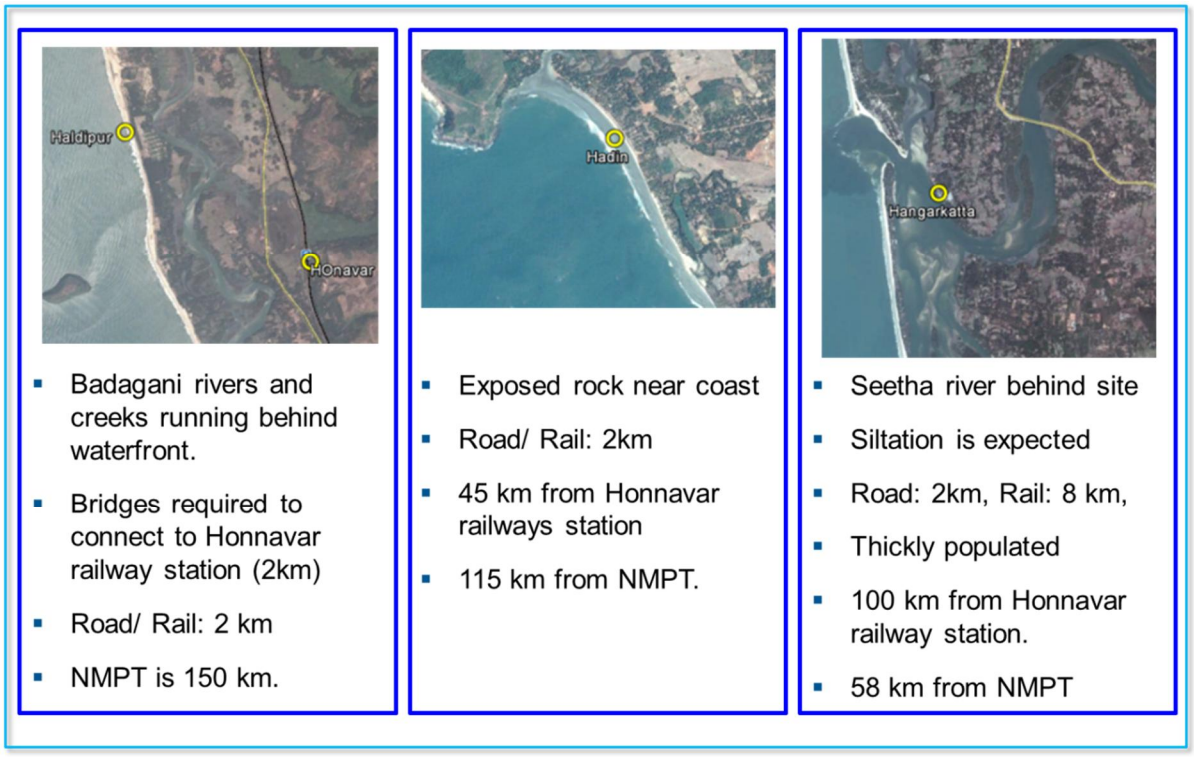


Figure 2.3 Evaluation of Sites (Haldipur, Hadin and Hangarkatta)

Out of these sites, two suitable sites are identified in order of preference Belekeri and Vannali (Kumta Beach). Considering the proximity of Belekeri to the proposed Hubli Ankola rail connection, this site has been shortlisted for the port development.

2.2 Port Location at Belekeri

The proposed site for development of Belekeri port is located in Ankola taluka of Uttara Kannada District of the state of Karnataka. The co-ordinates of the site are 14° 42' N and 74° 15' E (**Figure 2.4**).

The deep water contours are also close to the site and unlike most of the coastal stretch in Karnataka, Bhavikeri has relatively flat terrain. Bhavikeri village is approx. 500-700 m from the coast on the east of the proposed site. A suitable water front of about 2 km is available for port development between fishermen's colony and area earmarked for the Indian Navy (**Figure 2.5)**. Belekeri village is about 3.5 km north of the proposed port site. The backup area required for the Belekeri port development is proposed to be developed reclaiming the land on the coast of Bhavikeri village in Ankola taluka.

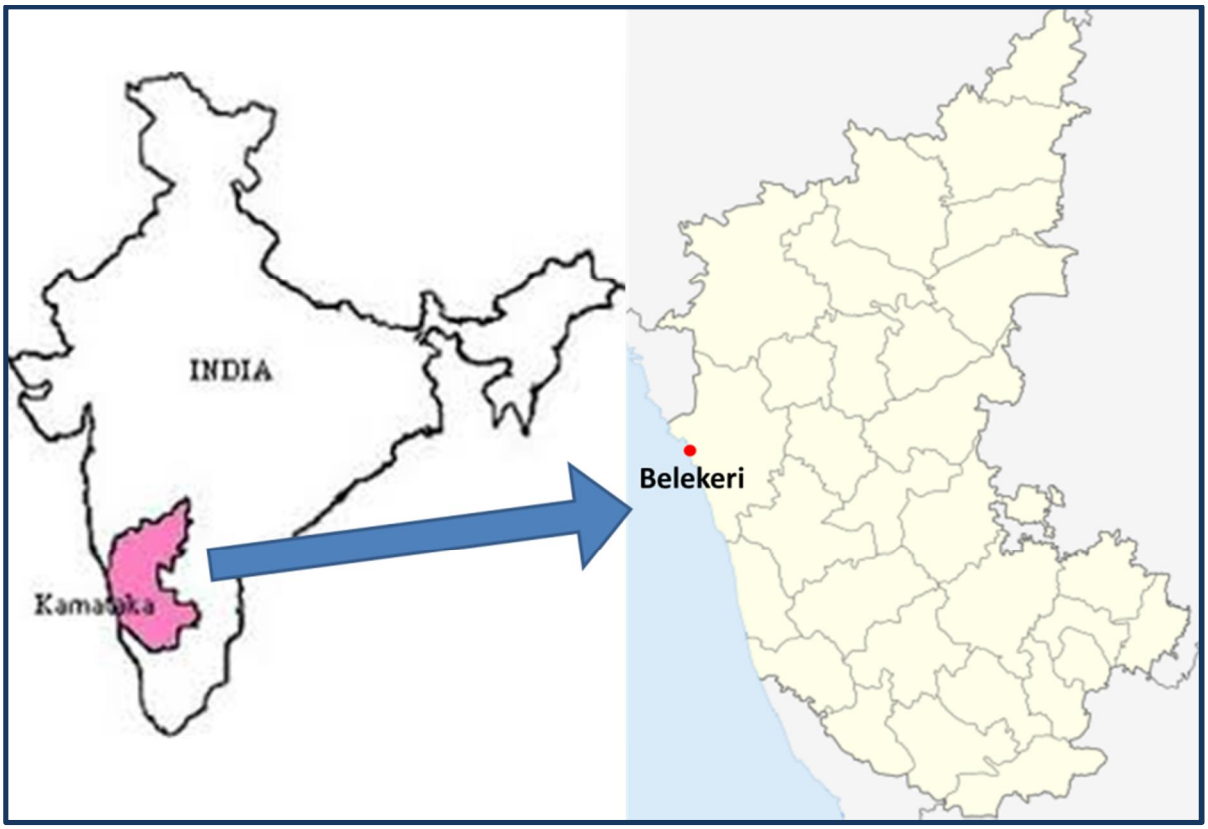


Figure 2.4 Location of Belekeri

Figure 2.5 Location of the Proposed Site

The waterfront identified for port development has a small village Keni in the immediate vicinity, while Bhavikeri village is about 500 m east of the sea coast (**Figure 2.6**).

About 100-120 households were found to be located in the village Keni and a total population of about 2000 has been reported. The villagers are mainly involved in small scale fishing and also agricultural activities.

Rain-fed agriculture activities are prevalent in the area where rice and groundnut are sown predominantly. Other crops that are grown in this area are coconut, Arecanut, Cashew, Banana, Water Melon and other leafy vegetables.

Figure 2.6 Picture Showing Identified Waterfront for Proposed Port

2.3 Meteorological Data

2.3.1 Climate

This region experiences tropical monsoon climate. The meteorological data for Karwar, which is about 35 km north from the proposed site, suggests that weather is hot and humid throughout the year (**Table 2.1**). The area may be broadly classified into four seasons. The temperature start rising from January and gets peaked in May. The summer is from March to May. During this season generally temperature may go up to 39°C.

The monsoon season is from June to September. The rain is fed to the area through South-West monsoon. The area gets 90% of its rainfall in this season. The average rainfall is more than 3000 mm. The period from October to December termed as Post Monsoon season. The period from January to March can be termed as dry season.

Table 2.1 Climatological Table for Karwar Based on Data Between 1961 – 1990

Months	Humidity (%)		Lowest Temp (°C)	Highest Temp (°C)	Monthly Rainfall (mm)	Mean Wind Speed (kmph)
	8:30	17:30				
January	76	62	15.8	36.4	0.4	5.7
February	80	67	16.6	38.1	0.0	6.4
March	79	70	18.6	39.0	0.7	8.0
April	75	70	21.9	38.9	6.4	9.4
May	76	73	22.8	37.3	140.7	11.7

Months	Humidity (%)		Lowest Temp (°C)	Highest Temp (°C)	Monthly Rainfall (mm)	Mean Wind Speed (kmph)
	8:30	17:30				
June	87	82	22.1	35.0	916.7	11.3
July	88	85	22.2	32.1	926.6	14.2
August	89	85	22.3	31.1	671.7	11.4
September	89	82	22.0	32.7	312.1	7.1
October	85	77	20.6	36.4	140.3	5.3
November	75	69	17.7	36.4	31.2	4.6
December	72	62	16.1	36.0	16.8	4.9
Average	81	74	14.8	39.0	3163.5	8.3

[Source: IMD, 2010]

2.3.2 Visibility

Visibility in the region is good throughout the year and is generally greater than 4 km. However, during the rainy season, the visibility is likely to be reduced when the rainfall intensity is high.

2.3.3 Wind

The predominant winds are South-westerly during summer and monsoon period and North-easterly during winter. As per IMD records, wind was found to vary between 4.6 kmph in November and 14.2 kmph during July.

The annual wind rose diagram for Karwar is shown in **Figure 2.7**, showing wind speed for number of hours from a particular direction. The wind speed is more between 0 and 12 kmph for about 1500 hours in a year, while 315 hours it exceeds 12 kmph.

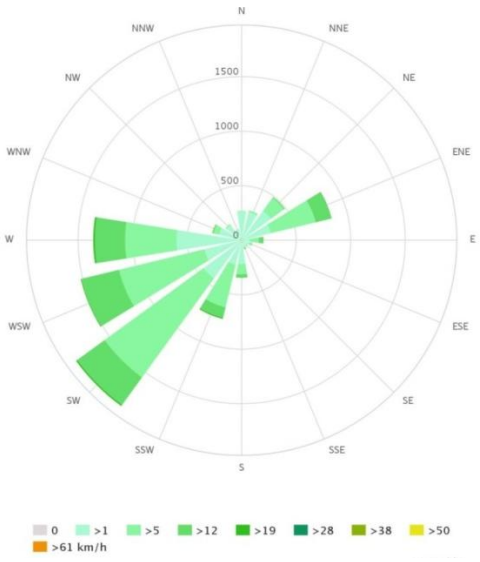


Figure 2.7 Annual Wind Rose Diagram

2.3.4 Cyclones

In general the west coast of India is less prone to cyclonic storms compared to the east coast. From the information reported by India Meteorological Department (IMD), only 25% of the cyclones that develop over the Arabian Sea approach the west coast. It is observed from the tracks of the cyclones in the Arabian Sea from 1877 to 2012 that only one cyclone hit the Uttara Kannada district in a period of 110 years.

2.4 Site Seismicity

Belekeri Port site is in **Zone III** of Indian Map of Seismic zones (IS-1893 Part-1 2002) which is a moderate risk seismic intensity zone.

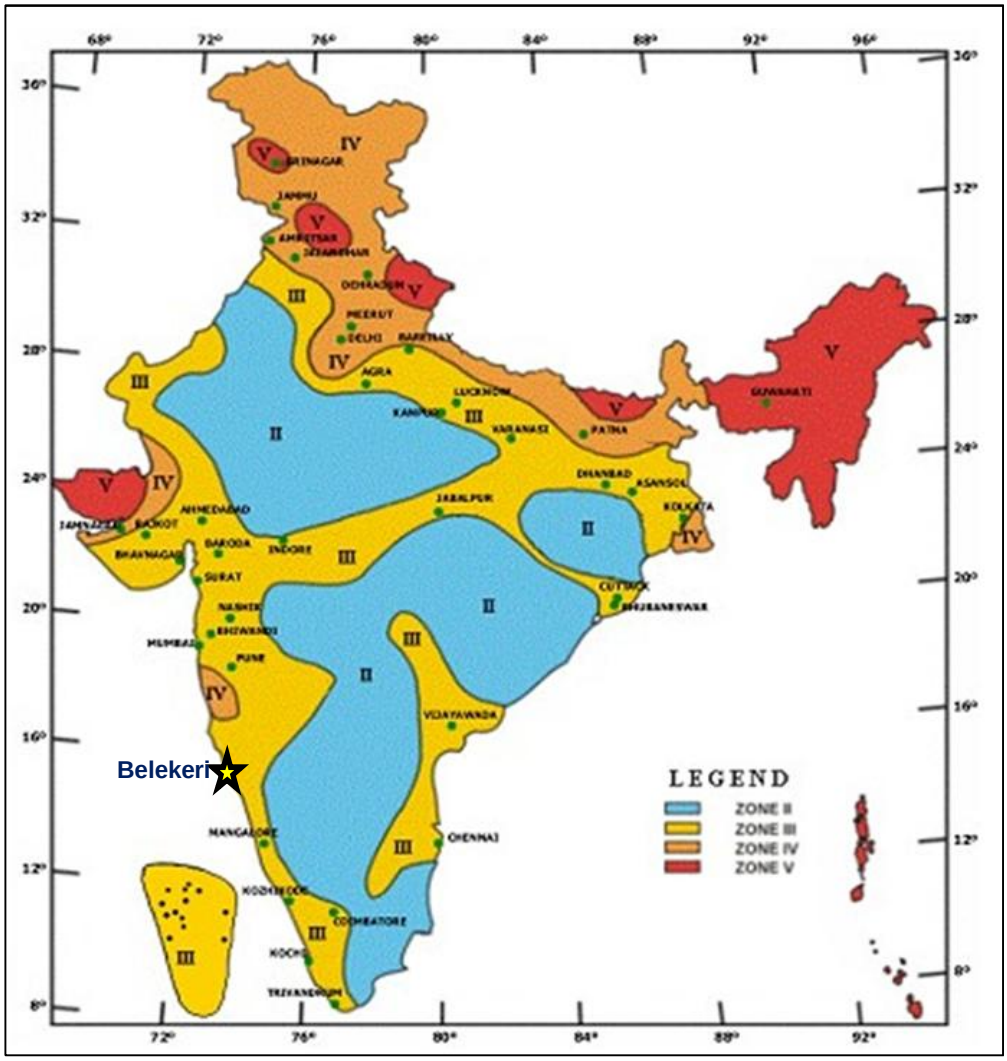


Figure 2.8 Seismic Zoning Map of India as per IS-1893 Part 1-2002

2.5 Oceanographic Information

2.5.1 Tide Levels

The tide at Belekeri is semidiurnal with two high tides and two low tides in a day. The tidal elevations referred to chart datum at Belekeri is as in **Table 2.2**.

Table 2.2 Tide levels

Tidal Datum	Elevation (m, CD)
Highest High Water Spring (HHWS)	+2.13
Mean High Water Springs (MHWS)	+1.90
Mean High Water Neaps (MHWN)	+1.64
Mean Sea Level (MSL)	+1.13
Mean Low Water Neaps (MLWN)	+0.92
Mean Low Water Springs (MLWS)	+0.32
Lowest Low Water Spring (LLWS)	+0.04

2.5.2 Wave Conditions

The west coast of India generally experiences higher wave activity during the Southwest Monsson and relatively clam sea condition during the rest of the year. The waves approach from West and West- South-West during the Southwest Monsoon, West-North-West during the Northwest Monsoon and Southwest during the fair weather. The annual offshore and nearshore rose diagrams is presented in **Figure 2.9**.

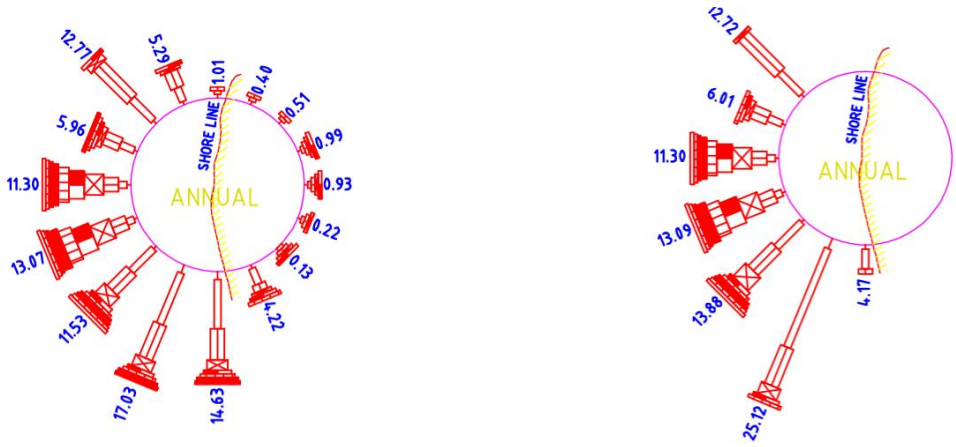


Figure 2.9 Resultant Annual Wave Rose Doagram for Deep and Nearshore Condition

As per the previous records/ database the monthly range of wave height and period are shown in **Figure 2.10**.

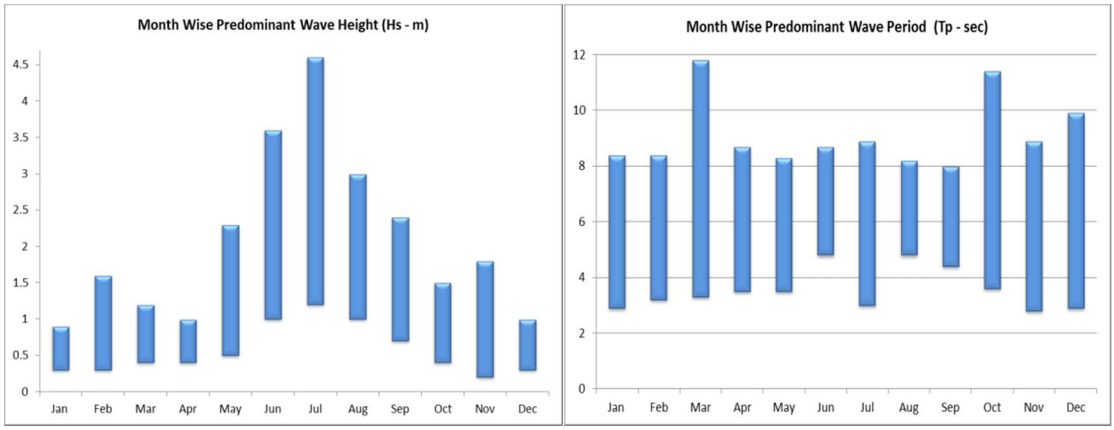


Figure 2.10 Range of Monthly Hs (m) & Tp (s)

2.5.3 Currents

The averaged current speed ranges from 0.1 m/s to 0.54 m/s. The flood currents (0.54 m/s) are stronger in the region as compared to ebb current (0.1 m/s). Currents are generally parallel to the coast, the flood currents are in a north-westward direction during the flood tide and south-eastward direction during the ebb tide.

2.5.4 Bathymetry

Naval Hydrographic Charts as presented in **Figure 2.11** suggests that 5 m contour is at around 2 km while 10 m and 20 m contour are about 6.5 km and 12.5 km from the coast. It is important to mention that the coast both upstream and downstream location to the proposed site is covered with rocks, but as NHC suggest the chosen site does not have dense rock patches except small area at about 1 km from coast on western direction.

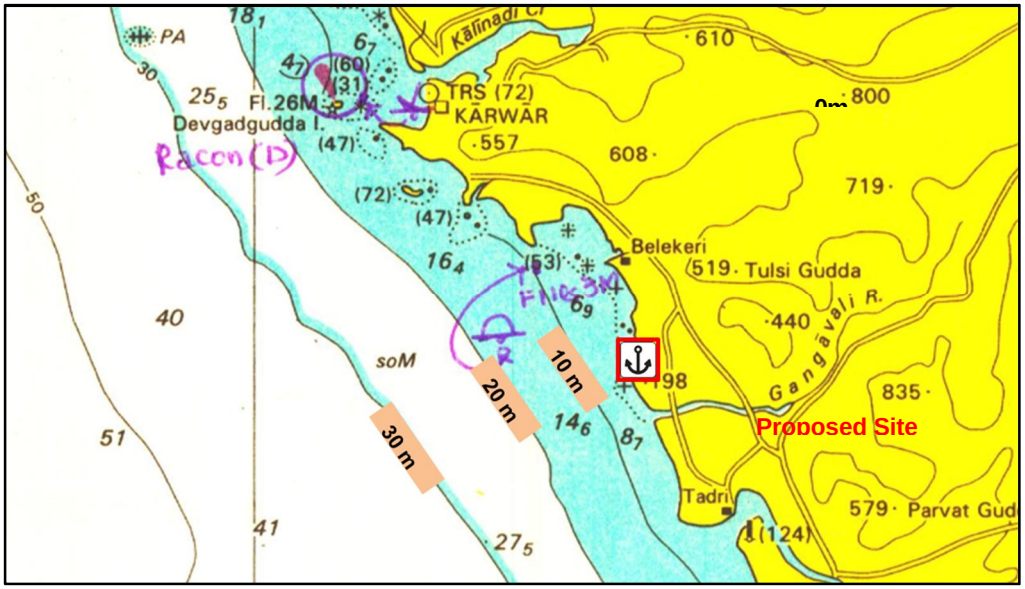


Figure 2.11 Hydrographic Chart of Proposed Port Site [Source: NHO Chart 293]

2.6 Littoral Drift

The longshore sediment transport is observed to be from north to south from March to September and from south to north the rest of the year. The yearly net longshore sediment transport is approximately 70,000 m^3/year southwards.

2.7 Connectivity

The proposed Belekeri Port location is about 3.5 km from Edapally-Panvel or Kochi-Panvel Highway (NH 66) and Konkan Railway Line (**Figure 2.12)**.

Figure 2.12 Belekeri Port w.r.t. Railway and Highway

2.7.1 Rail Connectivity

Konkan railway line is about 4 km from the site. The nearest railway station is Ankola which is about 6.7 km from the site on the SE direction. Harwada railway station is about 8 km on the North of the proposed site.

2.7.2 Road Connectivity

National Highway 66 (earlier known as NH 17) is about 3.5 km from the proposed site (**Figure 2.13**). The site may be reached from NH-66 via Ankola through Dr. Dinkar Desai road and further Keni Beach Road.

Site may also be approached from North through NH 66 via Hattikeri through Belekeri Port Road and thereafter taking a village road through Bhavikeri. This may not be a favourable route for port operations as this road intersects area reserved for Indian Navy.

Conditions of all the connecting roads are shown in **Figure 2.14**.

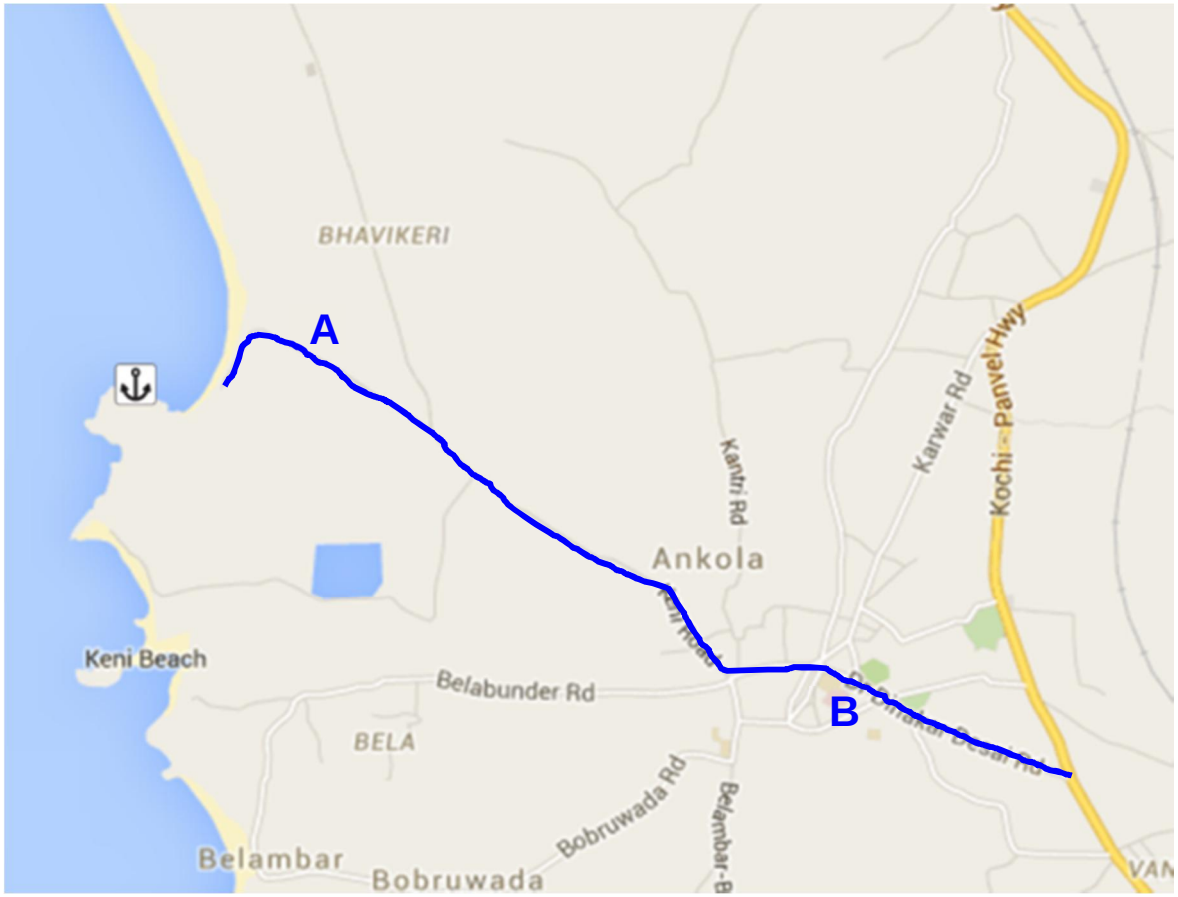


Figure 2.13 Existing Road Connecting to Proposed Site

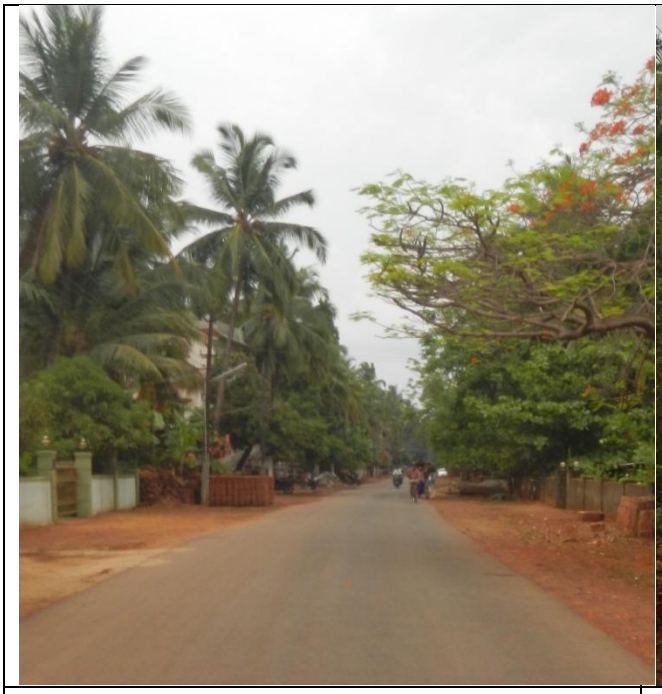
	
Road from Belekeri to Bhavikeri (about 3.5 m); houses, schools, shops on both sides	**A.** Road to Keni village (Project site); kutcha road (3-4 m); agriculture land on both sides
	
B. Dr. Dinaker Desai Road (4 - 5 m) connecting to Keni Village road; 0.7 km stretch; dense commercial establishments and habitation on both sides	Dr. Dinaker Desai Road (7 m) connecting Ankola to NH 17; 1 km stretch; commercial establishments and habitation on both sides

Figure 2.14 Road Connecting to Proposed Port Site

2.8 Water Supply

At present Ankola is being served with piped supply from Honnalli Water Supply Scheme having a capacity of 41 MLD. Water is drawn from river Gangavalli at about 22 km upstream of sea, through submerged intakes and treated with Poly-Aluminium-Chloride for coagulation of organic and mineral colloids prior to sedimentation and/or filtration. After treatment water is stored in two underground tanks of capacity 1 lakh and 2 lakh Gallons respectively. Form this location, water is pumped to another underground tank located at Navagadde having a storage capacity of 6 lakh Gallons.

From this location water is supplied through a 700 mm pipeline to Ankola town, villages, Seabird site at Karwar, Aditya Birla Chemicals limited (Caustic Soda plant) at Karwar. This tank is about 10 km from the proposed port location.

Satellite image showing Honnalli Water Scheme

Intake of Honnalli Water Scheme

Figure 2.15 Honnalli Water Supply Scheme

2.9 Power Supply

A 110/33/11 KV substation is located at Balegulli at Ankola. This substation has 6 feeder lines supplying to Seabird Site at Karwar (2×33 KV), Ankola Area (33 KV), Massikatta (33 KV), Navagadde (11 KV) and a standby feeder of 33 KV to Honnalli Water Supply scheme. This substation is about 4.8 km from the proposed site.

Figure 2.16 Location of Balegulli Substation

2.10 Quarry Sites

Construction of breakwaters requires a large quantity of rock thus it is a prerequisite to identify sources of rock for any port development. During site visit, efforts were taken to identify nearby quarries in the region. The locals reported that most of the quarry sites have been closed after Supreme Court's Judgement banning quarry sites in the forest land without Forest and environmental clearance.

Though, three minor quarries still exist in the region two at Ankola and one near Karwar, which have very limited area and are producing small aggregates only suitable for the local construction activities. Site at Karwar possesses permit for mining till 2017. It was reported that to get further forest clearance for the quarry operations is very difficult as the area has been mapped under Western Ghats.

There is shortage of construction material in the area. It is important to mention that all the required material for Navy's Seabird project has been and will be sourced through the hill cutting falling within the Naval Base. All required permits and clearances were taken by the Navy for hill cutting and quarrying. Widening of NH 17 from 2 lanes to 4 lanes is underway in this region, where all material recovered from their widening operation is used for grading and levelling.

Considering the current situation, new quarry will have to be developed for the rocks required for breakwater construction. This would require identification of quarry area and obtaining Forest and Environmental clearance for the same.

3.0 TRAFFIC PROJECTIONS

3.1 General

The origin-destination of key cargo for port at Belekeri and development of traffic scenarios for a period of 20 years has been carried out by McKinsey & Co. as mandated for this project.

This section covers the traffic projections for the proposed port of Belekeri. The proposed port site of Belekeri lies on the western coast of India in state of Karnataka. It has operational major ports of Mormugao on the north and Mangalore port on the south.

3.2 Major Commodities and their Projections

Thermal coal, iron ore and coking coal would be the key commodities that can be catered to by the proposed port. Each of the possible cargo centres in the hinterland for the proposed port has been mapped to assess whether the proposed port at Belekeri could be a gateway for their traffic. The details are attached in **Table 3.1**.

3.2.1 Thermal Coal

The proposed port has a current potential of attracting attract traffic of ~2.3 MTPA which can go upto 3 MTPA by 2025.

This is based on the assumption that for JSW power, the plant is based on imported coal, mostly handled in Mormugao. The current potential is estimated on the basis of Belekeri being better placed given the shorter distance.

In future, the potential has been estimated assuming plants operate at 80% PLF.

3.2.2 Iron Ore

The port is expected to divert part of the traffic currently handled primarily by Krishnapatnam port. JSW steel currently imports iron ore at Krishnapatnam. There is potential for using Belekeri for importing this cargo. Hence the current potential of port to handle iron ore is around 6.8 MTPA. This traffic could go up to ~9.5 MTPA based on the assumption that capacity of the JSW steel plant increases from 12 to 17 MTPA with the proportion of iron ore imports remaining the same.

Belekeri port would be better placed to handle iron ore moving inbound to Bellary as compared to Krishnapatnam as the distance from Belekeri to Bellary is significantly lesser than the distance between Bellary and Krishnapatnam port. This will result in reduced logistic costs if Belekeri port becomes the primary port to handle iron ore traffic. It is to be noted that this estimation is contingent on the implementation of the proposed rail line between Hubli and Ankola and Ankola and Belekeri port.

3.2.3 Coking Coal

The current potential is estimated to be ~5.7 MTPA as Belekeri port could be better placed to handle coking coal for JSW steel plant currently being received at Krishnapatnam and Mormugao ports. This traffic is expected to go upto 8 MTPA by 2025 based on the assumption that capacity of the steel plant increases from 12 to 17 MTPA.

Table 3.1 OD Analysis for Cargoes at Belekeri Port

S. No.	Customer	Sector	Cargo	Current	Rationale - Current	Future (2025)	Rationale - Future	Direction	Origin / Destination	Distance - Belekri	Closest alternative	Alternative Distance	Potential	2020	2030	2035
1	NTPC Kudgi	Power	Thermal Coal	9.00	Actual current consumption (2014 numbers) - this is presently moving by rail but has potential for being shipped coastally subject to leveraging efficiency of larger vessels (Panamax). If it moves to coastal, Belekeri would be ideally placed to handle this cargo	17.12	This is based on eventual expansion to 4000 MW and a PLF of 80%	Inbound	Hazaribagh	310	Mormugao	320	Medium			
2	JSW Power	Power	Thermal Coal	2.35	This plant is based on imported coal, mostly handled in Mormugao. Belekeri would be better placed given the shorter distance	2.90	This is based on PLF improving to 80%	Inbound	Indonesia / South Africa	332	Mormugao	382	High	2.6	3.7	4.8
3	KPCL Raichur	Power	Thermal Coal	6.00	Actual consumption at current PLF (2014). Currently received partly by rail and partly by coastal shipping via east coast ports (e.g. Krishnapatnam). This potential is based on the assumption that the entire cargo shifts to coastal and Belekeri being the preferred unloading port for coal	7.40	This is based on PLF improving to 80%	Inbound	Chandrapur	461	Krishnapatnam	482	Low			
4	KPCL Bellary	Power	Thermal Coal	2.60	Actual consumption at current PLF (2014). Currently received partly by rail and partly by coastal shipping via east coast ports (e.g. Krishnapatnam). This potential is based on the assumption that the entire cargo shifts to coastal and Belekeri being the preferred	9.10	This is based on PLF improving to 80% and commissioning of ongoing 700 MW Unit taking total upto 1700 MW	Inbound	Chandrapur	334	Mormugao	396	Medium			
5	JSW Steel	Steel	Iron Ore	6.68	Iron ore is currently imported via Krishnapatnam. There is potential for using Belekeri for importing this cargo	9.46	This is based on the assumption that capacity of the steel plant increases from 12 to 17 MTPA with the proportion of iron ore imports remaining the same	Inbound	Australia	332	Mormugao	382	High	8.07	12.61	16.80
6	JSW Steel	Steel	Coking Coal	5.68	Coking coal is received via Mormugao and Krishnapatnam ports. Belekeri could be well placed to handle this traffic	8.05	This is based on the assumption that capacity of the steel plant increases from 12 to 17 MTPA	Inbound	Australia	332	Mormugao	382	High	6.86	10.72	14.28
7	Bellary Hospet Cluster	Iron Ore	Iron Ore	0.15	Iron ore exports from Bellary Hospet were as high as 10 MTPA but due to mining bans and sluggish global demand, the volumes have dropped dramatically. About 0.1 to 0.2 MTPA of iron ore are still being handled by Chennai which could shift to Belekeri	1	This is based on partial lifting of iron ore mining ban in the Bellary Hospet region	Inbound	East Asia	332	Krishnapatnam	482	Low			
8	Hubli ICD	Manufacturing	Container	0.3	The Hubli area generated about 16,000 TEU of traffic which has been taken at 15 tons/TEU. Other regions around north Karnataka account for the balance	0.51	This has been projected at a rate of 5%. However if industrialization led by Bengaluru Mumbai Industrial corridor kicks in, the growth rate could be higher	Bidirectional	Global	131	Mormugao / JNPT	188/561	High	0.38	0.62	0.80
9	Coastal Fertilizer	Consumption	Fertilizer	0.25	Karnataka receives substantial volumes of fertilizers from key manufacturing states such as Andhra Pradesh and Tamil Nadu. A part of this has been assumed for coastal shipping potential. In turn about half of this has been considered for Uttara Kanara region which Belekeri can handle	0.43	This has been projected at a rate of 5%	Inbound	Coastal States	NA	Mormugao	NA	Medium	0.32	0.52	0.66
10	Coastal Cement	Consumption	Cement	0.5	There is potential for cement manufactured in Malkhed-Wadi-Gulbarga district can be potentially shipped to some coastal states instead of using rail. The movement from this cluster to Kerala has been considered under this head	0.86	This has been projected at a rate of 5%	Outbound	Kerala	NA	Mormugao	NA	Medium	0.64	1.04	1.33
11	Coastal Foograins	Consumption	Foodgrains	0.67	Karnataka receives substantial volumes of foodgrains from northern states and Gujarat. A part of this has been assumed for coastal shipping potential. In turn about half of this has been considered for Uttara Kanara region which Belekeri can handle	1.15	This has been projected at a rate of 5%	Inbound	Coastal States	NA	Mormugao	NA	Medium	0.86	1.39	1.78
12	Other cargo			1.71	Other cargo is considered at 5% of all the above traffic items	5.80	Other cargo is considered at 5% of all the above traffic items	Bidirectional		NA	Mormugao	NA	Medium			

The overall commodity wise projections for the port are as shown below.

Table 3.2 Belekeri Traffic Projection

S. No.	Cargo	I/E	2020	2025	2035
	Dry Bulk				
1.	Thermal Coal	I	2.6	2.9	4.8
2.	Coking Coal	I	6.9	8.0	14.3
3.	Iron Ore	I	8.1	9.5	16.8
	Containers				
4.	Total in TEUs	I/E	25,500	34,000	53,000
	Total in MT		0.38	0.51	0.80
	Total Traffic (MTPA)		**17.93**	**20.92**	**36.68**

3.3 Potential Trade and Development Opportunities for Belekeri Port

3.3.1 General

Above section provides the estimated cargo at the port that is certain if a port is established at Belekeri. In addition to diversion of traffic, Belekeri port can also build upon the industrial growth of Karnataka. The state is considered one of India's most industrialised states, comprising large public sector industrial undertakings as well as privately-owned industries, e.g., steel, sugar and textiles. The state has also evolved as the manufacturing hub for some of the largest public sector industries in India.

3.3.2 Hinterland Development

Some of the industrial sectors in Karnataka that might have implication on port traffic are:

- **Telecommunications and Electronics:** Karnataka has excellent telecom infrastructure with 140 of its 170 towns connected by Optic Fibre Cables (OFC) network. The districts of Hassan, Tumkur, Mysore, Mangaluru and Shimoga are the other new destinations that promote electronics and hardware industries.

- **Automotive:** Karnataka has a vibrant auto industry with investments of around USD 713 mn and annual revenues of USD 604 mn. The sector grew at a CAGR of 15 per cent from 2009 to 2014. The main locations for automobile industries are Bengaluru, Ramanagara, Kolar, Shimoga, Dharwad and Belgaum. It also has three auto clusters, one industrial valve cluster and one auto component cluster. Two manufacturing hubs are being developed in the Narsapur and Vemagal industrial areas in Kolar District.
- **Textiles:** Karnataka contributes over 20 per cent of the national garment production and 45 per cent of the national raw silk production. It is a major apparel sourcing destination for the global market. It is one of the leading producers of the key raw materials required for textile manufacturing units. According to the New Textile Policy 2013–18, the Karnataka government is planning to invest USD 1,650 mn in the sector.
- **Aerospace:** The state has been seen as the pioneer in the Indian aerospace industry. The state government plans to invest around USD 1.7 bn to develop an aerospace park. Further investment potential of USD 12.5 bn in this sector in the period from 2013 to 2023 has been identified and there are plans to develop aerospace clusters in different regions of the state.
- **Chemicals and Petrochemicals:** Karnataka has been trying to position itself as a major growth centre for the chemical industry with the presence of around 500 companies, such as MRPL and BASF. Mangaluru is evolving as the focal point of all chemical and petrochemical industries in the state.

3.3.3 Major Exports

Karnataka has a long tradition of overseas trade. While it has historically been a major exporter of coffee, spices, silk, cashew nuts and handicrafts, over the last two decades it has emerged as a major exporter of commodities such as electronics and computer software, engineering goods, readymade garments, petrochemicals, gems and jewellery, agro and food processing products, chemicals, minerals and ores and marine products.

As of 2014–15, total exports from Karnataka reached around USD 52.02 bn, approximately 13.01 per cent of India's total exports. The state's exports increased at a CAGR of 9.4 per cent from 2010–11 to 2014–15.

Some of the exports that can have impact on traffic at ports are –

- The engineering segment is the fastest growing sector of the state, seeing a 21.3 per cent CAGR growth between 2010–11 and 2014–15. Exports of engineering products increased from USD 1,605 mn in 2010–11 to USD 3,476.8 mn in 2014–15. The state is exporting engineering products to Germany, China, South Korea, Brazil, the US, Malaysia, Thailand, South Africa and Singapore. Exports include machine tools, industrial machinery, cutting tools, castings, automotive components, electrodes, welding equipment, construction and earthmoving equipment, and helicopter spares.
- Karnataka leads in the exports of silk in India accounting for approximately 25 per cent of the total Indian export market.
- Export of agriculture and processed food in the state grew at a CAGR of 11.8 per cent between 2010–11 and 2014–15. The export value increased from USD 146.9 mn in 2010–11 to USD 229.4 mn in 2014–15.

4.0 DESIGN SHIP SIZES

4.1 General

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

- The trading route
- Availability of a suitable ship in the market
- Available facilities mainly navigational channel and manoeuvring areas including the draft
- The available facilities for loading & unloading
- Volume and type of annual traffic to be handled and the likely parcel size as per the requirements of the users.

The following main cargo commodities for the proposed Belekeri have been identified as:

- Thermal/ Coking Coal
- Iron Ore
- Containers

4.2 Dry Bulk Ships

Dry Bulk as Coal and Iron ore are the main cargo commodities that are proposed to be handled at the proposed Belekeri Port. While selecting the design ship size, in addition to ascertaining the freight advantage of larger vessels, it is essential to study the origin/destination ports and the facilities available there for handling large carriers.

For dry bulk cargo, carriers are generally classified into the following groups:

Handysize	:	10,000–40,000 DWT
Handymax	:	40,000–60,000 DWT
Panamax	:	60,000–80,000 DWT
Cape	:	80,000–120,000 DWT
Super cape	:	Over 120,000 DWT with the largest carrier being 400,000 DWT

Coal and Coking coal is to be imported to the area, for which Panamax vessels for the immediate phase and Cape size are considered for the year 2035. For Iron Import, Panamax size vessels are recommended for all the phases.

4.3 Container Ships

Container ships are classified into six broad categories viz. Feeder, Feedermax, Handy, Sub-Panamax, Panamax and Post-Panamax. The following table, which has been compiled through data from the Shipping Register of Lloyds Fairplay database, gives a broad outline of the principal dimensions of the ships under the different categories. The **Table 4.1** gives the dimensions of the smallest and the largest ship in each category. This will help in planning the layout of the container terminal and the other facilities.

Table 4.1 Dimensions of the Smallest and Largest Ship

Parameters	1000 TEU	2000 TEU	4000 TEU	6000 TEU	9000 TEU
Nominal Capacity	1000	2000	4000	6000	9000
LOA (m)	160	200	290	320	350
Beam (m)	22	32	32	42	45
Loaded Draft (m)	10.0	11.0	13.5	14.0	15.0

[Source: Lloyds Fairplay Database]

4.4 Design Ship Sizes

Since the dimensions for any class vary between designs, there are no definitive dimensions for any particular vessel capacity. The principal dimensions of the ships considered for the preparation of the layouts and design of marine structures for the proposed Belekeri port are presented in **Table 4.2**.

Table 4.2 Parameters of Ship Sizes

Commodity	Design Ship Sizes (DWT)	Maximum Parcel Size (T)	Overall Length (m)	Beam (m)	Loaded Draft (m)
Coal	80,000	55,000	240	32	14.5
	120,000	80,000	260	40	16.5
	200,000	100,000	300	50	18.5
Containers	1000 TEUs	500 TEUs	160	22	10.0
	4000 TEUs	1,200 TEUs	290	32	13.5

5.0 PORT FACILITY REQUIREMENTS

5.1 General

The layout of any port will be based on the requirements in terms of number of berths, navigation aids, material handling equipment, storage area for each type of cargo, road and rail access for the receipt and evacuation of cargo, and other utilities. These requirements have to be worked out for development in a phased manner to enable preparation of the port's master plan.

The vessel size for Phase 1 needs to carefully chosen so that the capital investment commensurate with the traffic forecast. Accordingly, it is proposed to consider the following options for phasing of port:

1. Initial development for panamax size ships having draft of 14.5 m.
2. Initial development for cape size ships of draft up to 18.3 m
3. Initial development for Panamax size ships and deepening of the channel and harbour basin to handle cape size ships in phase-wise manner as per the market demand.

Considering that the dry bulk would be the key commodity for the proposed port, it is important that Phase 1 port facilities are able to handle the Panamax ships. Thermal coal is one of the key commodities for this port which moves through coastal shipping. Most of the quantity for this commodity is likely to be moved through panamax size ships and therefore it would make sense to limit the initial phase development for Panamax size ships only. Also, the other dry bulk expected to the port is the imported coking coal and iron ore which can be handled in panamax as well as capsize vessels. However, the projections for iron ore and coking coal, which shall be imported, being significant, there is a case for developing this port for cape size ships so as to be in a completive position vis a vis Krishnapatnam and Mormugao ports against which the proposed port shall be competing.

5.2 Berth Requirements

5.2.1 General

The required number of berths depends mainly on the cargo volumes and the handling rates. While considering the handling rates for various commodities it must be ensured that they are at par or better as compared to the competing facilities so as to be able to attract more cargo. Allowable berth occupancy, the number of operational days in a year and the parcel sizes of ships are other main factors that influence the number of berths.

5.2.2 Cargo Handling Systems

Considering the project throughput and the competiveness requirements, the handling systems assumed for various commodities are described below:

5.2.2.1 Dry Bulk Import

It is proposed to provide a common facility with the fully mechanised handling system for dry bulk imports like thermal and coking coal, iron ore etc. The system comprises of gantry type unloaders at berth, connected conveyor system from berth to yard, stacker and reclaimer at yard and wagon loading system.

5.2.2.2 Breakbulk and Containers

For containers, it is proposed to be handled through mobile harbour cranes with spreader arrangement. For handling at the container yard, suitable number of Rubber Tyred Gantry Cranes (RTGCs) shall be provided. At the railway yard reach stacker shall be provided for loading and unloading of rakes.

5.2.3 Operational Time

Considering that the port is planned as all-weather port, the effective number of working days is taken as 350 days per year, allowing for 15 non-operational days due to weather. Further, it is assumed that the port will operate round the clock i.e. three shifts of eight hours each. This results in an effective working of 20 hours a day.

5.2.4 Time Required for Peripheral Activities

Apart from the time involved in loading / unloading of cargo, additional time is required for peripheral activities such as berthing and de-berthing of the vessels, customs clearance, cargo surveys, positioning and hook up of equipment, waiting for clearance to sail, etc. An average of 4 hours per vessel call has been assumed for these activities.

5.2.5 Allowable Levels of Berth Occupancy

Berth occupancy is expressed as the ratio of the total number of days per year that a berth is occupied by a vessel (including the time spent in peripheral activities) to the number of port operational days in a year. High levels of berth occupancy will result in bunching of ships resulting in undesirable pre-berthing detention.

In order to be competitive, it is important that the ships calling at the port should have minimal pre-berthing detention. At the same time the investment at the port infrastructure has to be kept at optimal level. Keeping these in consideration it is proposed to limit berth occupancy of 60% for 1 berth and that 65% for 2 berths for similar commodity. This shall reduce the pre-berthing detention of ships and offer reduced logistics cost to the shippers.

5.2.6 Berths Requirements for the Master Plan

Based on the above criteria, the berth requirements for different cargo have been worked out. A summary of the estimated berths over master plan horizon is presented in **Table 5.1** below:

Table 5.1 Estimated Berths at the Belekeri Port Based on Traffic Forecast

S. No.	Commodity	Total Berths Needed		
		2020	2025	2035
1.	Bulk	2	2	3
2.	Multipurpose cum Container Berth	1	1	1
	Total Berths	**3**	**3**	**4**

5.2.7 Port Crafts Berth

For the initial stage development, the port would require 4 tugs (3 operational + 1 standby) with a capacity of 50 T bollard pull, 2 pilot launches and 2 mooring launches.

It is proposed to utilise the approach bund area for berthing of port crafts initially. An exclusive berth for the port crafts could be provided in the later phases.

5.2.8 Length of the Berths

Length of a single berth for a commodity depends on the LOA of the largest vessel of that commodity expected to use that berth. However, in case of multiple berths of a same commodity it is possible to optimise the total length based on the average LOA of the ships visiting that berth.

The proposed berth lengths for different design ships are presented in **Table 5.2** below.

Table 5.2 Berth Length

Berth Type	Design Ship Size	Design Ship's LOA	Minimum Berth Length
Coal/ Iron Ore Berths	80,000 DWT	240 m	290 m
	120,000 DWT	260 m	310 m
	200,000 DWT	300 m	350 m
Multipurpose/ Container Berths	1,000 TEUs	160 m	210 m
	4,000 TEUs	290 m	340 m

5.3 Storage Requirements

The storage requirement at port for a particular commodity is mainly determined by the dwell time of the cargo at port. It is a common practice to assume a dwell time of;

- 30 days for imported bulk cargo,
- 30 days for Break bulk cargo,
- 5 days for containers on an average.

It should also be ensured that the storage capacity at the port for a particular cargo is at least 1.5 times the parcel size so as to allow faster turnaround of the ship.

Other factors to be taken into account in determining the size of the storage areas are stacked densities, angle of repose, maximum and average stacking height, aisle space, reserve capacity factor, peaking factor, etc.

Based on the above criteria the storage areas have been worked out for various cargos. The Phase 1 storage area works out to about 24 Ha increasing to 49 Ha over the master plan horizon.

5.4 Buildings

Sufficient buildings as per their functional requirements shall be provided in the port area. The following buildings are generally envisaged:

5.4.1 Terminal Administration Building

It will be a 4 storied building housing the following:

- Administrative offices of various operational departments including documentation space
- Canteen
- First aid post
- Central control room for terminal operations
- A VIP floor on top floor to have an overall view of the terminal

5.4.2 Signal Station

A signal station with radar and VHF communication facilities will be provided at a suitable location near the water front to communicate with the ships calling at the port and control their movements.

5.4.3 Customs Office

An office building inside the port area at an appropriate location to accommodate the customs officials who are required to inspect the ships and give clearance for movement of cargo in and out of the bonded area.

5.4.4 Gate Complex

This will be a single storied building for security personnel and shall be provided near the port entrance.

5.4.5 Substations

Substation is envisaged to be provided for the proposed bulk terminals, apart from the main receiving substation at the terminal boundary.

5.4.6 Worker's Amenities Building

This shall provide locker and store rooms. It will also include bath and lavatory facilities. Separate buildings for container and bulk terminals are envisaged.

5.4.7 Maintenance Workshops

This shall comprise of a workshop plus store room, and an annex building to provide space for offices of the workshop foremen, mechanics, electricians, technicians and the storekeepers and rooms for off duty operational personnel and maintenance labour.

5.4.8 Other Miscellaneous Buildings

The following miscellaneous buildings shall also be provided in the port area:

- Fire Station to house firefighting equipment, fire tenders, etc.
- Dispensary buildings to be located near the operational areas and provide minimum first aid services.
- Other miscellaneous utility sheds as per requirements of a particular terminal
- Port Users Building for allocation to Banking, C&F Agents' offices
- A fuelling station shall be provided to cater to the requirements of ITV's and other vehicles used.

5.5 Receipt and Evacuation of Cargo

5.5.1 General

For the efficient functioning of a port, the essential pre-requisite is the rail and road connectivity for the effective movement of cargo in and out of the port.

Based on the market assessment and the infrastructure constraints, it is envisaged that the key cargo shall follow the evacuation pattern from Belekeri port, as shown in **Table 5.3:**

Table 5.3 Evacuation Pattern for Various Cargo

S. No.	Commodity	2020		2025		2035	
		Road Share	Rail Share	Road Share	Rail Share	Road Share	Rail Share
		%	%	%	%	%	%
1.	Thermal Coal	0%	100%	0%	100%	0%	100%
2.	Coking Coal	0%	100%	0%	100%	0%	100%
3.	Iron Ore	0%	100%	0%	100%	0%	100%
4.	Containers	100%	0%	100%	0%	100%	0%

5.5.2 Port Access Road

The port would need to be connected to national highway for evacuation of the cargo by at least a 4 land road initially. The width of the road shall be increased to 6 lane once the throughput picks up.

5.5.3 Rail Connectivity

The port shall be connected to the nearest rail link for effective evacuation of cargo.

5.6 Water Requirements

Water would be needed at the port for use of port personnel, dust suppression, firefighting and miscellaneous uses.

It is estimated that the average water requirement for the initial phase development will be around 1.0 MLD increasing to about 1.90 MLD in the master plan phase.

5.7 Power Requirements

HT and LT power supply at the port would be required for Handling Equipment, Reefer stacks, Lighting of the Port Area, Offices and Transit Sheds etc.

The electrical load demand for the proposed port for the initial phase development is about 13 MVA increasing to about 19 MW in the master plan stage. The major requirement is on account of the proposed mechanised cargo handling system at bulk berths.

5.8 Land Area Requirement

Large backup area has always been a prime requirement for major port development anywhere in the world. Therefore, especially in the case of a completely new port it will be prudent if a large area is specifically reserved for the long term development of the port, so that the port facilities which are so vital to the growth of the Nation can be developed easily to cater to its growing needs.

The minimum land area required for the purpose of cargo handling, storage, port operations, rail and road connectivity, greenery etc. has been worked out as shown in **Table 5.4** below:

Table 5.4 Minimum Land Area Requirement for Belekeri Port

S. No.	Commodity	Land Allocation over Master Plan Horizon (sqm)		
		2020	2025	2035
1.	Storage Space for various Cargoes	240,240	279,511	485,917
2.	Internal Roads and Circulation Space within Port @ 25%	60,060	69,878	121,479
3.	Port Building Complexes including parking	20,000	30,000	50,000
4.	Landscaping, Green belt and other for Expansion	105,699	125,198	216,941
5.	Rail and Road Corridor	530,000	530,000	530,000
	Minimum Land Area (Sqm)	**955,999**	**1,034,587**	**1,404,337**
	Minimum Land Area (Hectares)	**96**	**103**	**140**

The master plan details have been worked out based on traffic studies only up to 2035. However, ports are normally planned for 50 to 70 years of growth and hence there is need to provide at least another 100% excess over the area requirement assessed for the year 2035.

6.0 PREPARATION OF PORT LAYOUT

6.1 Layout development

The key considerations that are relevant for the establishment of a Greenfield port and its layout are given below:

- Potential Traffic;
- Techno-economic Feasibility;
  - Design ship size
  - Geotechnical Characteristics at site
  - Protection from waves and swell to create tranquillity at berths
  - Availability of material for Reclamation and Breakwater construction
  - Adequate manoeuvring area and Channel for the design ships
  - Scope for expansion beyond the initial development
  - Suitability for development in stages
  - Optimum capital cost of overall development and especially of initial phase
  - Flexibility to Expand Beyond Master Plan Horizon
- Land Availability;
  - Availability of adequate back-up land for storage of cargo and port operations
  - Rail and Road Connectivity to the Hinterland
- Environmental issues related to development.

6.2 Brief Descriptions of Key Considerations

The following sub-sections briefly discuss the relative importance and implication of each of the above factors in relation to the Greenfield port development at Belekeri.

6.2.1 Potential Traffic

The potential traffic that a new port could attract forms the first and foremost requirement of the project. Considering the site conditions and initial investment needed for creation of the basic port infrastructure, the projected traffic for the initial phases of development would govern the viability of port at Belekeri.

6.2.2 Techno-Economic Feasibility

6.2.2.1 Design Ship Size

The selection of design ship size is a key input for the port development as the required depths and the size of the navigational and manoeuvring area of the harbour as well as the cargo handling infrastructure are dependent on this. The ship size has direct implication on the cost of the port development and therefore has impact on the viability. As indicated previously the proposed port has to compete with the existing Krishnapatnam and Mormugao Ports, both having capabilities (or under execution) to handle cape size ships, it must be able to cater cape size ships at least in the later stage of development if not in Phase 1. The initial stage of development it should at least be able to handle panamax ships size of 80,000 DWT.

6.2.2.2 Geotechnical Characteristics of the Site

The geotechnical characteristics of the site could be a key factor in capital cost of port development. The rock levels at the site will impact the selection of marine layout because of the potentially very high cost of dredging in rock. Similarly very soft soil at the location would also have impact on capital cost as ground improvement works will have to be resorted to support the structures. Based on the site information rocky outcrop is observed close to the shore and therefore harbour area has to be located at a suitable distance away from shore.

6.2.2.3 Protection from Waves and Swell

The location of the port has to be evaluated in terms of the shelter available from the direct attack of waves. The locations which are in naturally protected zones do not require expensive breakwaters for protection from waves for round the year operations. The ports along the west coast are subject to waves from SW direction during southwest monsoons. North east monsoon has least impact in this region. The orientation of the breakwaters would need to be decided accordingly.

6.2.2.4 Availability of Construction Material

Transportation cost of the borrowed fill and rock from longer distance forms the major component of the overall cost of reclamation and breakwater. The availability of these materials at a nearby location is favourable to economise the capital cost of port development. During the site visits, as discussed in section 2.10, most of the quarry sites have been abandoned after Supreme Court's Judgement banning quarry sites in the forest land without Forest and Environmental Clearance. New quarry sites need to be developed for sourcing the material required for breakwater construction and reclamation. This would require identification of quarry area and obtaining Forest and Environmental clearance for the same.

6.2.2.5 Adequate Manoeuvring Area and Channel for Design Ships

This consideration requires provision of adequate channel width, stopping distance and the manoeuvring area for the design ship, as per the best international practices. The potential of marine accidents of the ships hitting the berth structure and approach trestle should be eliminated. The width of the channel would be based on the design ship size as well as requirement for one way or two way channel.

6.2.2.6 Scope for Expansion Over the Initial Development

With the costly basic infrastructure like breakwater, dredged basin, channel, hinterland connectivity in place, addition of more berths will not be so capital intensive. This is a likely incentive for investors to create additional cargo handling capacity by building new berths/ terminals in future. Therefore the port location and layout should allow for the flexibility for expansion to allow additional berths, storage and evacuation.

6.2.2.7 Flexibility for Development in Stages

The site should allow a development plan such that it is capable of being developed in stages, if needed for phase wise induction of cargo handling facilities.

6.2.2.8 Optimum Capital Cost of Overall Development and Especially for the Initial Phase

Capital cost is clearly the primary consideration while evaluating a port location. The cost of development of initial phase takes precedence. This aspect shall be duly kept into consideration while deciding the design ship size for Phase 1 development so as to minimise the cost of capital dredging.

6.2.2.9 Flexibility for Expansion Beyond Master Plan Horizon

An important and sometimes forgotten aspect of Master Planning is to consider what may happen after the end of the immediate time horizon of the Master Plan study. The traffic projections for a 20 year period inevitably have more inbuilt uncertainty than the more immediate 5 year projections. Therefore the requirements in 2035 may be more than, or less than, or different from, what can be predicted now. Furthermore, the port traffic will not stop growing in 2035. Therefore, in comparing the merits of different alternatives for Master Plan layout, preference should be given to those that allow space for further development.

6.2.3 Land Availability

6.2.3.1 Availability of Backup Area for Storage of Cargo and Port Operations

Adequate land must be available along the waterfront for an efficient cargo storage and port operations. Acquiring the land for this purpose may lead to protests from local residents resulting in abandoning of the project or involving significant cost towards land acquisition. **Figure 6.1** shows the current pattern of land along the proposed port site. Large chunk of area is reserved for Indian Navy behind Belekeri where no other development can take place. It may be noted that villages viz., Bhavikeri, Keni, Kolivada are located along the Belekeri bay. In order to avoid any land acquisition and subsequent R&R issues, it is therefore proposed that backup area of cargo storage and port operations be planned on reclaimed area.

Figure 6.1 Current Land Pattern along Proposed Site

6.2.3.2 Provision for Rail and Road Connectivity

The onshore cargo storage area should have good connectivity to the external rail and road linkages for faster evacuation of cargoes with minimum capital investment and minimum rehabilitation and resettlement. It shall be ensured that the road and rail alignment be selected in such a manner so as to minimise the need for any land acquisition.

6.2.4 Environmental Issues Related to Development

The environmental issues such as deforestation, rehabilitation and resettlement would need special consideration while arriving at the suitable layout of port.

6.3 Planning Criteria

6.3.1 Limiting Wave Conditions for Port Operations

6.3.1.1 Pilot Boarding

Ships arriving at the port will take on a pilot to guide it to the designated berth inside the port. The pilot will normally board the ship at the outer anchorage. Since the pilot has to board the vessel in the open sea through rope ladder along the ship side, the limiting condition is that the significant wave height (H_s) should not exceed 2.5 m. As in the present case the pilots shall be boarding seawards of navigational channel and then take the ship to the harbour.

6.3.1.2 Tug Fastening & Tug Operations

The tugs, which assist the ship while stopping, turning in the basin and manoeuvring to the berth, normally meet the vessel in protected water, just inside the breakwaters. The limiting wave condition for tugs to fasten to a ship and effectively assist and control the ship varies from Hs=1.0m to Hs=1.5m depending the type of tugs used.

6.3.1.3 Tranquillity Requirements for Cargo Handling Operations

For carrying out cargo handling operations at the berths, it has to be ensured that there are no excessive movements of the ships due to wave action that will hamper the ship-shore handling operations. This limit varies with the handling system for the different types of cargoes. 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 height (H_s) from different wave directions for cargo handling operations are stipulated in PIANC bulletin - "Criteria *for movements of moored ships in Harbours – a Practical Guide (1995)".* An extract is summarised in **Table 6.1** below:

Table 6.1 Limiting Wave Heights for Cargo Handling

Type of Ship	Limiting Wave Height (H_s)	
	Head or Stern (0°)	Quadrant (45°- 90°)
Dry bulk Carriers		
- loading	1.5 – 2.0 m	1.0 – 1.5 m
- unloading	1.0 –1.5 m	0.5 - 1.0 m
Break-bulk Ships	1.0 m	0.8 m
Containers	0.5 m	0.5 m

6.3.2 Breakwaters

The purpose of breakwater is to provide tranquil conditions inside the port in operating conditions. Breakwater is to be planned for predominant waves coming from South-West direction. This would require a south breakwater to protect harbour from the waves coming from southwest direction. The length of south Breakwater shall be sufficient enough to cover the berthing area and manoeuvring in the shadow zone. Final layout and alignment of the breakwater to be decided based on the harbour tranquillity study and the length shall be kept minimum to limit the overall capital expenditure.

6.3.3 Berths

The estimated berths and the total quay length for the various phases of development have been worked out and are presented in the **Table 6.2** below.

Table 6.2 Berth Requirement based on Traffic Forecast

S. No.	Commodity	Total Berths Required		
		2020	2025	2035
1.	Dry Bulk	2	2	3
2.	Multipurpose / Container Berth	1	1	1
Total Berths		**3**	**3**	**4**

It may be noted that the above only indicates the number of berths needed as per the traffic projections. The actual number of berths provided in different phases would be governed by the physical and financial constraints of the proposed port site.

6.3.4 Navigational Channel Dimensions

The dimensions of the navigation channel to the terminal are dependent on the vessel size, the behaviour of the vessel when sailing through the channel, required tidal access, the environmental maritime conditions (winds, waves, currents) and the channel bottom conditions.

6.3.4.1 Channel Width and Length

The channel width has been calculated from the latest PIANC Guidelines "Harbour Approach Channels – Design Guidelines: Report No. 121 – 2014". The detailed calculations are shown in attached **Table 6.3**.

Table 6.3: Calculation of Channel Width based on PIANC Recommendations

PIANC Recommendations						
					Channel	
Basic Lane Width W_{bm} (multiple of ship beam B)		Vessel Speed	Outer Channel Exposed to Open Water	Inner Channel Protected Water	outer	inner
vessel manoeuvrability						
- good		all	1.3	1.3		
- moderate		all	1.5	1.5	1.5	1.5
- poor		all	1.8	1.8		
TOTAL BASIC MANOEUVRING LANE W_{bm}					**1.5**	**1.5**
PIANC table 5.2 - Additional Width for Straight Channel Sections (multiple of ship beam B)						
(a)	**vessel Speed (knots)**					
	- fast >12		0.1	0.1		
	- moderate >8 - 12		0.0	0.0	0.0	0.0
	- slow 5 - 8		0.0	0.0		
(b)	**Prevailing cross wind (knots)**					
	- mild ≤ 15 (≤ Beaufort 4)	fast	0.1	0.1		
		mod	0.2	0.2		
		slow	0.3	0.3		
	- moderate > 15 - 33	fast	0.3	0.3		
	(> Beaufort 4 - Beaufort 7)	mod	0.4	0.4		
		slow	0.6	0.6		
	- severe >33 - 48	fast	0.5	0.5		
	(> Beaufort 7 - Beaufort 9)	mod	0.7	0.7	0.7	0.7
		slow	1.1	1.1		
(c)	**Prevailing cross current (knots)**					
	- negligible < 0.2	all	0.0	0.0		
	- low 0.2 - 0.5	fast	0.2	0.1		
		mod	0.25	0.2		0.2
		slow	0.3	0.3		
	- moderate >0.5 - 1.5	fast	0.5	0.4		
		mod	0.7	0.6	0.7	
		slow	1.0	0.8		
	- strong > 1.5 - 2.0	fast	1.0	-		
		mod	1.2	-		
		slow	1.6	-		
(d)	**Prevailing longitudinal current (knots)**					
	- low ≤ 1.5	all	0.0	0.0	0.0	0.0
	- moderate > 1.5 - 3	fast	0.0	0.0		
		mod	0.1	0.1		
		slow	0.2	0.2		
	- strong > 3	fast	0.1	0.1		
		mod	0.2	0.2		
		slow	0.4	0.4		
(e)	**Significant wave height H_s and length l (m)**					
	- Hs ≥ 1 and l ≥ L	all	0.0	0.0		0.0
	- 3> H_s > 1 and l = L	all	0.5			
	- H_s > 3 and l > L	all	1.0		1.0	
(f)	**Aids to Navigation**					
	- excellent with shore traffic control		0.0	0.0		
	- good		0.2	0.2	0.2	0.2
	- moderate		0.4	0.4		
(g)	**Bottom Surface**					
	- if depth ≥ 1.5T		0.0	0.0		
	- if depth < 1.5T then					
	- smooth and soft		0.1	0.1		
	- rough and hard		0.2	0.2	0.2	0.2
(h)	**Depth of Waterway**					
	- ≥ 1.5T (inner and outer waterway)		0.0	0.0		
	- 1.5T - 1.25T (outer waterway)		0.1			
	- < 1.25T (outer waterway)		0.2		0.2	
	- < 1.5T - 1.15T (outer waterway)			0.2		
	- < 1.15T (inner waterway)			0.4		0.4
(i)	**Cargo Hazard Level**					
	- low		0.0	0.0	0.0	0.0
	- medium		0.5	0.4		
	- high		1.0	0.8		

PIANC Recommendations					
Basic Lane Width W_{bm} (multiple of ship beam B)	Vessel Speed	Outer Channel Exposed to Open Water	Inner Channel Protected Water	Channel outer	Channel inner
TOTAL ADDITIONAL MANOEUVRING WIDTH FACTOR W_i				**3.0**	**1.7**
PIANC Table 5.4 - Additional Width for Bank Clearance					
- Gentle underwater Channel slopw (<1:10)	fast	0.2			
	mod	0.1		0.1	0.1
	slow	0.0			
- sloping channel edges and shoals	fast	0.7			
	mod	0.5			
	slow	0.3			
- steep and hard embankments and structures	fast	1.3			
	mod	1.0			
	slow	0.5			
TOTAL BANK CLEARANCE FACTOR W_{br} or W_{bg}				**0.1**	**0.1**
PIANC Table 5.3 - Additional Width for Passing Distance for Two-Way Traffic					
additional width for traffic speed	fast	2.0	-		
	mod	1.6	1.4		
	slow	1.2	1.0		
additional width for traffic encounter density					
- light	all	0.0	0.0	0.0	0.0
- moderate	all	0.2	0.2		
- heavy	all	0.5	0.4		
TOTAL EXTRA FOR STRAIGHT CHANNEL TWO-WAY TRAFFIC W_p				**0.0**	**0.0**
Curved Channel Width Factor W_c - PIANC Figure 5.9					
assume rudder angle 20 deg, W/D ratio 1.1, therefore Ws/B = 1.18	all	0.18	0.18	**0.18**	**0.18**

Required channel width

ship beam (m)	
Cape Size Bulker	**50**
Panamax Size Bulker	**32**

	Channel Width outer	Channel Width Inner
one way straight channel		
Cape Size Bulker	**235**	**170**
Panamax Size Bulker	**150**	**109**
one way curved channel		
Cape Size Bulker	**244**	**179**
Panamax Size Bulker	**156**	**115**
two way straight channel		
Cape Size Bulker +Panamax Size Bulker	377	271
two Panamax Size Bulker	294	211
two way curved channel		
Cape Size Bulker +Panamax Size Bulker	**392**	**285**
two Panamax Size Bulker	**306**	**223**

The calculated channel width for various design ship sizes is summarised below in **Table 6.4**.

Table 6.4 Particulars of Navigational Channel for Design Ships

Design Ship Size (DWT)	Beam (m)	Outer Channel Width (m)		Inner Channel Width (m)	
		One way Channel	Two way Channel	One way Channel	Two way Channel
200,000	50	230	380	170	270
80,000	32	150	300	110	210

The channel length for handling 200,000 DWT ships works out to approximately 12 km and therefore the transit time of the ships in the channel will be about 0.8 hours (49 mins) at 8 knots speed. Allowing for time required for tugs attachment, manoeuvre and tug return for next ships as 1 hour, maximum of 12 ship movements per day (6 in and 6 out) could be accommodated with one set of tugs. Taking an average of about 10 ship movements per day in the channel, a one way channel can handle about 1825 ship calls per year using one set of tugs. Considering the low projected traffic and consequent ship movements, one way channel would be adequate for the proposed port.

6.3.4.2 Dredged Depths

The depth in the channel is determined by the vessel's loaded draught; trim or tilt due to loads within the holds; ship's motion due to waves, such as pitch, roll and heave; character of the sea-bottom, soft or hard; wind; influence of water level and tidal variations; and the sinkage of the vessel due to squat or bottom suction. In case the bed level comprises of rock and hence additional underkeel clearance of 0.5 m would be needed.

The dredged depths at the port entrance channel and manoeuvring areas will be governed by the designed draft of the largest ship as shown in **Table 6.5** below:

Table 6.5 Dredged Levels at Port for the Design Ships

Ship Size	Draft (m)	Approach channel outside breakwater (m CD)	Inner channel and manoeuvring area (m CD)	At Berths (m CD)
80,000 DWT	14.5	16.1	15.4	16.5
200,000 DWT	18.3	20.4	19.5	20.6

It may however be noted that above values are arrived at considering that the design ship would navigate the channel after taking advantage of the mid tide level of +1.1 m CD. Considering the limited number of ships that to be handled each day this is a reasonable assumption and would reduce the capital dredging requirement and thus cost.

6.3.5 Elevations of Backup Area and Berths

Considering the mean high water springs as +1.9 m CD and allowing for the operational wave height of 1.0 m and thus crest height of 0.7 m and height of the structure as 1.5 m, the deck elevation of berths is arrived at +5.0 m CD. This elevation would also protect the berth from slamming action of waves under cyclonic conditions. However, the finished levels of onshore areas will be kept at around +4.5 m CD.

6.4 Alternative Marine Layouts

Various alternative layouts for the development of Port at Belekeri have been prepared keeping in view various planning criteria as discussed above.

Alternative Layout 1 is a nearshore harbour option with most of the berths located close to the shore. This would result in shorter breakwater length but higher dredging quantities. The suitable material obtained from dredging shall be used for reclamation and balance disposed offshore at a designated location. The channel orientation at the harbour entrance is from NW direction but after a suitable distance from harbour a bend is provided in the channel to reach deeper depths at a shortest possible distance. The Phase 1 and master plan layouts of this alternative are as shown in **Drawing DELD15005-DRG-10-0000-CP-BLR1001** and **BLR1002**.

Alternative Layout 2 involves offshore harbour option where the harbour area is located away from the shore. As compared to Alternative 1, the breakwaters in this alternative are longer but the amount of capital dredging is lower. The basic concept of developing this alternative is to minimise/ avoid the rock dredging, which is likely to be encountered within the dredged depths considering the geology of the area. The channel orientation is similar to as that of Alternative 1. The Phase 1 and master plan layouts of this alternative are shown in **Drawing DELD15005-DRG-10-0000-CP-BLR1003** and **BLR1004**.

6.5 Evaluation of the Alternative Port Layouts

6.5.1 Cost Aspects

One of the key considerations for the layouts evaluation is that it should be able to handle the project throughput in phased manner keeping the capital cost of development especially that of Phase 1 development as optimum. It is to be noted that the items such as Berths and Equipment, Stacking areas, Internal Roads and Railway, Port Crafts, Nav-aids, Utilities, Buildings etc. are of negligible cost difference for all the alternative layouts. Therefore, for cost comparison for various alternative port layouts, items of major cost difference need to be considered, as presented in **Table 6.6** hereunder:

Table 6.6 Cost Differential (Rs. in Crores) of Key Items of Phase 1 Development for Alternative Layouts

Item Description	Phase 1		Master Plan	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Breakwater	426	705	426	705
Dredging	327	215	697	528
Reclamation	172	172	231	231
Total	**926**	**1296**	**1152**	**1465**

From the above table, it is observed that cost of development is much lower in case of Alternative 1-Nearshore option but with a greater risk of cost escalation in case rock dredging is involved. Hence the rock levels would dictate the final port layout for Phase 1 development.

6.5.2 Fast Track Implementation of Phase 1

It is anticipated that the breakwaters construction would be on the critical path for the port development. The quantities of rock in the breakwaters and the estimated breakwater construction time are calculated approximately as given **Table 6.7** below:

Table 6.7 Estimated Rock Quantity and Construction Time of Breakwater

Alternative	Estimated Rock Quantity (million tonnes)	Estimated Construction Time (months)
Alternative 1	3.04	27
Alternative 2	4.85	38

6.5.3 Available Land for Phased Development

The selected port layout should be able to expand in a phased manner to meet the market demand. It is required that adequate land be reclaimed utilising the suitable dredged material for the cargo storage and operational areas.

6.5.4 Expansion Potential

It is observed that both the alternatives offer similar number of berths. However, alternative layout 2 would enable additional backup area by way of reclamation.

6.6 Multi Criteria Analysis of Alternative Port Layouts

The above alternative port layouts were evaluated using a Multi-Criteria-Analysis. The comparison of these layouts is presented in the **Table 6.8**.

Table 6.8 Multi-Criteria Analysis of Alternative Layouts

S. No.	Factor Description	General	Alternative 1	Alternative 2
1.	**Rock Levels and Estimate of Rock Dredging**	The higher rock levels would involve costly rock dredging.	The marine facilities are located away from shore but still could involve some rock dredging.	The marine facilities are located offshore and may not involve rock dredging for panamax size ships but may involve some rock dredging for particularly for Cape size ships.
2.	**Material for Reclamation Fill**	The borrowed fill material would be costly due to distant location of quarries.	Part of the dredged material can be used for reclamation and balance disposed offshore.	Optimal use of dredged material with minimal offshore disposal.
3.	**Protection to the berths from waves and swell**	The predominant wave direction is from SW during the SW monsoons	The berths are well protected from direct attack of waves	Same as Alternative 1.
4.	**Suitable location of back-up land for storage of cargo and port operations**	The storage area should located close to the berths so as to provide faster evacuation of cargo and also provide separation between dirty and clean cargo	Effective utilization of backup area. Clear separation of clean and dirty cargo possible.	Same as Alternative 1.
5.	**Provision for Rail and Road Connectivity**	The port layout should be such so as to be able to be connected to the main road and rail networks	Suitable rail and road connectivity can be provided along the land corridor proposed to be acquired for port development	Same as Alternative 1.
6.	**Connectivity to Hinterland**	Hubli - Ankola rail line for adequate traffic movement	The rail line is a key to provide cost economic movement of cargo. State government to pursue the EC for the rail line to come up	Same as Alternative 1
7.	**Environmental issues related to development**	Limitation of quarrying in Western Ghats	Proper EMP needs to be prepared to avoid impact due to quarrying required for port construction.	Same as Alternative 1.
8.	**Potential Reclamation Area**	The higher reclamation area would minimize the land acquisition.	Adequate land required for storage and port operations could be reclaimed	Same as Alternative 1.
9.	**Capital Cost of Phase 1 Development**	Optimized capital cost for the initial phase development so as to increase the project viability	Base case	Higher than alternative 1 but could be other way, if rock levels in the area are found to be higher.

S. No.	Factor Description	General	Alternative 1	Alternative 2
10.	**Expansion Potential**	Maximum number of berths possible in the harbour so as to meet the demand at least for master plan horizon	Total 6 berths possible	Same berth as alternative 1 but additional storage area could be created.

6.7 Recommended Master Plan Layout

It could be observed from above that alternative 1 appears to be the best in terms of minimal investment for Phase 1 development and it also meets the long term expansion requirements of the port. However during project appraisal appropriate contingency for the additional cost due to rock dredging would need to be taken into account.

The recommended master plan layout of Port at Belekeri is shown in **Drawing DELD15005-DRG-10-0000-CP-BLR1005**.

6.8 Recommended Port Layout Beyond Master Plan Horizon

It is however possible that port could be expanded beyond the master plan horizon. The extent of expansion would depend upon the availability of right of way to the north side of the bay. There could be two possible alternatives as mentioned below:

Alternative 1: In this alternative the root of north breakwater is taken from middle of the Bhavikeri bay as shown in **Drawing DELD15005-DRG-10-0000-CP-BLR1006A**.

Alternative 2: In this alternative the root of north breakwater is taken from tip of the north landmass of Belekeri Bay as shown in **Drawing DELD15005-DRG-10-0000-CP-BLR1006B**. It is understood that the tip and land adjoining areas are with existing Belekeri port. However, it could be considered during implementation stage after completing the necessary modalities and duly taking into account the possible utility of the additional land created by reclamation.

Depending upon the detailed cost benefit analysis to be carried out at a later date, providing a north breakwater (either part or full) as shown in above alternatives could also be considered either in Phase 1 itself or the later stages of development. This would have benefit of getting additional land by way of reclamation and also eliminate the difficulties that would be faced for construction of north breakwater in future due to urbanisation of the area around the port after commissioning of the port. The same needs to be considered during DPR stage after duly taking into account the financial benefit and strategic advantage.

6.9 Phasing of the Port Development

The development of port shall be taken up in phases. The key port facilities that shall be developed in the phased manner over the master plan horizon are indicated in **Table 6.9** below.

Table 6.9 Phasewise Port Development over Master Plan Horizon

Description	Total Port Facilities in Each Phase	
	Phase 1 - Year 2020	Master Plan - Year 2035
Maximum Ship Size		
· *Dry Bulk (DWT)*	*80,000*	*200,000*
· Breakbulk	*80,000*	*80,000*
Breakwater		
· *Southern Breakwater (m)*	*4780*	*4780*
Number of berths (Total length of berths in meters)		
· *Bulk Berths*	*2*	*3*
· *Multipurpose berths*	*1*	*1*
Navigational Areas		
· *Length of Approach Channel (m)*	*7,300*	*12,000*
· *Width of Approach Channel (m)*	*150*	*230*
· *Diameter of Turning Circle (m)*	*500*	*600*
Design Draft of the Ship (m)	14.5 m	18.3m
Dredged Depths at Port (m below CD)		
· *Approach Channel*	*-16.1m*	*-20.4m*
· *Manoeuvring Areas*	*-15.4m*	*-19.5m*
· *Berths*		
o *Breakbulk*	*-16.5m*	*-16.5m*
o *Bulk*	*-16.5m*	*-20.6m*
Incremental Dredging Quantity (million cum)	*16.4*	*18.5*
Incremental Reclamation Quantity (million cum)	*8.62*	*11.4*
Total Reclamation Area to be Developed (Ha)	*102*	*154*

The recommended Phase 1 development of port at Belekeri is indicated in **Drawing DELD15005-DRG-10-0000-CP-BLR1007**.

7.0 ENGINEERING DETAILS

7.1 Mathematical Model Studies on Marine Layout

MIKE 21 BW based on the Boussinesq's equation is applied to carry out the wave agitation study, which determines the tranquillity inside the harbour. MIKE 21 BW is a non-linear wave model and it simulates in the time domain the propagation of irregular, directional waves into the harbour taking into account all important effects like shoaling, depth refraction, diffraction, bottom friction, partial and full reflection, and transmission through porous structures.

The model bathymetry was created using the breakwater configuration and the approach channel shown in **Figure 7.1**. All the numerical simulations of the wave agitation were carried out with a water level corresponding to the Chart Datum (CD).

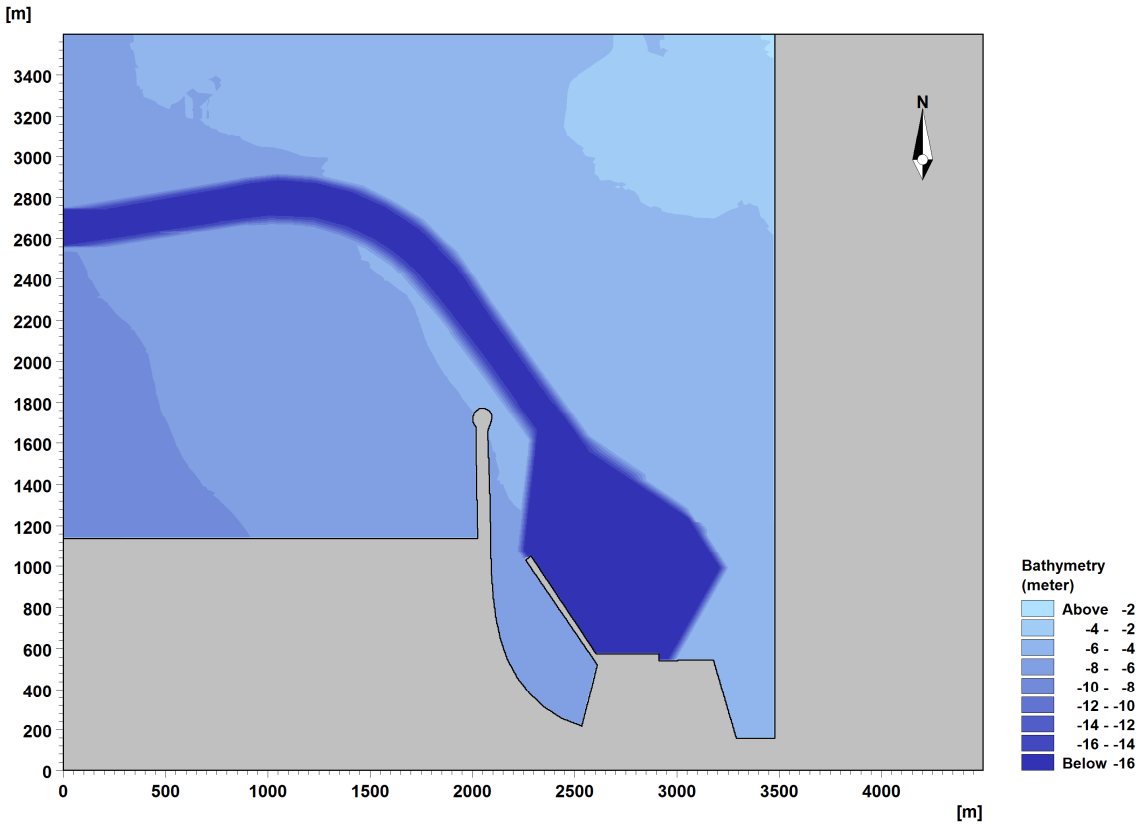


Figure 7.1 Bathymetry Used for the BW

The waves in the numerical model were generated along the open boundaries and to avoid reflection on the boundaries of the model thus so-called sponge layers (layers which smoothly absorb all wave energy entering the layers) were introduced along the open boundaries of the model. Sponge layers were also introduced at the land and closed boundaries (**Figure 7.2)**.

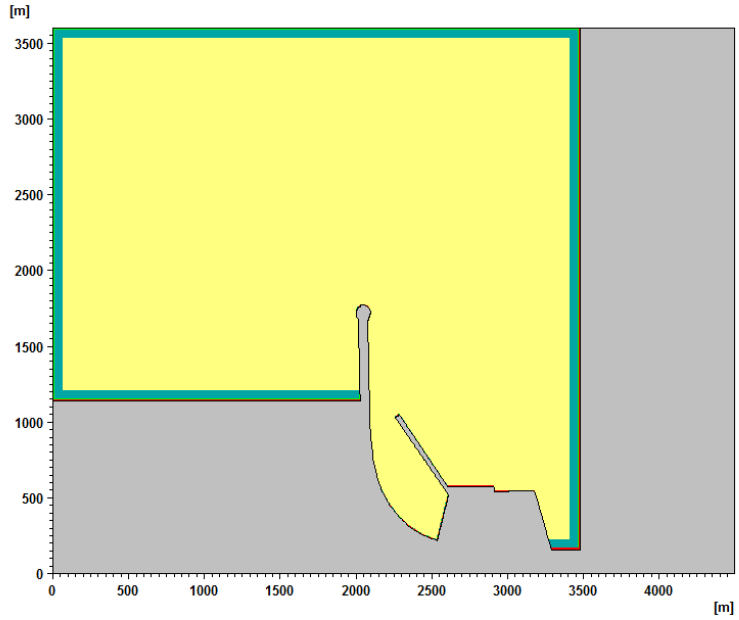


Figure 7.2 Sponge Layers (in Green) along the Non-Reflecting Boundaries

Various structural components of the port like Breakwaters, riveted banks, sheet piles, and vertical block works etc. have their own wave absorption capacity and reflectivity. In order to reproduce the structures in the model, different reflection and absorption coefficients are provided in the model as porosity layers (**Figure 7.3**). For the present study, the porosity coefficient for the breakwater has been taken as 0.5 while that for berths a value of 0.8 has been considered.

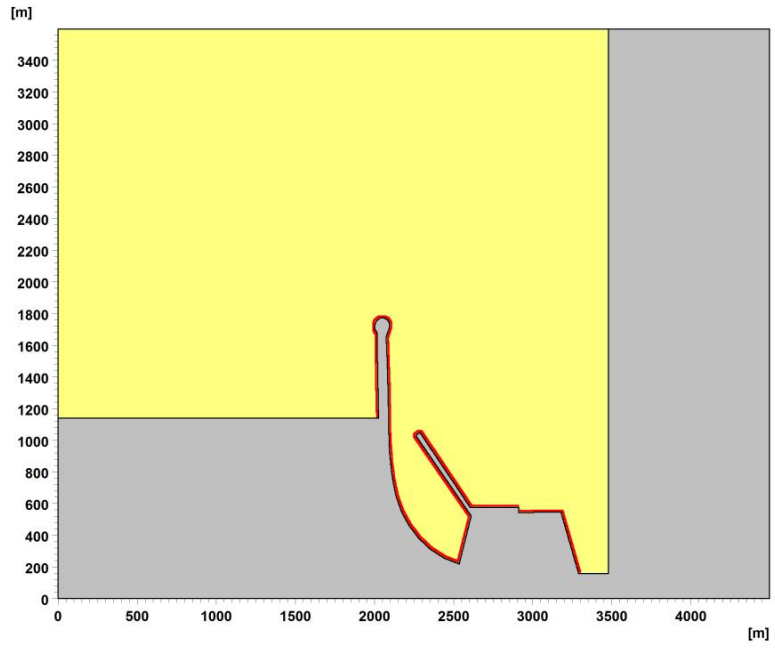


Figure 7.3 Porosity Layers (in Red) along the Port Structures

The proposed layout provides effective protection from W, SW, SSW direction. Thus the partially protected directions were chosen to carry out wave agitation simulations. The input wave heights were taken as 1.0 m with peak wave period of 6.5 s.

7.1.1 Model Results

Figure 7.4 to Figure 7.6 provides wave height that may be encountered within the harbor under the impact of 1 m waves from NNW, NW and W directions respectively. It may be observed that the waves entering from NNW, NW and W directions are mostly attenuated at the breakwater.

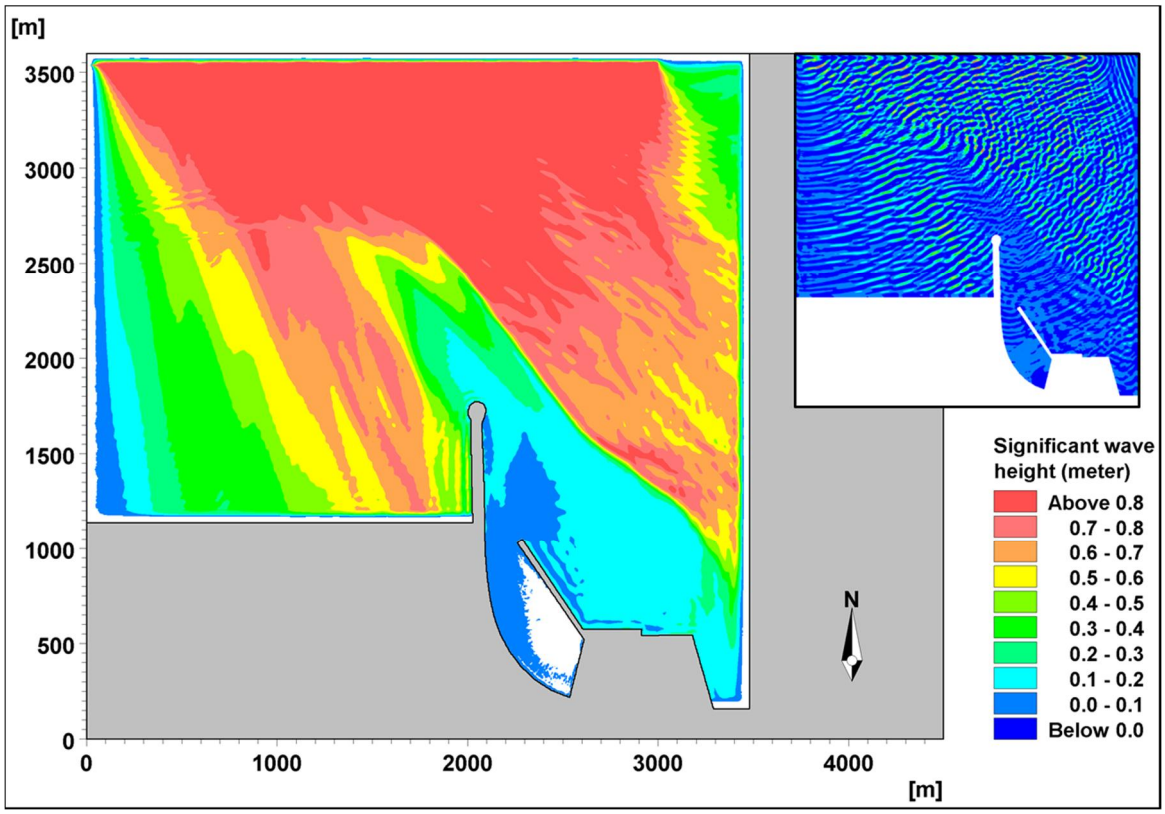


Figure 7.4 Wave Tranquillity Assessment for Waves from NNW Direction

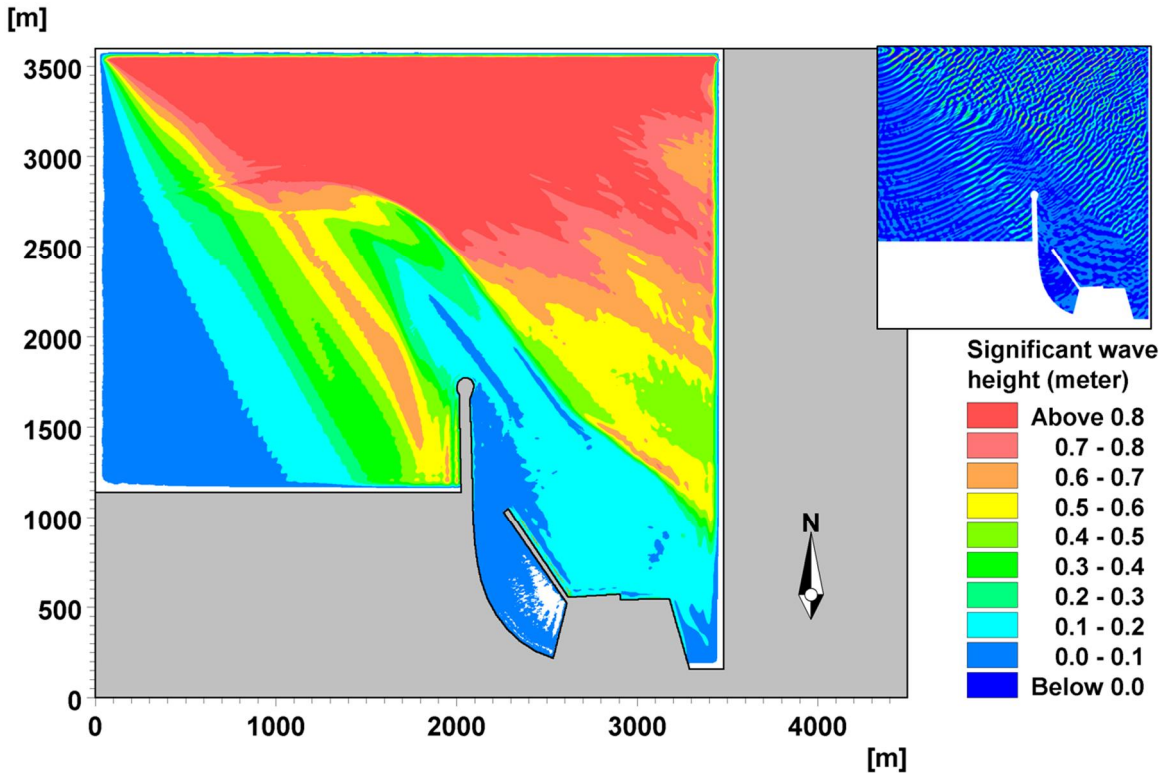


Figure 7.5 Wave Tranquillity Assessment for Waves from NW Direction

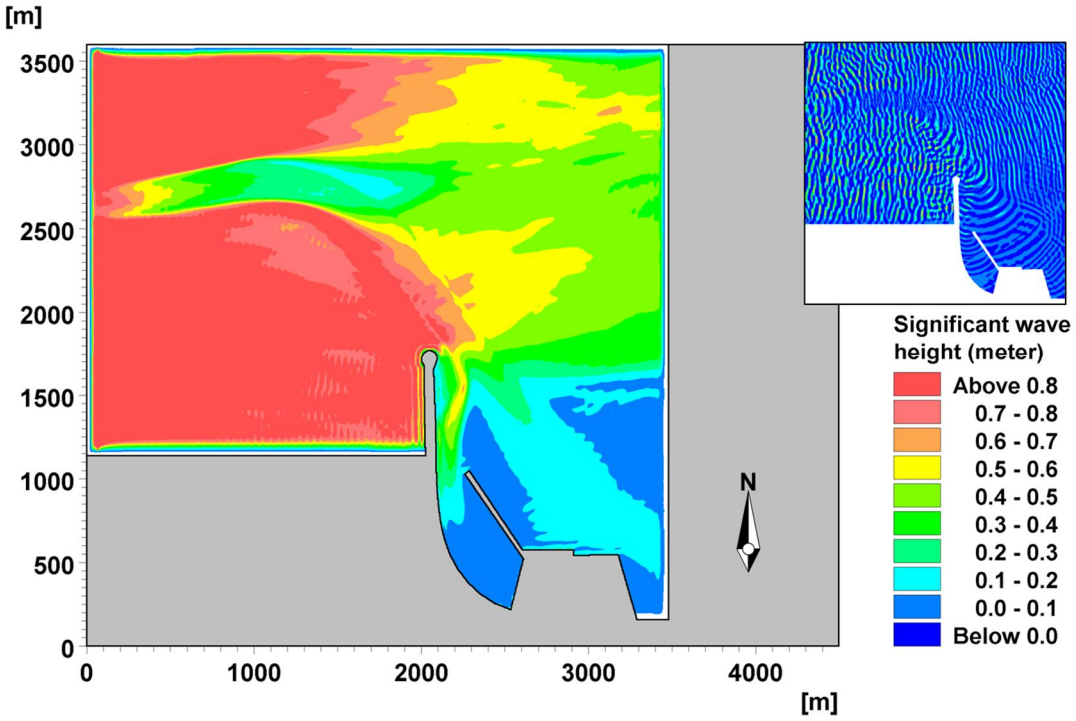


Figure 7.6 Wave Tranquillity Assessment for Waves from W Direction

Based on the model runs carried out for the above conditions the wave disturbance coefficients i.e. ratio of H_{mo} (Site)/H_{mo} (incoming), are calculated at the locations of proposed berths and turning circle (**Table 7.1**).

Table 7.1 Wave Disturbance Coefficients

Label	Description	NNW	NW	W
C1	Outer Channel	0.78	0.57	0.21
C2	Inner Channel	0.18	0.12	0.31
T1	Turning Circle	0.16	0.12	0.17
B1	Berth 1	0.10	0.07	0.06
B2	Berth 2	0.10	0.08	0.07
B3	Berth 3	0.15	0.10	0.14

Using these coefficients, a representative mean significant wave height (Hm0, mean) can be estimated by multiplication of the wave disturbance coefficient of the location with the incident significant wave height (Hm0). Wave disturbance coefficients estimated from the study suggests that the maximum of 0.15 m of wave will reach berth locations if incident wave of 1 m approach the port. While, wave height of 0.16 m, 0.12 m and 0.17 m are estimated at the turning circle for 1 m incident wave from NNW, NW and W directions respectively.

The proposed port will handle bulk cargo, operation at these berths withstand significant wave height up to 0.6 m. thus considering the wave disturbance coefficients the cargo handling operations can be effectively undertaken until incident wave height of about 4.0 m.

Based on the percentage exceedance of waves at 14 m contour, it is assessed that waves exceeding 3 m are less than 1% at Belekeri and hence it may be safely concluded that downtime at the port with proposed layout is practically nil under the normal wave conditions.

7.2 Onshore Facilities

The onshore facilities for port operations and cargo storage are located in the reclaimed land. The cargo storage for the breakbulk cargo has been earmarked contiguous to the multipurpose berth for operational ease. However, the storage area for bulk cargo is located close to shore on the reclaimed land, where the material shall be transferred from the bulk berth using the conveyor system.

While arriving at the onshore layout adequate space has been earmarked for the railway lines to be provided within the port area.

7.3 Breakwaters

7.3.1 Basic Data for Breakwaters Design

7.3.1.1 Design Wave Height

The wave heights to be considered for the breakwaters design would depend upon the extreme wave conditions for 1 in 10 years and 1 in 50 year return periods for the respective depths in which breakwaters are located from considerations of over topping and section design respectively.

Based on the available data in the region having similar water depths upto which the breakwater extends, the design wave height adopted is 5.5 m for the head and truck sections located in deeper waters. For sections closer to shore the design wave height shall be governed by corresponding breaking wave height in that water depth, whichever is critical.

7.3.1.2 Design Assumptions

- Stones upto 5.0 T are economically available with density of 2.6 T/m^3
- The minimum density of concrete armour units will be 2.4 T/m^3
- Concrete slab with a parapet will be provided at the crest of the breakwater
- The design life of the breakwater is 100 years.
- The breakwater construction will be by end-on dumping method and that there will be no restriction/ limitations of crane for laying armour units. However where ever possible construction shall by carried out by Barge dumping also.

7.3.1.3 Crest Width and Elevation

The primary purpose of the breakwaters at the port is to provide the required tranquillity conditions in the manoeuvring areas and berths. The required minimum crest height of the breakwater is determined by the allowable wave penetration by overtopping during extreme conditions.

The crest level has been decided based on the limiting the overtopping discharge to 50 l/s/m. The crest width is determined after allowing a 2 way roadway for the maintenance of breakwater.

7.3.1.4 Armour Units

For the armour units following options have been considered:

- Rock as armour layer
- Accropodes as Concrete Armour Units

While evaluating the above options the major factor under consideration will be the cost of breakwaters and the implementation schedule. It is expected that at the present site conditions, the placement of rock for breakwater construction, will be limited on an average to about 7,000 T/day by end on dumping method including the quantity of rock that could be placed by using the barge dumping also.

Wherever possible, rock would be utilised as armour layer. However concrete armour units would be used once the rock size increases beyond 5 T. The present base case design has been undertaken considering accropodes as armour units but during detailed engineering a decision could be taken to adopt other armour units such as Coreloc or Xblock.

7.3.2 Breakwater Cross Sections

Hudson formula is used for calculating the weight of armour unit.

$$W = \frac{e_s H^3}{K_D \left(\frac{e_s}{e_w} - 1\right)^3 \cot a}$$

where

W	=	weight of armour unit
e_s	=	Mass density of armour unit
H	=	Design Wave height
K_D	=	Stability Coefficient
e_w	=	Mass density of water
cot α	=	Armour slope (H/V)

The design wave height is taken as follows:

- 1 in 100 year return period significant wave height at the corresponding location or the breaking wave height at that location, whichever is severe, when using the concrete armour units.
- $H_{1/10}$ (i.e. 1.27 times Hs) for 100 year return period at the corresponding location or the breaking wave height at that location, whichever is severe, when using rock as armour unit.

The values for K_D considered (under non breaking conditions) are as follows:

Stones (in double layer) K_D = 2.8 for head portion
K_D = 4.0 for trunk portion

Table 7.2 K_D Values for Breakwater

Breakwater Portion	K_D values for Accropodes
Trunk	15
Head	12

The typical cross section of the breakwater is presented in **Drawing DELD15005-DRG-10-0000-CP-BLR1008**.

7.3.3 Geotechnical Assessment of Breakwaters

The seabed level at the breakwaters increases from +2.0 m CD near the shore to a maximum of –7.0 m CD. The crest level of breakwater is assumed at the maximum depth is about +8.5 m CD.

The stability of the breakwater foundation needs to be analysed for the subsoil conditions at the locations. In the present case the breakwaters are likely to be on a good founding strata overlaying rock.

7.3.4 Rock Quarrying and Transportation

7.3.4.1 Location of Quarries

It is understood during the site visit, the the environmental ministry has imposed ban on rock quarrying due to the sensitivity of the western ghats. The rock for the construction of breakwater works need to sourced out from the government approved quarries in the area.

7.3.4.2 Transport to Site

The quarry material will have to be transported in through dumpers. Some localise 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.

7.4 Berthing Facilities

7.4.1 Location and Orientation

The location and orientation of the proposed berths is shown **Drawing DELD15005-DRG-10-0000-CP-BLR1007**. Ideally the Container / Multipurpose berths should be built contiguous to the land for ease of handling operations, whereas the bulk berths could be located away and connected to shore by means of an approach trestle. Considering the high dredging requirement at the berth locations, it is proposed to provide the bulk and multipurpose berth away from the shore and some portion of backup area is created behind multipurpose berth for transit storing and backup area near the shore to which the connection shall be by approach bund/trestle.

7.4.2 Deck Elevation

The deck elevation of the berths has been fixed at +5.0 m CD. This deck elevation will prevent the waves slamming the deck during cyclones. This deck level will also ensure adequate clearance to the deck during operational wave conditions.

7.4.3 Design Criteria

The structural design of the bulk and multipurpose berths shall be carried out for the maximum size of the ships expected to be handled at these berths at the ultimate phase. The details of design ship sizes are given in **Table 7.3** below:

Table 7.3 Characteristics of Design Ships

Commodity	Design Ship Size (DWT)
Coal	200,000
Multipurpose	80,000
Containers	4,000 TEUs

7.4.3.1 Design Dredged Level

Structural design of the berths shall be carried out for design dredged level of -21 m CD.

7.4.3.2 Design Loads

- **Dead Loads** comprising the self-weight of the structure plus superimposed loads of permanent nature shall be considered as per IS: 875 (Part-I) 1987.
- **Live Load** on the deck slab shall be 5 T/m^2
- **Vehicle and Crane Loads** as per details below:
  - *Loads due to Gantry type unloaders with rail centres at 20 m c/c on bulk berth*
  - *Mobile Harbour Cranes LMH500 or equivalent on Multipurpose berth*
  - *Single train of IRC class AA vehicle or Loads due to mobile crane of 70 T lifting capacity*
- **Seismic Loads** on the structures shall be computed in accordance with the seismic code of India IS: 1893.
- **Wind Loads** on the structures shall be calculated using a basic wind speed of 40 m/s as per the Indian standards. However, wind speed during the operational conditions shall be limited to 20 m/s only.
- **Current Loads** on the structure shall be applied on the submerged parts of the structure considering the maximum current velocity as 1.0 m/s.
- **Wave Loads** shall be computed considering maximum wave height of 4.5 m (~ 1.8*2.5m) for the design of the berths on a conservative side.
- **Mooring *Loads*** shall be calculated considering 200 T bollard pull.
- **Berthing Loads**

The berthing loads have been calculated as per relevant Indian standards. Considering the tidal range at the site and also the variation in the sizes of vessels to be handled at the jetty, the fendering system is designed such that sufficient contact area between the hull of the ship and the fender face is ensured at all tidal levels, for all possible size of ships expected to be berthed at the jetty. Based on these criteria it is proposed to use fenders with a frontal frame reaching down to the lowest water level at all the berths.

It is observed that the berthing energy of the fully loaded 200,000 DWT ships would govern the design. Basis this selection of suitable fender has been made has been and the corresponding design reaction force has been worked out based on the standard fender design catalogues. The details are provided below:

Table 7.4 Details of Berthing Energy, Fender and Berthing force applied at Berths

Parameters	Bulk Berth	Container cum Multipurpose Berth
Berthing Energy	2975 kNm	1234 kNm
Fender	Trelleborg Cell Type Fenders SCK 2500H E1.1 or equivalent	Trelleborg Cell Type Fenders SCK 2000H E1.0 or equivalent
Rated Berthing Force	2711 kN	1397kN

In addition a longitudinal force equal to the 25% of above transverse berthing force is also applied simultaneously on the fender point to account for the friction between the ship's hull and the fender. The parameters of the fender need to be confirmed after getting the exact details from the supplier during the detailed engineering stage.

7.4.3.3 Load Combinations

The above loads with appropriate load combinations, as per IS 4651 (Part 4) shall be applied on the different components of the berths.

7.4.3.4 Materials and Material Grades

Concrete of minimum grade M40 and high corrosion resistant thermo-mechanically treated bars of Fe500 grade shall be used for berth construction.

7.4.4 Proposed Structural Arrangement of Berths

7.4.4.1 Dry Bulk Berths

The cargo complexion under dry bulk includes thermal/ coking coal and iron ore for the port at Belekeri. As the transfer of dry bulk between berths and stackyard is through conveyors, these berths do not require contiguity with land. The access to the shore for operations and maintenance is provided through an approach bund/ trestle in the lee of south breakwater connecting the berths to the reclaimed land.

A common system is proposed to handle thermal coal, coking coal and iron ore at 2 bulk berths. The berths shall be provided with a conveyor system which will carry the dry bulk from the berth and transfer to the conveyor provided over the approach bund/ trestle.

The minimum width of the berth, keeping in view the rail span of the coal unloaders, service ducts and the end clearances should be about 30m. The total length of each dry bulk berth is taken as 300m.

In view of the above arrangement of berth and its location, founding strata, piled foundation is considered as best option for the structural system. The proposed structural scheme consists of four rows of vertical bored cast-in-situ RCC piles of 1.2 m diameter, spaced at 8.0 m c/c in the longitudinal direction. The piles will be founded in substrata at levels beyond -40 m CD.

In the transverse direction, main beams are provided supported over the piles, which in turn support beams in the longitudinal direction. The longitudinal beams, at the front row and the fourth row, are designed for loads due to ship unloaders. A 300 mm thick deck slab will be provided supported over the intermediate longitudinal beams.

Bollards and rubber fenders will be provided @ 24 m c/c along the berthing face. A service trench will be provided on the berthing side to accommodate cables/utilities. The conveyor supports are provided in the rear side of the berth at a spacing not exceeding 24 m. The typical cross section of bulk berth is as shown in **Drawing DELD15005-DRG-10-0000-CP-BLR1009**.

7.4.4.2 Container cum Multipurpose Berths

The container cum multipurpose berth is connected to land by means of approach trestle. Due to the requirement of placing the ship's hatch covers additional area has been created by reclaiming the land behind the berth and hence the width of the berth is taken same as that of bulk berth i.e. 30 m.

The structural arrangement of the berth is based on the design criteria. The proposed scheme consists of four rows of vertical bored cast-in-situ RCC piles of 1.2 m diameter, spaced at 8.0 m c/c in the longitudinal direction. The piles will be founded in subsea strata at levels beyond -40 m CD.

In the transverse direction, main beams are provided supported over the piles, which in turn support beams in the longitudinal direction. The longitudinal beams, at the front row and the third row, are designed for crane loads. A 500 mm thick deck slab will be provided supported over the intermediate longitudinal beams.

Bollards and rubber fenders will be provided @ 24 m c/c along the berthing face. A service trench will be provided on the berthing side to accommodate cables/utilities.

The berth is connected to the shore by means of 980 m long and 15 m wide approach bund to back up area. The approach shall be either in the form of bund or a trestle supported over three rows of 1.1 m diameter bored cast in situ piles. The typical cross section of bulk berth is as shown in **Drawing DELD15005-DRG-10-0000-CP-BLR1010**.

7.5 Dredging and Disposal

7.5.1 Capital Dredging

The capital dredging for Phase 1 of the port development is estimated to be around **16.4 million cum** required for handling panamax size ships. Nearly half of the dredged material shall be used for reclamation and balance shall be disposed off at a suitable location offshore at about 30 m contour.

7.5.2 Maintenance Dredging

As the harbour area is located in deeper waters and there is no river estuary nearby bringing in large sediments. Therefore the annual maintenance dredging volumes are expected to be very low and limited to about 700,000 cum per annum only including the littoral drift material that could find way to the channel.

7.6 Reclamation

7.6.1 Areas to be Reclaimed

It is proposed that the area behind the bulk and container cum multipurpose berths shall be reclaimed to provide the space for transit storage and area along the shore line to create the backup area for storage and operation. The reclamation level is proposed to be +4.5 m CD and the total quantity of reclamation fill is estimated as **8.6 Mcum** which can be carried out through suitable material from capital dredging.

The reclamation process comprise of creating bunds in the reclamation areas of suitable heights to receive the dredged material. Considering that most of the fill will be placed under water, the bunds will need to be formed of Rock/ boulders. Thereafter the reclamation levels within the bunds are raised in suitable stages, to prevent overloading of the underlying subsoil. Placement of the reclamation fill will be mostly Sub-aqueous i.e. in the water body, considering that the tidal levels in the area vary between +0 to +1.9 m CD. Between the elevations + 2 to +5 m, the placement will be sub-aerial, i.e. in the air. The reclamation sequence should be such that there is no accumulation of silt/clay at one place. The fill material shall be placed in layers with height of each layer limited to 2 m.

7.7 Material Handling System

7.7.1 Bulk Import System

7.7.1.1 General System Description

A fully mechanized common ship unloading system is planned at the bulk berths to handle thermal/ coking coal and iron ore. The system is designed for a rated capacity of 4,000 TPH to ensure faster turnaround of vessels at berth.

The major components of the mechanized bulk import system are:

- Ship unloaders
- Stacker cum Reclaimer units at stackyard
- Wagon Loading System
- Connected Conveyor system

7.7.1.2 Ship Unloaders

The bulk berth shall be provided with two numbers rail mounted gantry type Grab Unloaders of designed capacity of 2,200 TPH each. This shall enable average total unloading capacity of about 2500 TPH throughout the ship discharge operation. However, the actual unloading capacity could be lower while unloading a partly loaded panamax ship due to higher proportion of bottom cargo.

The material from the grab of the ship unloaders is discharged into a central hopper integral with each unloader which is mounted on the gantry frame fitted with load cells. From the hopper a VVVF driven belt feeder shall transfer the material at an adjustable rate via a chute into the elevated jetty conveyor provided on the rear side of the rear crane rail.

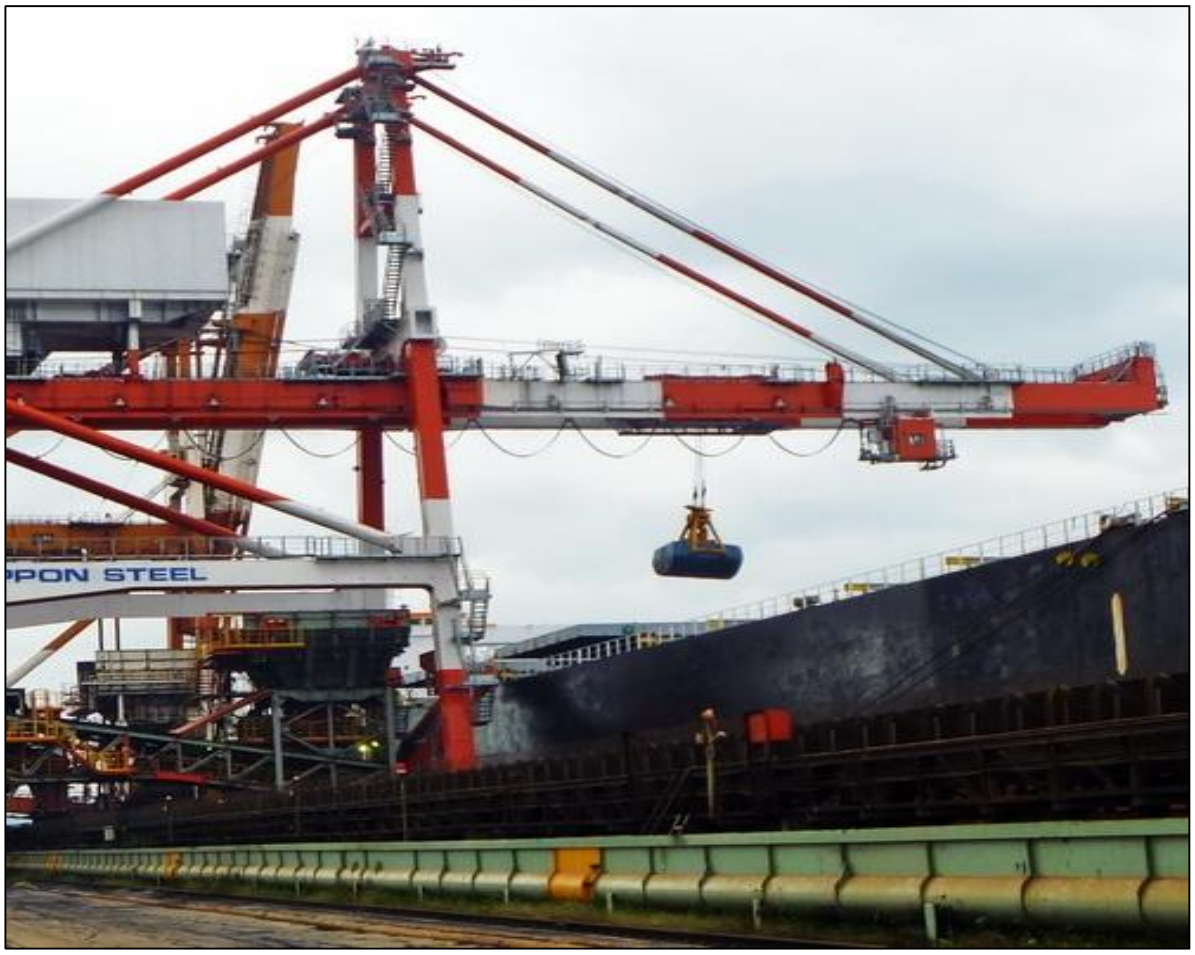


Figure 7.7 Typical Ship Unloader

Unloaders on the jetty shall have adequate under clearance to allow movement of general purpose cargo handling equipment for operation / maintenance requirement.

The same system is proposed to handle thermal/ coking coal and iron ore cargo by means belt cleaning arrangement. The system consists of suitable pump, storage tank, nozzles for belt cleaning at discharge / feeding points of belt conveyors at each transfer tower for efficient belt washing system.

In addition to above suitable spray system shall also be provided at ship unloader, coal stackyard and wagon loading station.

7.7.1.3 Conveyor System

The material unloaded from the ship will need to be conveyed to the stackyard. The ship-unloading rate typically peaks during initial operation of a ship, when the cargo holds are full and conditions are favourable for “cream digging”. The conveying system will be rated for such operations and short-term surges, as anticipated. However, the required conveying capacity will reduce as the ship is progressively emptied. The designed capacity of the connected conveyor is 4400 TPH.

The conveyor galleries will be covered, for environmental protection. At road crossings, the conveyor galleries will have a clear height of at least 6 m.

7.7.1.4 Stacking and Reclaiming

It is proposed to provide four stacker-cum-reclaimer units at the stackyard. This equipment shall be used to receive thermal/ coking coal and iron ore from the ship and stacking in different rows in the yard. The same equipment shall also be utilised to reclaim these cargoes from stackyard for further transportation by conveyor to Wagon loader. The Stacker cum Reclaimer units will travel on ballasted tracks and slew through the requisite angles. The rated capacity of stacker cum reclaimer is 4400 TPH.

7.7.2 Break Bulk Handling System

7.7.2.1 Container

The projected container traffic is in the initial phase of development is only 25,000 TEUs per annum in the initial phase which increases to 53,000 TEUs per annum in the year 2035. In view of the limited throughput, it is proposed to handle the containers at the multipurpose berth. Mobile Harbour Cranes (MHCr) fitted with the spreader attachment are well proven for the efficient handling of containers.

Figure 7.8 Mobile Harbour Crane with Spreader Arrangement

This arrangement will have benefit in the sense that the cranes can also be used to handle breakbulk cargo.

7.7.2.2 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 NOX, PM, CO emissions can be reduced at greater level with use of E-RTGs. **Figure 7.9** shows an E-RTG in operation.

Figure 7.9 Typical E-RTG for Yard Operation

Figure 7.10 Typical Details of Electric Buss Bar Arrangement for E-RTG

7.7.2.3 Reefer Load Container Storage

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.

Figure 7.11 Typical 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.

7.7.2.4 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.

Figure 7.12 Snapshot of Typical Reach Stacker Handling

Considering the throughput of the import export containers of gateway traffic, it is proposed to provide one numbers of Reach Stackers for train loading/unloading and handling in the stackyard.

7.7.2.5 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.

Figure 7.13 Typical ITV for Handling Containers

7.8 Road Connectivity

7.8.1 External Road Connectivity

As discussed in section 2.10.2, roads connecting to NH 17 from project site passes through a dense population at Ankola town and any upgradation of road will lead to displacement of people and related R&R issues. A new road alignment is proposed in order to have minimal R&R as shown in **Figure 7.14**.

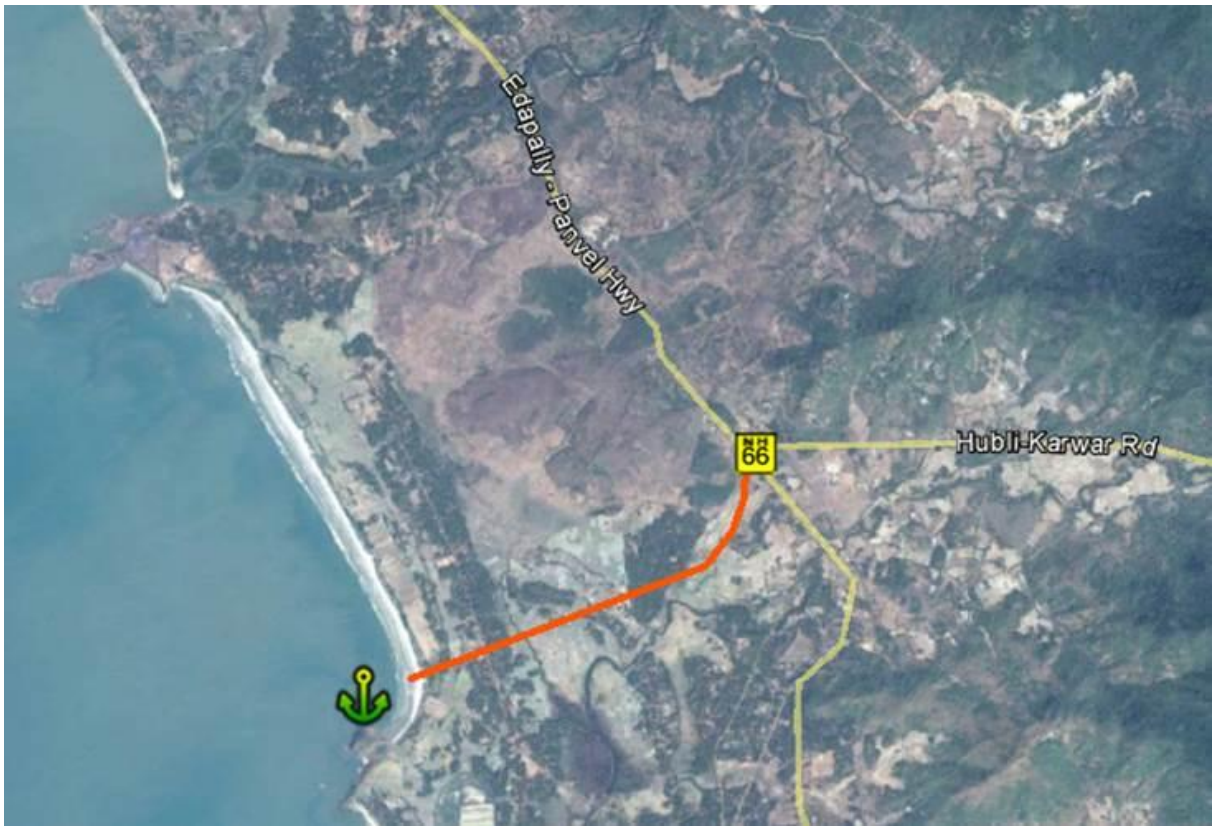


Figure 7.14 Proposed Alignment of External Road Connectivity

7.8.2 Internal Roads

The main approach road to the port shall be located parallel to the backup area. Within the terminals internal roads shall be planned based on the cargo handling and storage plans with 1 way circulations to avoid any criss crossings.

7.9 Rail Connectivity

7.9.1 External Rail Connectivity

Three alternatives alignments were analysed to provide rail connectivity to the port as shown in **Figure 7.15**.

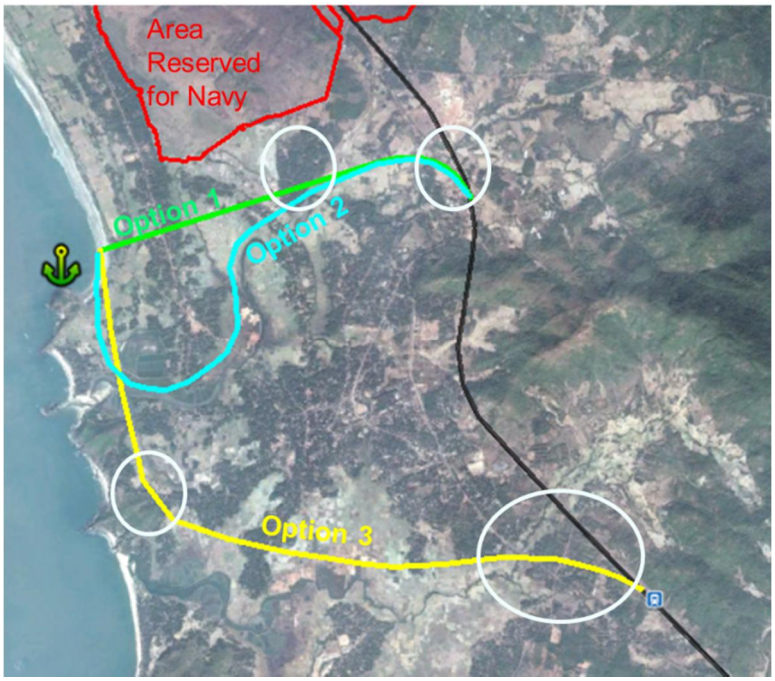


Figure 7.15 Alternative Rail Alignment to Port at Belekeri

Option 1: The route is about 4.2 km and traverse through Bhavikeri village. It also passes through a hill.

Option 2: This option provides a route length of about 6.6 km along the creek and is provided to avoid habitation of Bhavikeri village. It also traverses though a hill. This route will need 3-4 bends, which may present technical challenges for rail alignment.

Option 3: This route is largest of the three (8 km) and was assessed to avoid population and sharp bends in alignment. This would require passing through two hills and will need 1 minor bridge.

Out of the three options, Option 1 is found to be most suitable as it is shortest, requires lesser land acquisition, and does not involve construction of any major bridge.

However options 1 and 2 are very close to the navy boundary and would hinder any expansion plans of Navy that may be needed to increase the runway length in future. There are no documented details available of area that will be required but this must be duly taken into account at the DPR stage. In case of expansion plans of Navy go through, options 1 and 2 will not possible and hence only alignment that will be possible is Option 3. Both rail and road will have to follow this option for connectivity, which will require higher capital cost as compared to the suggested options.

7.9.2 Internal Rail Links

The internal rail lines will be developed so that the rakes for bulk cargo could be taken to the wagon loading system. It shall be ensured that their location does not obstruct the movement of port vehicles. At the bulk import yard two rail sidings shall be provided including one engine escape line. A separate siding for the handling of breakbulk and containers shall be provided.

7.10 Port Infrastructure

7.10.1 Electrical Distribution System

7.10.1.1 Introduction

The handling systems for bulk loading and unloading are power intensive and hence require considerable high tension electrical power for their operation. This apart the illumination of the terminal areas, stacking areas, storage sheds, roads and auxiliary services viz., dust suppression system, firefighting system and port buildings would all require considerable HT and LT power. The various terminals within port will contain all the features of a modern first class terminal, and as such will require a reliable power supply system.

7.10.1.2 Estimation of Electrical Load

Based on the proposed port facilities the total installed power load for the proposed Phase 1 development are estimated to be around 13 MVA. This is expected to go up to 19 MVA over the proposed master plan horizon.

7.10.1.3 Source of Power Supply

Power supply to Port at Belekeri shall be tapped from the existing grid. It is proposed that the transmission lines be tapped off and extend up to the proposed location of the main receiving substation at the port.

7.10.1.4 Incoming Supply – System Requirements

The HT power shall be brought at 33 KV till the port boundary, where the main receiving substation shall be located. This outdoor switch yard will have two numbers of 33 KV transformers with 15 MVA rating and convert the power at the secondary voltage of 11 KV. Of the two transformers, one will be main and the second will be a stand by and each transformer is designed is to cater to 100% of the maximum demand of the port.

7.10.1.5 Distribution of Power

11 KV feeders from main receiving substation will feed the substations. The distribution of power in the terminals shall be through this substation.

The substations will be equipped with a 11KV /0.415 KV transformer of suitable capacity to cater to LT loads of different buildings for illuminations, area lighting, street/road lighting, firefighting, water supply system, etc. The substation shall be equipped with capacitor banks for automatic power factor correction and for maintaining a PF of not less than 0.9.

7.10.1.6 Standby Power Supply

It is proposed to install one diesel generator of 2 MVA in the substation. This would serve as standby to provide power backup for lighting and emergency loads during failure of mains.

7.10.1.7 Illumination

The illumination level in various areas will be maintained as per the industry standards and shall generally be as in **Table 7.5** below:

Table 7.5 Illumination Level

Area	Lux Level
Gate houses, Buildings	50
Transfer House	150
Substation, pump houses and fire houses	250
Workshops	200-300
External illumination (Road Lightings), Parking	15-20
Stock pile areas and open storage areas	20-30
Berths	50
Conveyor galleries	50

For transfer house, high-pressure sodium vapour fixtures (SON) will be provided. For illumination of street, road, and conveyor galleries poles of suitable height with HPSV fittings will be installed. Power supply will be made available from suitably located feeder pillars. For illumination of roads 9 metre high steel tubular type pole with 250 W HPSV street light fixtures shall be provided. For stackyard area high mast (30 m) and for berth area high mast (40 m) with HPSV (SON) will be installed.

7.10.1.8 Cables

To meet the HT load requirement 11 KV XLPE aluminium armoured cables will be used. Cables will be laid on cable trays, ducts, directly buried in ground and in trenches, etc. as per site requirement.

LT power distribution to various services such as illumination, firefighting, air conditioning water supply etc. will be done through 1.1 kV grade PVC insulated aluminium armoured power cables. Laying of cables will be done as per site requirement.

Internal wiring to be done in recessed UPVC conduit or on surface with GI conduit and single core PVC insulated FRLS copper wire to be done in case of transfer towers, conveyors, workshops, substations, pump house, fire house, etc.

7.10.1.9 Earthing & Lightning Protection

Suitable lightning protection system will be installed as per the guide lines of the IS: 2309. An efficient earthing and lightning protection system will be designed to ensure protection of men & material in worst of the weather conditions.

7.10.1.10 Power Factor Improvement

Suitable rating HT capacitors with automatic power factor correction arrangement will be installed to maintain the overall power factor correction to 0.97.

7.10.2 Communication System

7.10.2.1 General

The Communication system comprising Radio Communication units, Telephone System and PA system of suitable capacities will be provided to suit the port operation requirement.

7.10.2.2 Telephone System

To meet the total port requirements, an EPABX of 100 lines capacity will be installed. Suitable telephone instruments to suit the site requirement with adequate protection will be provided.

7.10.2.3 Radio Communication

A radio communication system will be installed for transfer of information between various operational areas of port like Unloaders, MHCr, shore side duties, control room, terminal engineering services, operational management, supervision etc.

7.10.2.4 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 located at top floor of the administrative building.

Distribution type public address system will provide a comprehensive paging system for oral communication and announcement by loud speakers and handset stations with built-in amplifiers covering all working areas of the port terminal. The loud speakers will be mounted on purpose built supports provided on permanent structures. The exterior speakers will be weather proof. One number master control station with microphone to zone selection and all call facility will also be provided at control room.

7.10.3 Computerized Information System

7.10.3.1 Overall Objectives

The computerised information system proposed for proposed port will have the following objectives:

- Establish one common IT infrastructure that is based on scale operations in order to deliver services of high quality.
- Enable centralized control of the Infrastructure to ensure effective management and security.
- Ensure mobility of users located at different office premises by providing the necessary services to ensure connectivity from anywhere.
- Utilize best practices for technology selection and implementation.

7.10.3.2 Terminal Operating System

Terminal handling equipment will have control systems to maintain and manage bulk terminal operations. These control systems will be interfaced with BI systems for reporting and MIS. Terminal Operating systems will be deployed for handling the following processes:

- Berth Planning
- Terminal Planning, Monitoring and Execution processes
- Operations Equipment Control (OEC)
- Cargo Control (CC)
- Yard Planning, gate delivery and receipt control
- Landside planning processes
- Enterprise Resource Planning

7.10.3.3 Technology Infrastructure

The IT Infrastructure of Port at Belekeri like hardware, software, network etc. will be implemented according to a long-term strategic plan. The capacity plan includes the necessary infrastructure for the IT strategy development as well as to support the general day-to-day IT requirements.

7.10.4 Water Supply

7.10.4.1 Water Demand

The water demand for the Port at Belekeri Port has been worked out in the **Table 7.6** below:

Table 7.6 Estimated Water Demand for proposed Port at Belekeri

S. No.	Consumer	Water Demand (KLD)	
		Phase 1	Master Plan
1.	Raw Water (KLD)	908	1,840
2.	Potable Water (KLD)	42	51
Total Water Demand at Port (KLD)		**950**	**1892**

7.10.4.2 Sources of Water Supply

The water requirement for the port shall be sourced from Honnaili Water Supply Scheme which is 10 km from the port. Alternatively, the option of providing dedicated desalination plant could also be examined at the detailed engineering stage.

7.10.4.3 Storage of Water

The water supply from the main header shall be fed to the underground water tank of 1000 cum located at the port boundary which is equivalent to one day consumption. Water from this tank shall be treated in the water treatment plant, consisting of chlorination, filtration and softening units (depends on the water quality test). Potable water shall be stored in the underground domestic water tank of 50 cum capacity for potable use. For this purpose a small filtration plant is provided at this place. This treated water will be stored in a sump adjoining the main sump for the raw water. The water treatment plant must ensure that it produces water of acceptable quality as per the provisions of IS 10500: 1991.

The water from the main sump would be pumped to secondary sumps of 500 cum capacity each located near the stackyard. The secondary sump at multipurpose terminal shall be split into three compartments of 200 cum, 200 cum and 100 cum. The compartment of 200 cum will retain water permanently for firefighting; the compartment of 100 cum will be used for water supply to buildings and greenery. The third compartment of 200 cum will provide water for dust suppression system in the bulk import terminal.

7.10.5 Drainage and Sewerage System

7.10.5.1 Drainage System

Storm Water Drainage at the port will be through a system of underground covered drains provided to discharge the collected runoff. At the bulk import stackyard, the drainage system would comprise of open drains for taking the discharge to the settling pond. Before discharging the collected storm water into the main drainage system of the port it would be passed through the necessary filters for further reduction of PPM.

Surface drainage system shall be provided in the container yard and other dry storage area through which water shall be diverted to the secondary covered drains, which shall ultimately discharge to the main drain.

7.10.5.2 Solid Waste Management

For the buildings complex having administration building and port user buildings, a small sewage treatment plant of 20 KLD capacity is proposed. The treated sewage shall be discharged to the main drainage network. The sludge from the treatment plant will be processed and converted into Biomass used as manure.

For the isolated buildings where the quantity is negligible, it is proposed to construct septic tanks and connect the septic tank outlets to soak pits for disposal.

There will be very little sewage water generated at the quay walls and hence separate treatment proposals are not contemplated.

7.10.6 Floating Crafts for Marine Operations

7.10.6.1 Tugs

For berthing / un-berthing of the design vessels four harbour tugs of 50 T bollard pull capacity are required initially, including tug for standby/ emergency.

7.10.6.2 Pilot cum Security Vessels

These vessels are required for the pilots to travel to and fro between the port and boarding point, where the port's pilot will embark/disembark the ship. It is proposed to provide two pilot vessels including one standby vessel.

7.10.6.3 Mooring Boats

These boats will be required to carry the lines from the ships and pass it to the required points during berthing and un-berthing operations. Two boats are required per vessel for berthing and un-berthing operations. Considering the frequency of the ships, two mooring boats are considered adequate for Phase 1.

7.10.6.4 Harbour Crafts

The requirements of Harbour Crafts for the Phase 1 development of port of Belekeri are given in **Table 7.7** below.

Table 7.7 Harbour Craft Requirements

S. No.	Harbour Craft	Number
1.	Tugs 50 T bollard pull	4
2.	Pilot cum Security Vessels	2
3.	Mooring Boats	2

7.10.7 Navigational Aids

7.10.7.1 General

It is envisaged that navigation will be carried out throughout the year, by day and night, except during cyclonic weather, when rough seas, high wind speeds, and negative storm surge may result in low/inadequate draft. Navigation aids are required for ensuring safe navigation of ships entering and leaving the port through the approach channel as well as berthing / un-berthing requirements inside the docks. These aids are such as fairway buoys, port and starboard buoys, leading / transit lights, beacons and Vessel Traffic Management Information System (VTMIS) etc., which are installed on land or in water for guidance to all vessels for safe and regulated navigation in channels, anchorages, berths and docks. VTMIS will have the requisite communication, Radar system integrated into it.

7.10.7.2 Buoys

The approach channel has a total length of 12 km from the breakwater head which require safe navigation and pilotage. It is necessary to mark the channel with suitable number of navigational buoys by following the IALA zone ‘A’ code. Considering the need to provide adequate assistance for safe navigation of the ships, it is recommended to provide paired buoys at a spacing of 1 Nautical mile. In addition some buoys are proposed in the harbour basins as well. IALA maritime buoyage system as per region A, in which Belekeri port falls, will be followed. The lateral marks will be red and green colours to denote the port and starboard sides of channel.

7.10.7.3 Leading / Transit lights

Considering the channel being straight and long and adequately marked with navigational buoys, it is not proposed to install any leading / transit lights to guide the ships through the channel.

7.10.7.4 Beacons / Mole lights

One Beacon at breakwater head is proposed to be provided.

7.10.7.5 Vessel Traffic Management System (VTMS)

The purpose of the VTMS is to provide a clear and concise real time portrayal of vessel movements and interaction in the Vessel Traffic Service (VTS) area. For Belekeri Port, the service area will be the approach channel, the anchorage area, the harbour basin etc. This system will be used for marine operations and will also be linked to the PMIS (Port Management and Information System). The information provided by VTMS system allows the operator or user of the system to:

- Provide the required level of VTS: Information, Assistance or Organisation
- Enhance safety of life and property
- Reduce risks associated with marine operations
- Enhance efficiency of vessel movements and port marine resources
- Distribute VTS related information
- Provide Search and rescue assistance
- Provide VTS data for administrative purposes, analysis of incidents and planning

The VTS in recent years has changed from Traffic Monitoring to Traffic Planning by introduction and interconnection of databases and expert systems. It allows access of static and dynamic information about ships, their cargo and port service requirements. Together with an automatic update of traffic information the VTMS provides a powerful tool for programming of traffic movement within the surveillance area. Operators can associate tracked targets with vessels registered in the database, which makes the data readily available and allows the system to automatically provide pertinent voyage information to other port service providers.

7.10.8 Security System Complying with ISPS

Security system of the port is required to provide sufficient protection against:

- Sabotage
- pilferage and thefts
- encroachments by unauthorised persons
- trespassers and antisocial elements

The security system must comply with the requirements of ISPS Code.

Keeping in view the importance of various areas in the port, the following proposals are made:

- The custom bound area will be provided with a rubble masonry wall 2.4 m high with barbed wire fencing of 1 m high over the wall.
- A security office and check post at the entrance to the terminals.
- Provision of watch towers at suitable intervals for manual monitoring with night vision binoculars for use during nights.
- Adequate isolated area would be allocated for storage of dangerous goods
- The lighting in the port area shall be to the acceptable standards
- Close circuit Television system (CCTV) to capture activities at all vantage, vulnerable and sensitive locations.

The security arrangements proposed would have to be to the approval of the Director General of Shipping who is the designated authority under the ISPS code.

7.10.9 Firefighting System

7.10.9.1 General

The firefighting system shall be designed to be capable of both controlling and extinguishing fires. The firefighting system for berths and terminal areas will be a fresh water system with a separate pump house with pumps which will draw water from the respective fresh water tanks.

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

7.10.9.2 Dry Bulk Berths and Stackyard

It is proposed to install Fire Hydrant System, which shall be designed to give adequate fire protection for the facility based on Indian Standard or equivalent and shall conform to the provisions of the Tariff Advisory Committee's fire protection Manual.

Fire hydrant system is proposed at the following areas, which are classified as ordinary hazard areas.

- Berths
- Stackyards
- Wagon Loading Station
- All galleries of Coal Conveyors

The fire hydrant system shall be designed to ensure that adequate quantity of water is available at all times, at all areas of the facility where a potential fire hazard exists. Each hydrant connection shall be provided with suitable length of hoses and nozzles to permit effective operation.

7.10.9.3 Container cum Multipurpose Terminal

The firefighting system shall be designed to give suitable fire protection for the containerised/breakbulk cargo and container handling facilities in the terminal and shall conform to the provision of Tariff Advisory Committee's fire protection manual. The firefighting system shall be a combination of water hydrants, fire alarm system and fire extinguishers.

7.10.10 Pollution Control

7.10.10.1 General

One of the essential regulatory functions of a Port Authority is to ensure that the port waters are free from pollution. To this end, pollution control assumes a significant role in any port operations. The main sources of pollution during operations 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.
- Dust from cargo.
- Smoke from ships, vehicles.
- Noise from vehicles, machinery.
- Accidents

7.10.10.2 Dust Suppression

Dust control equipment is proposed for efficient control of dust pollution to the environment during storage and handling of thermal coal at the berth and stackyard. An efficient dust suppression system will contain dust particles before it becomes airborne.

A system consisting of pumps, storage tank, nozzles for dust suppression at discharge / feeding points of belt conveyors have been proposed at each transfer tower for efficient dust control. In addition to above, suitable spray system shall also be provided at ship unloader, coal stackyard and wagon loading station.

The water pumping system shall be designed to operate only when it is required thus saving energy. The spray in dust generation area shall operate only when material is being handled in that location.

8.0 ENVIRONMENTAL SETTINGS AND IMPACT EVALUATION

8.1 Introduction

This section presents environmental conditions in and around the proposed port location at Bhavikeri about 4 km south of Belekeri. It briefly describes general environmental conditions of the project area, i.e., physical environment, flora and fauna; identifies environmental issue that may arise due to the considered project and its components, suggests mitigation measures to minimise adverse impacts. This section also details environmental policies and legislation to highlight the permissions and clearances required for the project.

The section is largely based on the review of literature, available secondary data and information gathered during the site visits.

8.2 General

Bhavikeri is located in Ankola Taluka of Uttara Kannada District in the state of Karnataka. As per Census of India 2011 it has total population of 8160 from 1911 households. Total male population is about 4058 as compared to 4102 females. Average Sex Ratio of Bhavikeri village is 1011 which is higher than Karnataka state average of 973. Bhavikeri village has higher literacy rate of 83.66%, where 90.52% males and 76.91% of females are literate.

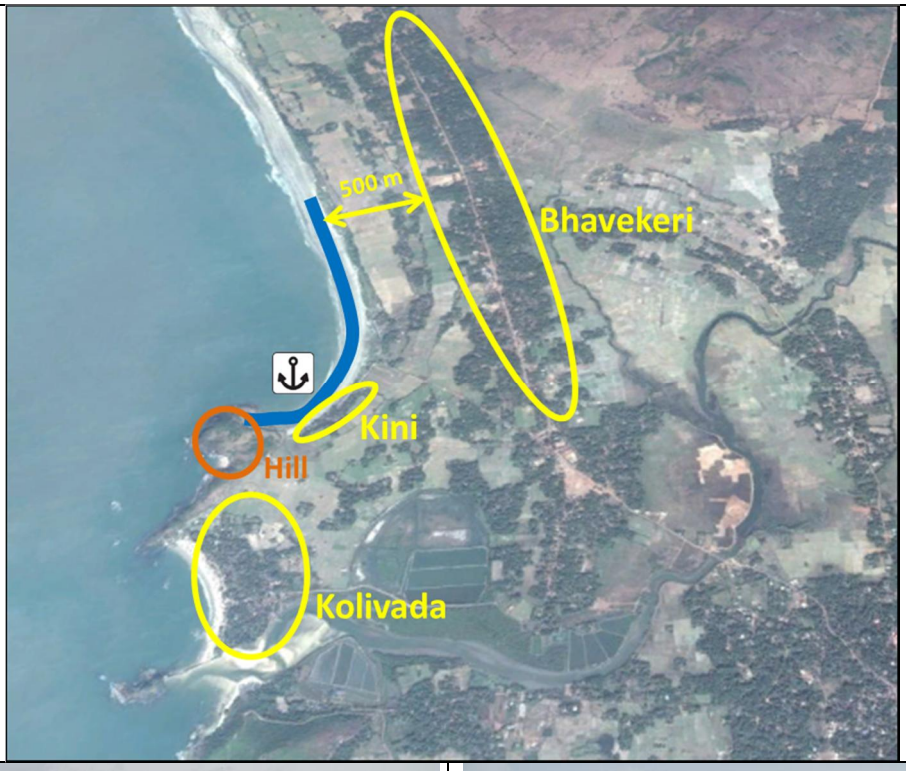
Rain-fed agriculture activities are prevalent in the area where rice and groundnut are sown predominantly. Other crops that are grown in this area are coconut, Arecanut, Cashew, Banana, Water Melon and other leafy vegetables.

8.3 Site Setting

A Greenfield port is planned to be developed on the coast near the Bhavikeri village. The waterfront identified for port development has a small village Keni in the immediate vicinity, while Bhavikeri village is about 500 m east of the sea coast (**Figure 8.1**).

About 100-120 households were found to be located in the village Keni and a total population of about 2000 has been reported. The villagers are mainly involved in small scale fishing and also agricultural activities.

The coast has rocky outcrops and is also demarcated as stable (**Figure 8.2**).



Proposed site with coconut plantation in the backdrop

Proposed site with habitation of Keni Village and Hill in the backdrop

Habitation at Keni

Agriculture fields behind Keni Village

Figure 8.1 Location of the Proposed Site

Figure 8.2 Coastal Stability Map of Uttara Kannada District

[Source: ChenthamilSelvan et al, 20141]

8.4 Environmental Policies and Legislation

Table 8.1 presents Environmental regulations and legislations relevant to this project, along with the details of the competent authority for implementation.

Table 8.1 Summary of Relevant Environmental Legislations

S. No.	Act/Rule/ Notification, Year	Relevance	Applicability	Implementing Agency
1.	Environment Impact Assessment Notification and amendments made thereafter, 2006	· For environmental clearance to new development activities following environmental impact assessment	Yes, Category A. For port having cargo more than 5MTPA.	MoEF&CC
2.	Indian Forest Act, 1927 Forest (Conservation) Act, 1980	· Conservation of Forests, Judicious use of forestland for non-forestry purposes; and to replenish the loss of forest cover by Compensatory Afforestation on degraded forestland and non-forest land	No forest land is involved in the project.	MoEF&CC; Department of Forest, GoK

[1] ChenthamilSelvan et al, 2014, Assessment of Shoreline Changes along Karnataka Coast India, using GIS and Remote Sensing Techniques, Indian Journal of Marine Science, Vol 43(7).

S. No.	Act/Rule/ Notification, Year	Relevance	Applicability	Implementing Agency
		· Permission for tree felling		
3.	Wild Life (Protection) Act, 1972	· To protect wildlife in general and National Parks and Sanctuaries in particular · Permission for working inside or diversion of sanctuary land	Pulicat Lake Bird Sanctuary is within 10 km radius	Chief Conservator of Wildlife, Wildlife Wing, Forest Department, GoK; National/State Board for Wildlife
4.	The Water (Prevention and Control of Pollution) Act, 1974	· CPCB/ SPCB to establish water quality and effluent standard; monitor water quality; prosecute offenders · Issuance of Consent to Establish (CTO) and Consent to Operate (CTP)	Yes, Consent required to establish and not to pollute water during construction and operation	Karnataka Pollution Control Board
5.	The Air (Prevention and Control of Pollution) Act, 1981	· CPCB/ SPCB to establish air quality and emission standard; monitor air quality; prosecute offenders · Issuance of Consent to Establish (CTO) and Consent to Operate (CTP)	Yes, Consent required to establish and not to pollute air during construction and operation	Karnataka Pollution Control Board
6.	Noise Pollution (Regulation and Control) Rules, 1990	· Standard for noise	Yes, construction machinery to conform to noise standards	Karnataka Pollution Control Board
7.	The Motor Vehicle Act, 1988 Central Motor Vehicle Rules, 1989	· Licensing of driving of motor vehicles, registration of motor vehicles, with emphasis on road safety standards and pollution control measures, standards for transportation of hazardous and explosive materials. · Issuance of Pollution Under Control (PUC) certificate to vehicles used in	Yes, all vehicles shall comply with these provisions	State Motor Vehicle Department
8.	The Explosive Act (& Rules), 1884	· Regulations with regard to the usage of explosives and suggests precautionary measures while blasting and quarrying	Yes, If new quarrying activity needs to be undertaken for construction material	Chief Controller of Explosives.
9.	Public Liability and Insurance Act, 1991	· Protection to general public from the accidents due to hazardous material	Yes, Any hazardous material used as raw material or waste for activities	District Collector
10.	Hazardous Wastes (Management and Handling Rules), 1989	· Guidelines for generation, storage, transport and disposal of Hazardous waste · Issuance of authorisation for all above mentioned activities.	Yes, NOC to handle any hazardous waste, i.e., waste oil from machineries etc.	Karnataka State Pollution Control Board
11.	Mines and Minerals (Regulation and Development), Act, 1952, 1996	· Permission of mining of aggregates and sand	Yes, mining of borrow material to be undertaken.	Department of Mines, GoK
12.	The building and other construction workers (regulation of employment and conditions of services) Act, 1996	· Employing labour/ workers	Yes, as construction workers will be appointed	District Labour Commissioner

Apart from the environmental stipulations mentioned above, other acts applicable for the project are Child Labour (Prohibition and Regulation) Act, 1986; The Factories Act, 1948 and The Minimum Wages Act, 1948.

8.5 Anticipated Environmental Impacts and Mitigation Measures

Potential impacts on environment due to the proposed port project have been summarized in **Table 8.2**. The impacts due to the project location are generally irreversible and cannot be mitigated through environmental enhancement measures. However, impacts related to construction are normally short term, which can be off-set to a large extent by observing a set of precautionary measures. The impacts during operation phase are permanent and can be mitigated following environment management plan provided in next section strictly.

Table 8.2 Potential Environmental Impacts

Environmental aspects	Pre-construction/ Land Acquisition/Construction		Operation	
	Activities	**Potential Impacts**	**Activities**	**Potential Impacts**
Impact on Land & Soil Environment	· Quarrying for fill material · Construction of road and rail · Clearing of site and land levelling · Dumping of liquid and solid waste from labour camps, stack yards, workshops etc. · Construction of breakwater	· Change in land use · Loss of trees/vegetative cover hence increase in soil erosion · Soil contamination due to dumping of solid waste (municipal and construction) and spillage of hazardous waste, i.e., oil or other chemicals. · Shoreline changes	· Dumping of liquid and solid waste from labour camps, stack yards, workshops etc. · Spillage of cargo and hazardous material/waste	· Shoreline changes due to permanent breakwater structures · Contamination due to spillage
Impact on Water Environment	· Construction of road and rail · Setting up of Labour camps · Dredging and construction	· Change in natural drainage · Water Pollution from labour camps · Increase in turbidity due to dredging and construction activities	· Handling and Storage of cargo such as coal, iron ore etc. · Sewage generation · Oily effluent from maintenance area · Discharge of bilge and ballast water · Maintenance dredging	· Change in marine water quality due to wastewater from stack yards, sewage, bilge and ballast. · Oil spill from vessels serving port · Increase in turbidity
Impact on Air Environment	· Operation of vehicles and construction machinery · Fuel burning at labour camps	· Dust emissions due to construction activities and vehicle movement · Emissions from labour camps, vehicles, machinery and DG sets	· Vehicle movement · Cargo Handling	· Vehicular pollution · Emission from ore and coal handling
Impact on Noise Environment	· Operation of vehicles and construction machinery · Quarrying and transportation of material to the site.	· Increased noise levels from heavy machinery and increased human activities	· Operation of vehicles and machinery Including stand-by generators	· Increase in noise · Health impacts on workers

Environmental aspects	Pre-construction/ Land Acquisition/Construction		Operation	
	Activities	Potential Impacts	Activities	Potential Impacts
Impact on Ecology	· Quarrying for fill material · Construction of road and rail · Clearing of site and land levelling · Reclamation and dredging	· Loss of vegetation due to site clearing including mangroves · Loss of habitat to birds and small animals · Impact of dredging and dumping of dredged material on marine flora and fauna	· Cargo Handling · Maintenance dredging	· Impact of dredging and dumping of dredged material on marine flora and fauna.
Impact on Socio-economic	· Construction activities · Traffic Movement · Influx of outside workers/ population	· Hindrance in the fishing activities · Discomfort to nearby communities due to noise, air and water pollution · Loss of land/ livelihood in case of rail and road development · Relocation of CPR and utilities for rail and road development · Increased traffic movement	· Operations · Traffic movement	**Negative Impacts** · Discomfort to nearby communities due to noise, air and water pollution · Restrictions to the fishing activities · Reduction in fish catch. **Positive Impacts** · Increased Jobs · Increased Business opportunities · Better roads · Community development programs

8.6 Impacts During Construction Phase

The construction phase, in general, has adverse influence on all the components of environment. Most of these impacts are short lived and reversible in nature, hence proper care is must to minimize the disturbance so as to the restoration of natural and ecological services.

8.6.1 Impacts on Land and Soil

The proposed port is planned on reclaimed land between shoreline to 5 m depth. Thus, no land is required for port development and only activities that require land are road and railway connectivity development. Thus, vegetation clearing will be kept to the minimum.

The anticipated impact of the project are soil contamination that may be caused from roadside litter, oil spillage from machinery, sanitation and waste disposal, spillage of hazardous chemicals etc. Any soil contamination will also impact marine water as the site is located in the intertidal region.

Mitigation Measures

Considering the activities and their impact on land and soil the following mitigation measures are discussed below.

- Vegetation clearance shall be confined to the minimum area required for the project.
- Re-plantation shall be taken up followed by construction in another identified area.
- All the waste has to be collected and nothing to be dumped on land or water.
- The contractor will be held responsible to clean all debris before leaving the construction site and also to make necessary arrangements with scrap dealers to sell off the waste scraps.
- The waste from labour camps and administrative activities during construction will all be disposed to a designated solid waste collection point.

8.6.2 Impacts on Water Quality

Impacts on water resource are two-fold, one increased water demand and disposal of waste water.

Additional water demand due to this project is anticipated towards construction activities and drinking water needs for labours and employees. The water will be sourced from Honnalli Water Supply scheme, for which all the required permissions from the state authorities will be sought.

It is generally assumed that 80% of the domestic consumption is generated as sewage, which if discharged untreated will act as a source of water pollution. During construction phase, sewage of 20 m^3/day is expected to be generated.

Other sources of contamination are accidental disposal of construction debris and spillage of oil and grease from the vehicles and construction machineries.

The construction activities have potential influence on the water resources within the activity area. The pile driving, rock cutting and dredging will cause high turbidity, removal of nutrient due to dredging, which would ultimately affect the marine flora and fauna.

Natural drainage may be impacted due to the provision of the road network and hence it needs careful planning.

Mitigation Measures

In order to mitigate negative impacts on water that are expected from the projects, the following measures will be implemented:

- Bore wells, if required to source water for construction phase will be drilled after an exhaustive historical study of the region and after obtaining necessary permission and approvals from the state water board or Central Ground water Authority.
- Water cess shall also be paid to relevant authority.
- The embankments of any surface water bodies will be raised to prevent contamination from run-off.
- Workers shall be provided proper sanitation facilities including mobile toilets or 10 ‘Sulabh Shauchalayas’ (community toilets).
- All the waste water will be collected and treated using soak pits and sludge from soak pits will be cleaned.
- The construction site and camp will be provided with temporary drainage.
- Avoid water stagnation/ ponding near work and camp sites to curb vector borne diseases.
- Fuel/ oil storage will be stored away from any watercourses.
- Leakage of oil wastes from oil storage and vehicles shall be avoided in order to prevent potential contamination of streams or ground water.

- Surface runoff from machine operations, oil handling areas/devices will be treated for oil separation before being discharged into the sea or river.
- Waste Oil/ grease/ lubricants are categorized by MoEF as Hazardous Wastes. All such waste will be collected and stored at a protected place and sold to a vendor authorized by KPCB or MoEF.
- No construction activity will be undertaken during monsoon period.
- Use of silt curtains is recommended to confine areas of high turbidity during dredging and pile driving.
- To avoid impacts from dumping of dredged material the following measures shall be adopted:
  - Most of the quantity of dredged material will be used as reclamation material and for revetments.
  - Limited material, which will not be suitable for reclamation, will be disposed off at an identified site beyond 20 m depths in the sea.
  - Areas with high fish yield or used by locals for fishing shall be avoided.
  - Dumping activity shall not be carried out during monsoon season.
  - To reduce the potential for error on the part of the contractor, efforts should be made to monitor regularly the activities during dredging and disposal of spoils.
  - Where appropriate, disposal vessels should be equipped with accurate positioning systems. Disposal vessels and operations should be inspected regularly to ensure that the conditions of the disposal permit are being complied with and that the crews are aware of their responsibilities under the permit.

8.6.3 Impact of Air Quality

Air emissions due to construction activities, fuel burning, vehicle movement, machinery and DG sets are the most significant sources of air pollution during construction phase.

Air pollution can cause significant impacts on the environment, and subsequently on humans, animals, vegetation and materials. It primarily affects the respiratory, circulatory and olfactory systems in humans. In most cases, air pollution aggravates pre-existing diseases or degrades health status, making people more susceptible to other infections or the development of chronic respiratory and cardiovascular diseases.

Mitigation Measures

- Power supply from State Electricity Board shall be sourced for electrically operated construction machinery/equipment.
- The use of DG set would be limited to backup during power failure.
- Dust suppression systems (water spray) will be used near the earth handling sites, asphalt mixing sites and other excavation areas to reduce the wind-blown fugitive dust emissions.
- Earth moving equipment, such as bulldozer with a grader blade and ripper will be used for excavation work.
- Excess idling of construction equipment as well as vehicles to be prohibited.
- Vehicles and construction equipment will be fitted with internal devices i.e. catalytic converters to reduce CO and HC emissions.
- All stationary machines/ DG sets / construction equipment emitting the pollutants will be inspected weekly for maintenance and shall be fitted with exhaust pollution control devices.
- Vehicles and machineries will be regularly maintained to conform to the emission standards stipulated under Environment (Protection), Rules 1986.
- “No Objection Certificate (NoC)” for setting up of crusher, hot-mix plant and DGs will be obtained from Karnataka Pollution Control Board.

- Ensure that all vehicles must possess Pollution under Control (PUC) Certificate and shall be renewed accordingly.
- All the roads in the vicinity of Port site and the roads connecting quarry sites to construction sites will be paved to minimize the fugitive emissions.
- If any of the road stretches are not paved due to some reason, then adequate arrangements will be made to spray water on such stretches of the road.
- The labours shall be provided with clean fuel so that they neither cut the trees for fuel wood nor burn firewood.

8.6.4 Impacts on Noise Quality

During construction phase, there could be high noise levels due to operation of various construction equipment and increased number of vehicles supplying man and material to the site. It is known that continuous exposure to high noise levels above 90 dBA affects the hearing acuity of the workers/operators or residents and hence, require mitigation planning.

Mitigation Measures

- The construction works will be carried out during the day time. The work hours should be limited depending on convenience of the local people.
- Noise levels of machineries used shall conform to relevant standards prescribed in Environment (Protection) Rules, 1986. Workers shall not be exposed to noise level more than permitted for industrial premises, i.e. 90 dBA (Leq) for 8 hours.
- Exposure of workers near the high noise levels areas can be minimized. This can be achieved by job rotation/automation, use of ear plugs, etc.
- Labour camps shall be established away from high noise generating area. Workers exposed to high noise level shall use ear plugs or ear muffs.
- Regular maintenance of all vehicles and machinery shall be made mandatory to keep noise under check.
- Nearby communities will be notified of the construction schedule and construction works shall be structured to daylight working hours.
- Any ‘High Noise Area’ shall be posted with warning signs and will have restricted access.
- Noise from air compressors could be reduced by fitting exhaust mufflers and intake mufflers.
- Chassis and engine structural vibration noise can be dealt with by isolating the engine from the chassis and by covering various sections of the engines.
- Crushers, if any, will be fitted with rock lining to act as natural sound insulator during the crushing process.
- Noise levels from the construction equipment can be reduced by fitting of exhaust mufflers and the provision of damping on the steel tool.
- It is proposed to develop a greenbelt within the port premises including along the road stretches.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- Regular monitoring and maintenance of all the equipment and DG sets shall be taken up to keep a note on noise levels and to take corrective actions.

8.6.5 Impacts on Ecology

Although the land requirement for port development is not envisaged but any development to provide for rail and road connectivity will require careful planning to avoid sensitive locations (habitation, vegetation etc.). Tree cutting is inevitable at this location for infrastructure development.

Pile driving, deposition of rubble, sand compaction and other construction work in water may cause increase in sediment concentration, which may also reduce sunlight penetration. Disturbance from construction activities may cause displacement of fishery resources and other mobile bottom biota.

Mitigation Measures

- All care shall be taken that trees shall be protected as far as possible while site clearing and infrastructure development.
- In consultation with Forest Department, more than twice number of the trees will be planted in lieu of trees removed.
- Detailed ecological survey shall be conducted during detailed EIA study to assess the impacts.
- No construction activity will be allowed during the monsoon season so as to avoid breeding period of fishes.
- Use of silt curtains is recommended to confine areas of high turbidity during dredging and pile diving.
- Controlled dumping of the dredged material will be carried out beyond 20 m depths in the sea as a designated site.
- Areas with high fish yield or used by locals for fishing shall be avoided.
- All care shall be taken to avoid mangroves vegetation while construction activity. It is also proposed to plan and develop mangroves in the area identified and suggested by Forest Development.

8.6.6 Impact on Social Conditions

During the site visit no major settlement were seen at the proposed site. In addition, no major social impacts associated with the proposed port like loss of land and associated lively hood activities is anticipated as proposed port will be developed on reclaimed land.

However, limited acquisition of land and loss of livelihood is anticipated for the provision of rail and road connectivity.

Mitigation Measures

- It is proposed that existing roads will be strengthened wherever possible and as far as possible government land will be used for rail and road alignment.
- Detail survey of the land will be undertaken to ascertain land losers, properties etc. falling within the area. Each stakeholder will be adequately compensated as per government regulations.
- A Rehabilitation and Resettlement (R&R) plan has also been put forth to take up activities for well-being of affected families and panchayats.

8.7 Impacts During Operation Phase

8.7.1 Impact on Water Quality

The most likely impacts from the operation phase of the project will be on the marine water, primarily due to (a) effluent from coal stack yard; (b) oily wastes such as bilge water, washing water, lubricant oil and other residues from vessels and machineries (c) sewage; (d) cargo spillage. All these may lead to odour and degradation of water quality.

Mitigation Measures

- An aerated lagoon is proposed to be provided for treatment of effluent from domestic sources and the settled sludge will be dried in sludge drying beds and then used as manure for local use.
- Effluent generated from coal stack yard will be treated in a settling tank. The sludge produced will be mainly coal dust, which will be dried on sludge drying beds.
- The effluent from workshops, oil storage, etc. will contain oil and grease particles which shall be treated in an oil skimmer. The collected oily matter is stored in cans and disposed of at through authorised waste recycler.
- To combat oil pollution near the port, inflatable type containment boom with oil skimmers will be provided at the berth. A clean sweep oil recovery unit consisting of a power pack and the recovery unit mounted on a system will also be deployed for this purpose.
- Any kind of spill, release and other pollution incidents is to be reported promptly to the coastguard personnel to take appropriate actions.
- Strom water drain shall be made to collect run off from rain but care shall be taken that it is not contaminated.
- 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 STP on board.
- The International Convention Guidelines for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL, 73/78) will be strictly adhered at proposed Port area for prevention of marine pollution.

8.7.2 Impact on Air Quality

Vehicle traffic to service cargo at the port, emissions from port equipment, cargo handling (Coal, iron ore, etc.) and fuel burning at labour camps are the major source of air pollution during operation phase.

The coal stock pile is another potential source for entrainment of fugitive coal dust.

Mitigation Measures

- As such, a system consisting of pumps, storage tank, nozzles for dust suppression at discharge feeding points of belt conveyors will be provided at each transfer tower for efficient dust control.
- In addition to above, a suitable spray system will also be provided at ship unloader, coal stack yard & wagon loading station. The effluent generated by washing from coal terminal will be treated in a settling tank and sludge so produced dried on sludge drying beds.

- All vehicles shall have a valid PUC certificate and regular maintenance shall be mandated.
- All the roads in the vicinity of the project site will be paved or black topped to minimize the entrainment of fugitive emissions.
- If any of the road stretches cannot be blacktopped or paved due to some reason, then adequate arrangements will be made to spray water on such stretches of the road.
- For wind generated dust, a windshield with a wire mesh fencing with fast growing creepers up to a height of 10 m around the stackyard shall be installed.
- In addition to all the above measures, a 10 m wide greenbelt will be developed for dust arresting proposes.
- It will be a responsibility of labour contractors to provide for clean fuel to the labours.

8.7.3 Impact on Noise Quality

As discussed in construction phase, noise due to equipment and vehicles and human activities will be chief sources. Noise from vehicles can be attributed to the engine, vibration, friction between tyres and the road, and horns. Increased levels of noise depend upon volume of traffic, road condition, vehicle condition, vehicle speed, congestion of traffic and the distance of the receptor from the source.

Mitigation Measures

- Noise levels of port equipment used shall conform to relevant standards prescribed in Environment (Protection) Rules, 1986. Workers shall not be exposed to noise level more than permitted for industrial premises, i.e. 90 dBA (Leq) for 8 hours;
- Exposure of workers near the high noise levels areas shall be minimized. This can be achieved by job rotation/automation, use of ear plugs, etc.
- Labour camps shall be established away from high noise generating area. Workers exposed to high noise level shall use ear plugs or ear muffs;
- Regular maintenance of all vehicles and machinery shall be made mandatory to keep noise under check;
- Any ‘High Noise Area’ shall be posted with warning signs and will have restricted access.
- It is proposed to develop a greenbelt within the port premises including along the road stretches.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- Regular monitoring and maintenance of all the equipment and DG sets shall be taken up to keep a note on noise levels and to take corrective actions.

8.7.4 Impact on Ecology

Once port is in operation, major impacts are anticipated from vessel movement, cargo handling, waste water discharge and disturbance due to maintenance dredging.

Release of heavy metals and other chemicals and compounds from the spilled cargo in long run may cause bioaccumulation of these substances in sediment as well as marine flora and fauna.

The constituents of oil are toxic to marine life and release of oil contents on to water will result in formation of a shining film on the surface of water which prevents dissolution of oxygen across the surface of water. Moreover, oil gets accumulated on the body of the small species of fish or invertebrates and coat feathers and fur, reducing birds' and mammals' ability to maintain their body temperatures.

Due to maintenance dredging, some quantity of dredged disposal is anticipated.

Once the project is operation, a green belt will be developed around the ports site and shoreline.

Mitigation Measures

The following actions shall be taken to avoid any major damage due to oil spill:

- Indian Coast Guard (CG) is the Central Coordinating Authority for Oil Spill Response, so in case of any such event CG shall be informed immediately.
- All the measures shall be taken according to the "Guidelines and Policy for use of OSD in Indian Waters" issued in 2002 and in consent with CG.
- Booms, skimmers and dispersant inventory shall be maintained to contain spill at the port location.
- All recovered oily material shall be disposed-off properly. Either to waste oil dealers or dumped in secured landfill sites.
- Role and responsibility of personnel taking part in oil spill emergency shall be clearly spelled out.
- Regular drill for oil spill containment shall be conducted and any lag shall be recorded and corrected.

8.7.5 Impact on Socio-Economic Conditions

It is envisaged that during operation stage impacts are mostly positive in nature. Once the project is operational, the project has several benefits to the immediate affected community and society in large. The following positive impacts envisaged from the project:

- Employment generation for locals
- Development of road and rail connectivity
- Business opportunity due to ware-housing, cargo handling (stevedoring), transport requirements.

In addition, under Corporate Social Responsibility initiatives will be undertaken in consultation with the local administration and local population to benefit local population and environment. The key thrust areas for CSR activities will be:

- Environment
- Primary Education
- Health Care
- Employment Skill & Job Trainings
- Environmental Services and climate resilience.

8.8 Environmental Monitoring Plan

This section presents the environmental monitoring framework for the project where parameters, frequency and locations for the environmental monitoring are suggested (**Table 8.3**).

Table 8.3 Environmental Monitoring Plan

Environmental Components	Parameters	Frequency of Monitoring	Location
Air	PM2.5, PM10,SO2,NOx,CO, HC	Continuous monitoring, 2 times a week for 24 hours	3 - 4
Surface water / Marine water	pH, DO, BOD, O&G, Salinity, Electrical Conductivity, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides and heavy metals (Zinc, Lead, Cadmium, Mercury)	Once every months	3 - 4
Ground water	Comprehensive monitoring as per IS : 10,500:2012	Once every months	5 – 8
Noise	Leq (Night), Leq (day), Leq (24 hourly)	Once every month	8 – 10
Ecological Environment (Coastal)	No. of species and density: · Phytoplankton · Zooplankton · Benthos · Fisheries · Mangroves Invasion of new plant species and plant communities, increased habitat diversity, invasion of new species.	Once a year	3 – 4
Bed Sediment	Texture, size, O&G, Heavy Metals (Zinc, Lead, Cadmium, Mercury)	Once every six months	4 - 5

8.9 Environmental Management Cost

A site specific Environmental Management Plan (EMP) shall be prepared for avoiding, mitigating, monitoring the adverse impacts envisaged on various environmental components during construction and operational phase of the project. About 1% of the project cost is estimated to be earmarked for environmental management activities.

In addition about 1% of average net profits of last 3 years will be spent on Corporate Social Responsibility (CSR) activities each year during operational phase (Companies Act, 2013). The CSR activities may be formulated to deal with hunger and poverty; promoting public health; supporting education; addressing gender inequality; protecting the environment; and funding cultural initiatives and the arts.

9.0 COST ESTIMATES AND IMPLEMENTATION SCHEDULE

9.1 Capital Cost Estimates

9.1.1 General

The capital cost estimates prepared for the project are based on the project descriptions and drawings given under the relevant sections of the present report. The drawings were prepared after carrying out basic engineering of various components of the project. The quantities have been calculated from the drawings for cost estimation purpose. The basis of the costing is as follows:

- The cost estimates of civil works have been prepared on the basis of current rates for various items of work prevailing in the region and also on the past costs for similar works elsewhere.
- The costs of equipment and machinery are based on budgetary quotations and discussions held with the manufacturers and also in-house data. The costs include all taxes, duties, insurance freight etc.
- The price level used for the estimates is as of the first quarter of 2016.
- All costs towards overheads, labour, tools, materials, insurance, financing costs, etc., are covered in the rates for individual items.
- The costs towards plant and machinery include manufacture, supply, transport, installation and commissioning of the respective items.
- The exchange rate has been assumed as 1 US $ = Rs. 65/-
- Provision towards contingencies, engineering and establishment has been included separately.

These site information and assumptions are subject to many factors that are beyond the control of the consultants; and the consultants thus make no representations or warranties with respect to these estimates and disclaim any responsibility for the accuracy of these estimates.

9.1.2 Capital Cost Estimates for Phased Development

The capital cost of phased development of port, as per the proposed phasing as per **Table 6.9** has been worked out as furnished below in **Table 9.1**.

The costs given are for the facilities created during Phase 1 and Master plan phase only.

Table 9.1 Block Capital Cost Estimates (Rs. in crores)

A. Port Development Cost Only

S. No.	Item	2020	2035	Total
1.	Project Preliminaries and Site Development	30	15	45
2.	Dredging	327	370	697
3.	Reclamation	142	10	152
4.	Breakwater	426	-	426
5.	Berths	353	90	443
6.	Buildings	29	9	38
7.	Stackyard and Other Backup Area	48	28	75
8.	Internal Roads and Railway	50	30	80
9.	Equipment	677	333	1,011
10.	Utilities and Others	166	59	224
11.	Navigational Aids	8	2	10
12.	Total (1+2+3+4+5+6+7+8+9+10+11)	**2,256**	**945**	**3,201**
13.	Contingencies @ 10%	226	94	320
14.	Engineering and Project Management @ 5%	113	47	160
Incremental Capital Cost (Rs. In Crores)		**2,595**	**1,086**	**3,681**

B. Total Cost Including External Rail, Road Connectivity and Land Acquisition

S. No.	Components	2020	2035	Total
1.	**Port Development Cost**	**2,595**	**1,086**	**3,681**
2.	**External connectivity including land acquisition**			
	Rail	**110**	-	**110**
	Road	**115**	-	**115**
	Total Cost (INR in Crores)	**2,820**	**1,086**	**3,906**

These capital cost estimates do not include the following:

- Port crafts, as these are proposed to be leased out
- Financing and Interest Costs

9.2 Operation and Maintenance Costs

9.2.1 General

Operation and maintenance costs have been calculated under various heads as described in the subsequent paras.

9.2.2 Repair and Maintenance Costs

The following norms have been used for estimating the annual maintenance and repair costs:

- 5% of Mechanical equipment and Electrical Works
- 1% of Civil Works
- 3% of Utilities and Other Works

For dredging, the actual cost based on the maintenance dredging volume estimated from model studies is taken into account.

9.2.3 Manpower Costs

The estimated manpower for the initial phase of development is about 200 increasing to about 300 in the master plan stage of development. The manpower costs have accordingly been calculated considering the number and types of personnel deployed.

9.2.4 Operation Costs

The operation costs include the fuel, water and power costs. These have been considered as below:

- Power - Rs. 4.50 per unit plus Rs. 225 per kVA of demand rate per month
- Water Charges - Rs. 50 per kilolitre
- Diesel - Rs. 50 per litre

The operation costs for the equipment run by electrical power have been calculated based on the maximum throughput and utilisation of the equipment. Similarly the operation cost of major equipment like ITVs run by diesel has been worked out based on the utilisation level for the annual throughput. Further the operation costs of the following items have been estimated as a percentage of their capital cost, as given below:

- Diesel Driven Equipment (minor) - 5% per annum
- Other Works such as Firefighting & Pollution Control - 3% per annum

9.2.5 Annual Incremental Operation and Maintenance Costs

Based on the various criteria discussed above, the annual operation and maintenance cost for various phases of development of Port at Belekeri are summarised below in **Table 9.2** below:

Table 9.2 Annual Operation and Maintenance Costs (Rs. in crores)

S. No.	Item	2020	2035	Total
1.	REPAIR AND MAINTENANCE COSTS	51.0	23.2	**74**
2.	OPERATION COSTS	81.0	34.9	**116**
3.	**TOTAL**	**132.0**	**58.0**	**190**
4.	Contingencies (Rites, @ 10%-Aecom)	13.2	5.8	**19**
5.	Administrative Expenses @ 5%	6.6	2.9	**10**
Incremental O & M Costs (Rs. In Crores) per annum		**152**	**67**	**219**

The above O&M costs do not include the repair and maintenance of external rail and road connectivity.

9.3 Implementation Schedule for Phase 1 Port Development

9.3.1 General

The main components for the development of Belekeri Port comprise of construction of breakwater, capital dredging for approach channel and manoeuvring basin, reclamation, construction of berths, supply and installation of material handling equipment, onshore infrastructure and marine support systems. The implementation schedule of the critical project items is discussed below.

9.3.2 Construction of Breakwater

The construction of the breakwaters is considered as the most critical item in the project implementation schedule, as the other marine works like berths construction, dredging and reclamation have to be synchronised carefully with the progressive construction of breakwaters.

It is estimated that about 3 million tonnes of rock is required for the construction of the proposed breakwater. The major quantity of rock required for armour and sub armour layers would be obtained from identified quarry sites.

It is proposed to construct the breakwater by end on dumping method as well as using the marine equipment viz. self-propelled side dumping and/or bottom opening barges of approximately 500 T to 1000 T capacity.

The floating equipment shall be used for dumping of filter and core, as well the Accropodes, beyond about -4m CD contours. The cross section above -4m CD will be constructed by end on method. It is envisaged that using the end on dumping and the floating equipment, about 7,000 T stones can be placed per day. Upon completion of the Accropode armour / stone armour to full length, the mass concrete capping shall be commenced from the root. This would mean that the construction of breakwaters could be completed in a period of about 27 months duly accounting for weather downtime.

9.3.3 Dredging and Reclamation

The overall dredging quantity is estimated to be about 16.4 Mcum. Initially the reclamation bunds shall be built to receive the suitable material from the dredging operations and then dredging activity can commence in the fair weather season. While the dredging by cutter suction dredger would be limited during fair weather season the same using TSHD shall be carried out round the year. The overall duration of the dredging and reclamation is expected to be 22 months. However in case some rock patches are found in the dredging area the duration will increase.

9.3.4 Berths

As bulk berths are not proposed to be contiguous to the land, construction of these berths would be independent of the dredging. However the construction of multipurpose berth having backup area would need to be synchronised with dredging and reclamation.

Considering the berths are located a distance of about 3.1 km from shore, the construction of berths could be either undertaken using floating equipment or by launching the gantries from the partly completed breakwater. The latter option is most likely as it would involve lesser downtime due to weather and relatively lower cost of construction.

The berth piling would be commenced using piling gantries installed from the completed portion of the breakwater. The superstructure would be mainly built using precast concrete elements to avoid soffit shuttering. This would also enable the construction of superstructure on the piles already completed. The construction of berths is expected to take about 30 months.

9.3.5 Equipment and Onshore Development

It is envisaged that the delivery and installation of equipment and the development of onshore works can be carried out to match the implementation schedule of the project.

9.3.6 Implementation Schedule

The construction time of Phase 1 development of Belekeri port is likely to take over 40 months. This has been worked out taking into account all the items of the project, the various activities involved and the duration of each activity. The project implementation schedule for the Phase 1 Development of Belekeri Port is shown in **Table 9.3**.

Table 9.3 Implementation Schedule for Development of Belekeri Port

S.No.	Task Description	Year: 2016 (Oct Nov Dec)	2017 (Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec)	2018 (Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec)	2019 (Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec)	2020 (Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec)	2021 (Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec)
A	**Appointment of Consultant for DPR Preparation** (Zero)						
1	Preparation of DPR						
2	Prepration of Tender Documents						
3	Prepration of EIA Report and Approvals						
B	**Tendering Activity of Common Infrastructure to be developed by NMPT**						
1	Tendering Period						
2	Evaluation, Negotiations and Award of Contracts						
3	Financial Closure						
C	**Construction Activity of Common Infrastructure**						
1	Establishment at Site by Contractor						
2	Approach Roads						
3	Breakwaters						
4	Dredging						
5	Reclamation Bund						
6	Reclamation						
7	Rail and Road Connectivity						
D	**Terminal Construction by BOT Operator(s)**						
1	RFP to selected bidders, Evaluation and Selection of Concessionaire for Terminals						
2	Detailed Engineering By Concessionaire						
3	Tendering and Selection of Contractor by Concessionaire						
4	Financial Closure						
5	Berths						
6	Storage Yard and Pavement						
7	Supply and Installation of Mechanical Equipment						
8	Buildings						
9	Onshore Infrastructure						
10	Commissioning of Port Facilities						★

10.0 FINANCIAL ANALYSIS FOR ALTERNATIVE MEANS OF PROJECT DEVELOPMENT

10.1 Assumptions for Financial Assessment

The following assumptions have been made while making the financial assessment of the project and arriving at the suitable means of project development:

- Due to the minimal incremental traffic the financials have been worked out assuming the there is no expansion after Phase 1 development of port. However, any subsequent expansion would improve the project viability.
- Based on the profiling of competing ports following tariff has been assumed
  - o Coal - Rs. 200 per tonne
  - o Containers - Rs. 4500 per TEU
- The cost of Debt is assumed as 11% for PPP operator.
- The cost of Debt for the SPV, in case of Landlord model, is assumed at 4%.

10.2 Option 1 – By Project Proponents

In this option, the project shall be executed by the public sector entity, i.e., (New Mangalore Port Trust and/or State Government/SDC), who shall also arrange funds for the project financing, manage and operate the port.

The financial analysis has been carried out considering the overall capital investment of Rs. 2820 crores for Phase 1 port development. The project IRR in this scenario works out to about 11.5%.

10.3 Option 2 – Full Fledged Concession to Private Operator

In this option, the entire project is allocated to a private developer like in case of Mundra, Gangavaram, Krishnapatnam ports on revenue share basis.

In this case the costs towards External Rail and Road Connectivity to port and land acquisition for connectivity and port facilities shall be borne by the government entities.

Therefore the capital investment for the private operator shall be limited to Rs. 2595 crores only. However, in this case also the project IRR for the private developer works out to about 12.4% even after considering that the developer does not do any revenue sharing with government.

10.4 Option 3 – Landlord Model

In this option a Special Purpose Vehicle (SPV) shall be formed comprising of New Mangalore Port Trust and other government entities which may include Karnataka State Government, Sagarmala Development Corporation etc. The exact composition of SPV and the % share of the entities could be decided once the decision to go ahead with the project is taken. The following shall be modalities for development under this option:

1. The basic infrastructure in terms of Breakwaters, capital dredging, reclamation, access rail and road, water and power connection, harbour crafts etc. shall be arranged by SPV. Apart from that, the SPV shall also be responsible providing external rail and road connectivity to port including any land acquisition for connectivity and port development. In addition SPV shall also be responsible for:
    - Appointing a Harbour Master and conservator of the port.
    - Navigation in the port by having qualified and licensed pilots to pilot ships with aids like tugs etc., attending to berthing and de-berthing of ships calling at the port.
    - Providing and maintaining the basic infrastructure.
    - Payment of lease-rent for areas leased to it and other payments to the State Government as may be contained in the agreement.
    - Furnishing management information to the appropriate authorities and administering subleases for the various marine terminals leased to users, terminal operators as applicable.

2. The cargo handling terminals and associated facilities comprising of berths, stackyard development, equipment, utilities etc. will be developed with private participation on PPP mode. PPP Concessionaire would be responsible for terminal operations and maintenance and sharing of its revenue with SPV as per the concession agreement.

In the proposed implementation model the cost split between the project proponents and the terminal operators is estimated as below in **Table 10.1**:

Table 10.1 Estimated Cost Split

A. Port Development Cost Only

S. No.	Item	SPV	Concessionaire	Total
1.	Project Preliminaries and Site Development	18	12	30
2.	Dredging	327	-	327
3.	Reclamation	129	13	142
4.	Breakwater	426	-	426
5.	Berths	-	353	353
6.	Buildings	20	9	29
7.	Stackyard and Other Backup Area	-	48	48
8.	Internal Roads and Railway	25	25	50
9.	Equipment	-	677	677
10.	Utilities and Others	82	84	166
11.	Navigational Aids	8	-	8
12.	Total (1+2+3+4+5+6+7+8+9+10+11)	**1,036**	**1,221**	**2,256**
13.	Contingencies @ 10%	104	122	226
14.	Engineering and Project Management @ 5%	52	61	113
Capital Cost of Phase 1 Port Development (Rs. In Crores)		**1,191**	**1,404**	**2,595**

B. Total Cost Including External Rail, Road Connectivity and Land Acquisition

S. No.	Components	SPV	Concessionaire	Total
1.	**Port Development Cost**	**1,191**	**1,404**	**2,595**
2.	**External connectivity including land acquisition**			
	Rail	**110**	-	**110**
	Road	**115**	-	**115**
	Total Cost (INR in Crores)	**1,416**	**1,404**	**2,820**

For the limiting project IRR of 15% for the PPP operator, he can share maximum 36% of revenue with the SPV. Basis this revenue an overall IRR of about 9.9% for SPV is estimated which is though low but could still be manageable in case SPV can manage debt from the international funding agencies. Further if the external rail and road connectivity to the port could be undertaken by NHAI, Railways and IPRCL, the burden on SPV shall reduce. This could be worked out in during project structuring to be carried out at DPR stage.

11.0 WAY FORWARD

With the projected traffic, there is a strong case for development of port at Belekeri on landlord model. However the entire port development is dependent on the completion of Hubli Ankola rail link. It is also suggested that the proposed Hubli Ankola Rail link be extended till Belekeri as a single project to get synergy and also provide competitive multi-modal transport to the destination. It is further proposed that all efforts must be directed to get environmental clearance for this connecting rail link before undertaking any further study or work for the proposed port.

In case it is decided to pursue the project, the following action plan is recommended:

1. The current road blocks to the completion of development of Hubli Ankola rail need to be removed with active participation from State and Central government.

2. An SPV for development of the port may be formed.

3. Once it is certain that Hubli Ankola rail link would be completed in a given time frame start for the process of port development by initially appointing a consultant for preparation of detailed project report.

4. The detailed project report shall use the present TEFR as a base document and refine it further by:

    a. Carrying out marine geotechnical investigations

    b. Real Time Ship Navigational Studies

    c. Engineering of the Marine Structures, material handling system and onshore infrastructure to further refine the cost estimates

    d. Two and three dimensional model studies for design of breakwaters.

    e. Mathematical model studies on the updated layout, if any, for further optimisation. Apart from that model studies for dispersal of dredged plume at the proposed disposal site would be needed as per the requirement of MoEF.

    f. Updated financial analysis

5. Approvals from SFC/ EFC/ PIB/ PPPAC/ CCEA

6. Preparation of EIA report and approval of MoEF

7. Preparation of tender documents for Selection of contractors for the works to be undertaken by project proponents (PPT)

8. Start the construction of Breakwaters, reclamation, dredging and basic onshore infrastructure

9. Selection of Transaction Advisor and bidding for the selection of operator(s) for the terminal development

10. Terminal development works by the BOT operator

11. Coordination with various agencies for getting project approvals as mentioned in **Figure 11.1**.

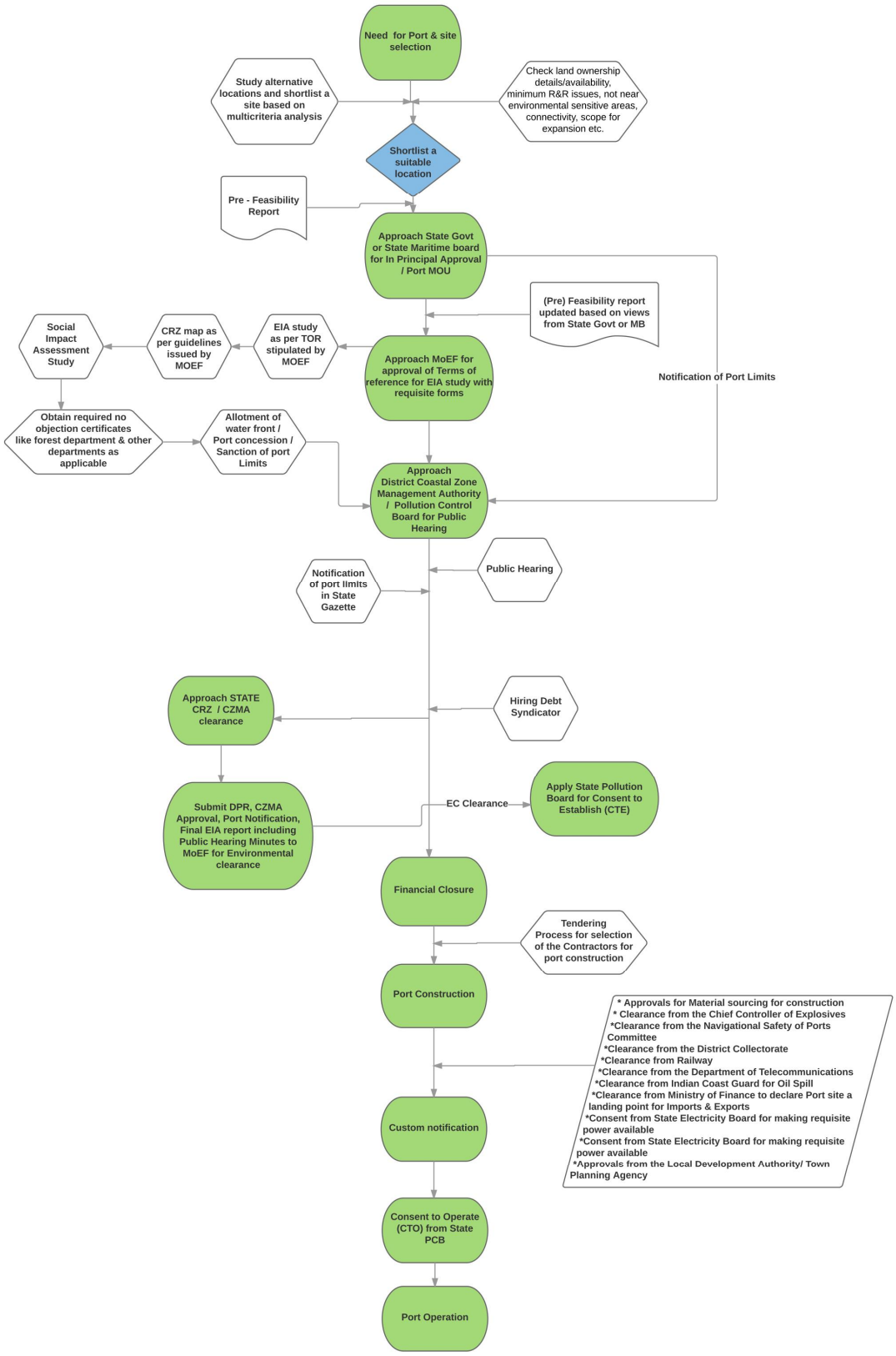


Figure 11.1 Process for the Greenfield Port Development

Drawings

Project Management Initials: Designer: SV Checked: AM Approved: SG ISO A1 594mm x 841mm

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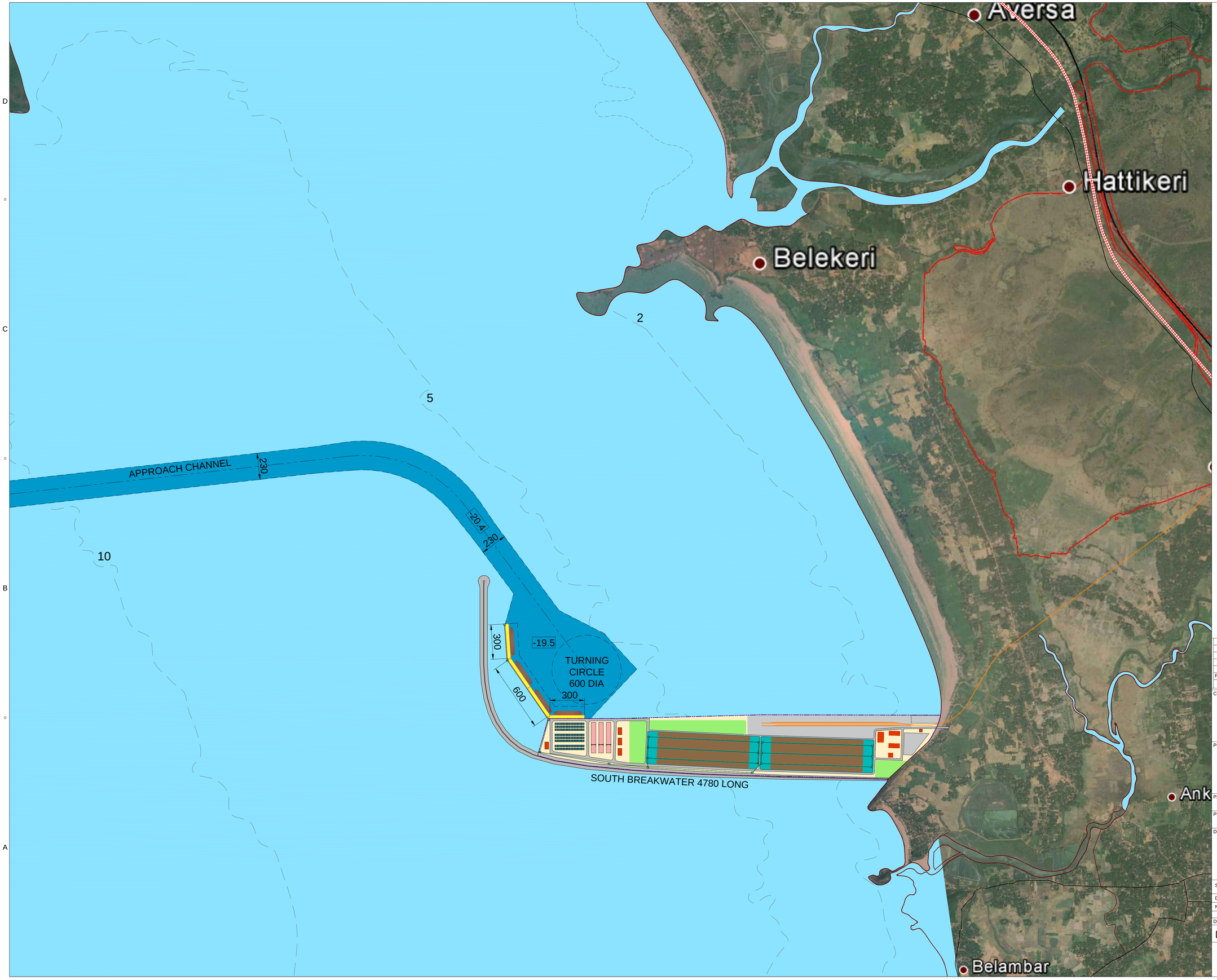

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping
Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

ALTERNATIVE 1
MASTER PLAN

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1001 REV. 0

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2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping
Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

ALTERNATIVE 1
PHASE 1

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1002 REV. 0

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ISO A1 594mm x 841mm
Approved: SG
Checked: AM
Designer: SV
Project Management Initials:

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Filename: D:\PROJECTS\BELEKARI\DELD15005-DRG-10-0000-CP-BLR1002.DWG

Project Management Initials: Designer: SV Checked: AM Approved: SG ISO A1 594mm x 841mm

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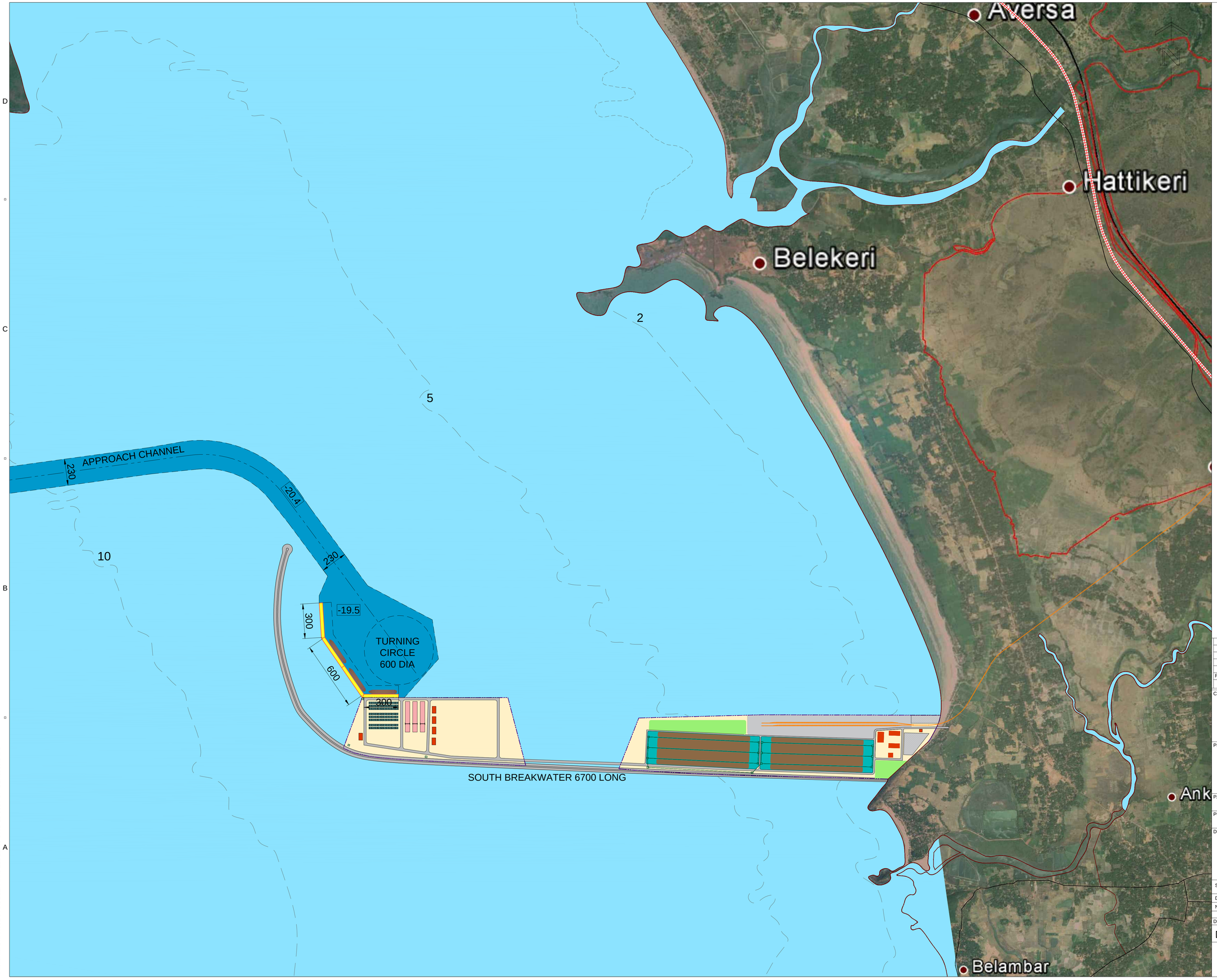

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping
Government of India

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

ALTERNATIVE 2
MASTER PLAN

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1003 REV. 0

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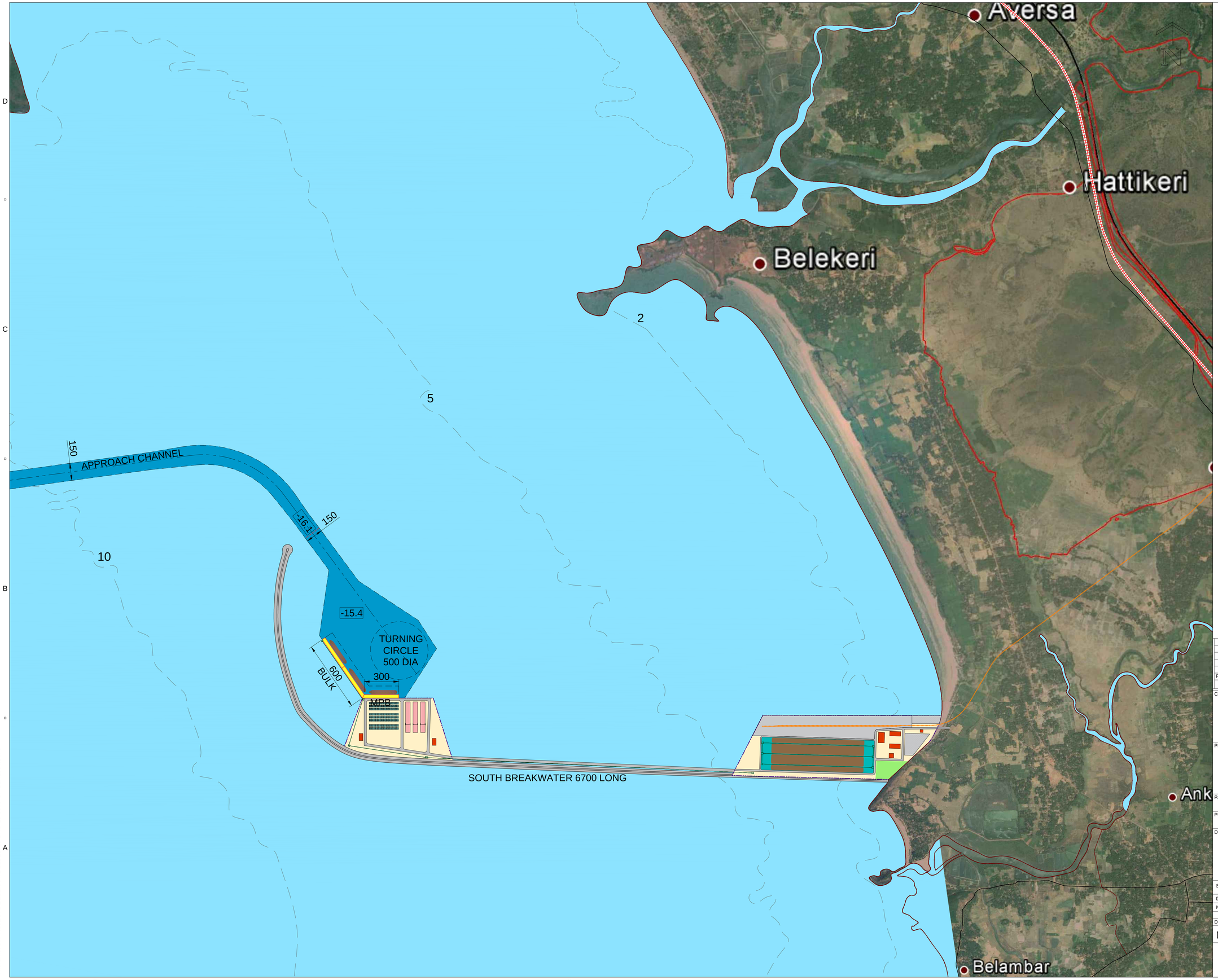

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping
Government of India

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

ALTERNATIVE 2
PHASE 1

SHEET 1 OF 1

Designed by	Checked by	Approved by
Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1004 REV. 0

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Project Management Initials: Designer: SV Checked: AM Approved: SG ISO A1 594mm x 841mm

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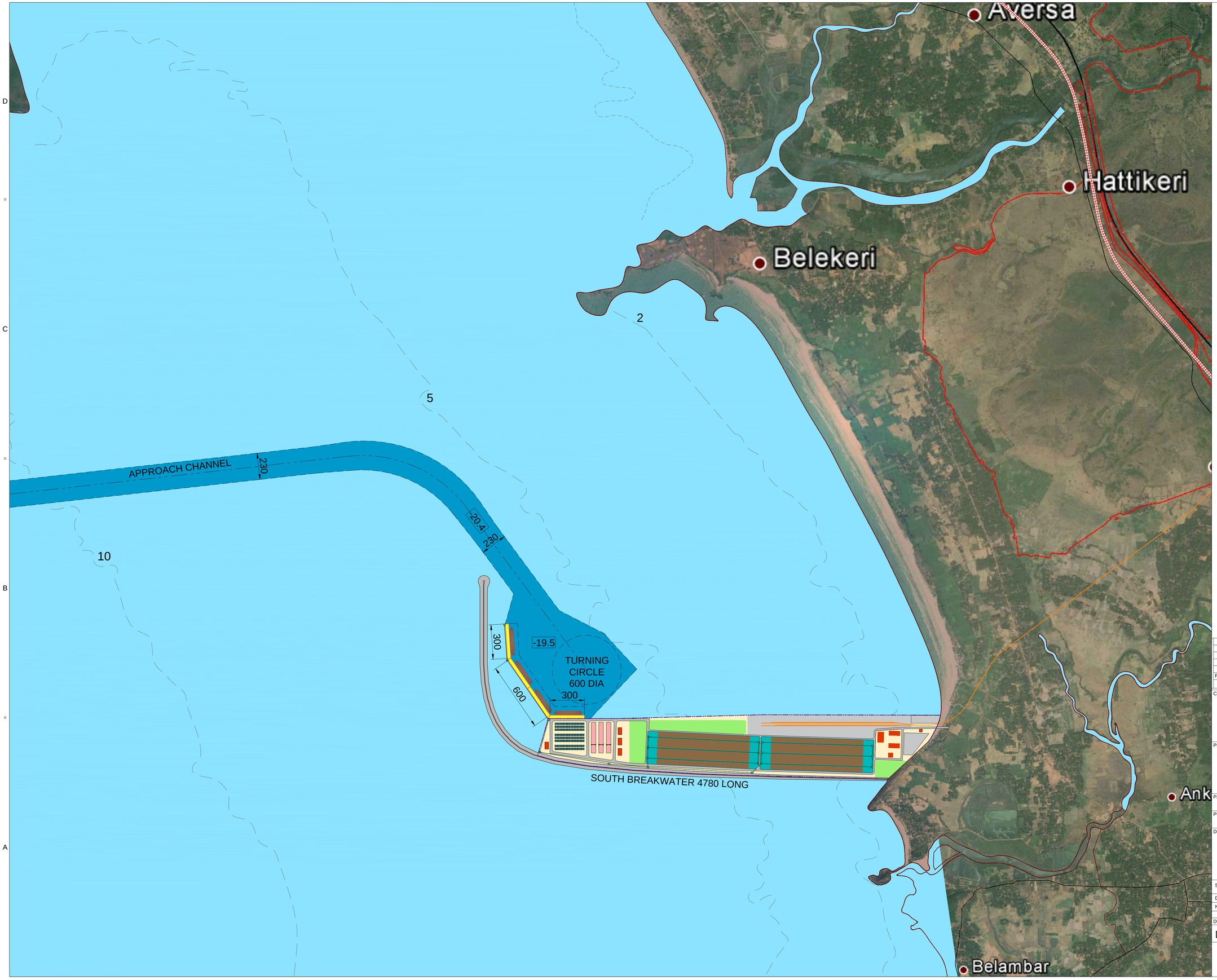

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping
Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

RECOMMENDED LAYOUT MASTER PLAN

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1005 REV. 0

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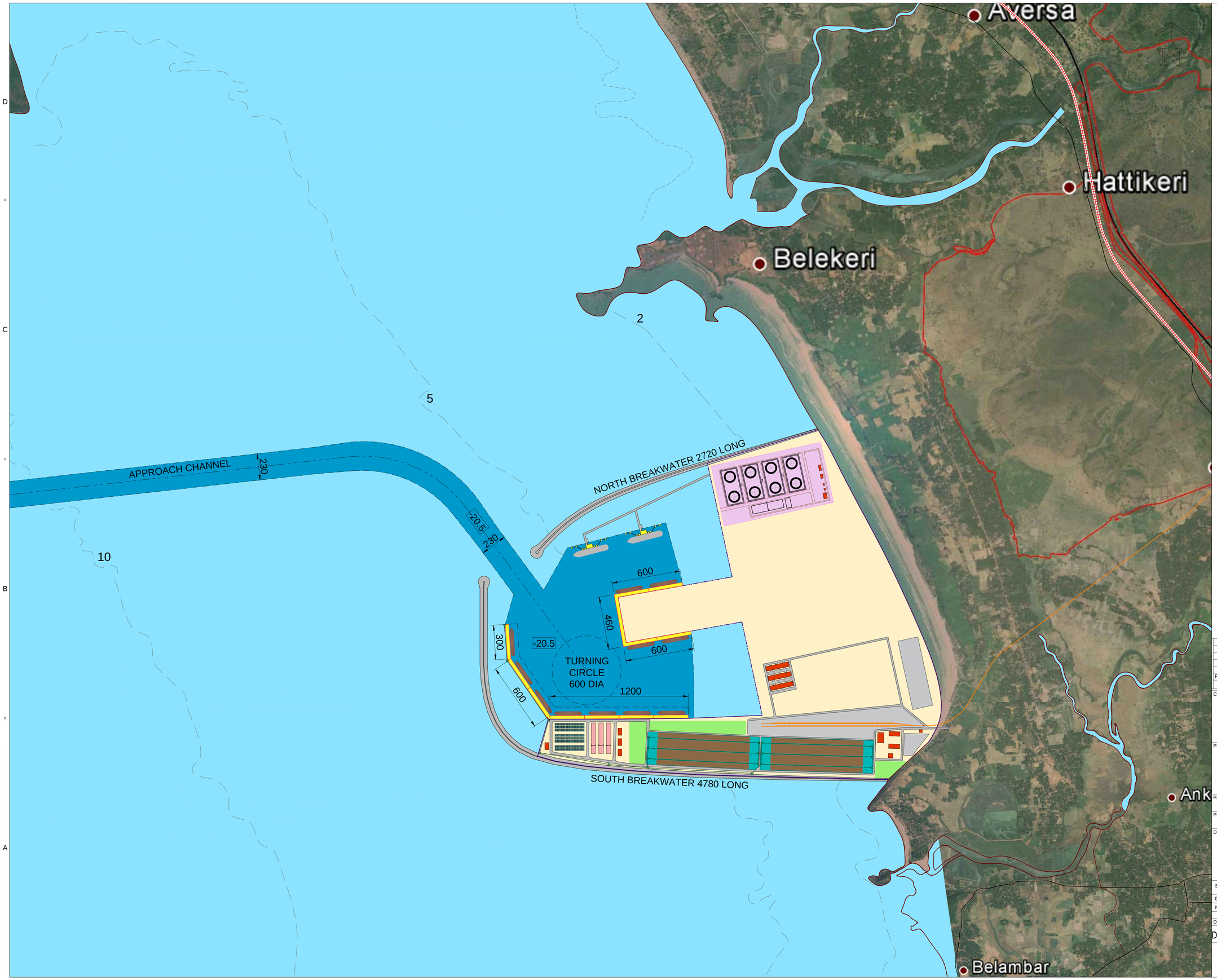
Filename: D:\PROJECTS\BELEKARI\DELD15005-DRG-10-0000-CP-BLR1006A.DWG



NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

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REV.	DATE	DESCRIPTION	DR.	CH.	APR.

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CLIENT/OWNER:

Ministry of Shipping
Government of India

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

POTENTIAL EXPANSION BEYOND MASTER PLAN HORIZON ALTERNATIVE 1

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1006A REV. 0

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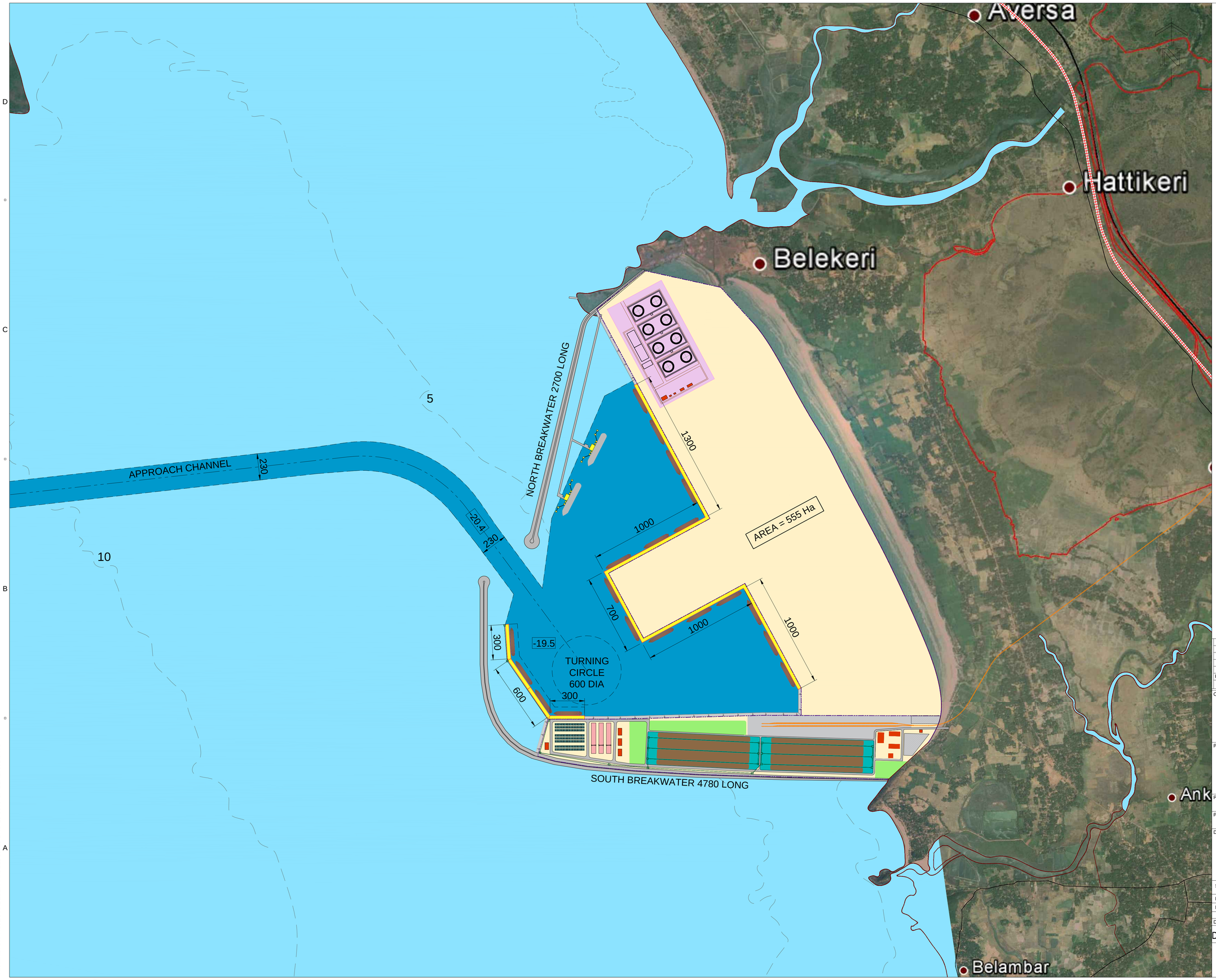

NOTES:-

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2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

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Ministry of Shipping
Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

POTENTIAL EXPANSION BEYOND MASTER PLAN HORIZON ALTERNATIVE 2

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1006B REV. 0

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1					

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CLIENT/OWNER:

Ministry of Shipping
Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

RECOMMENDED PHASE 1 DEVELOPMENT

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1007 REV. 0

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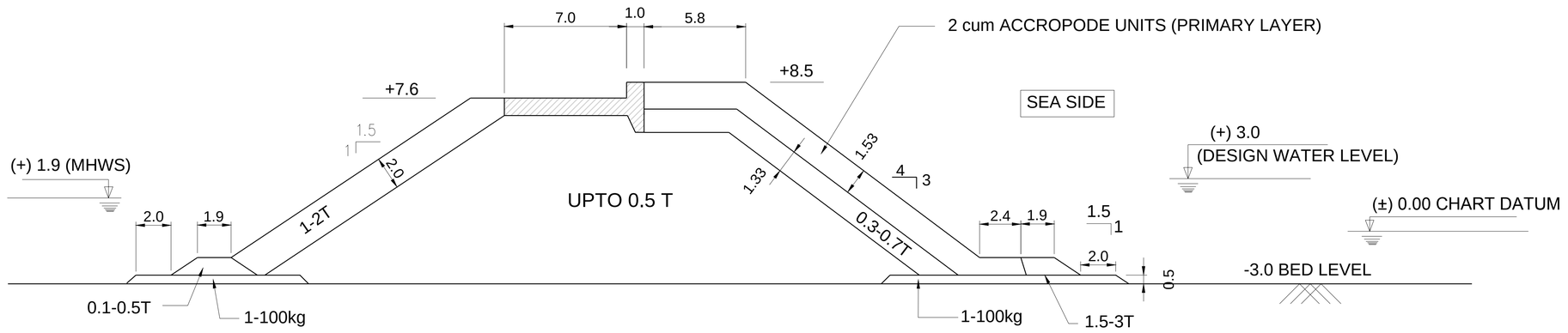
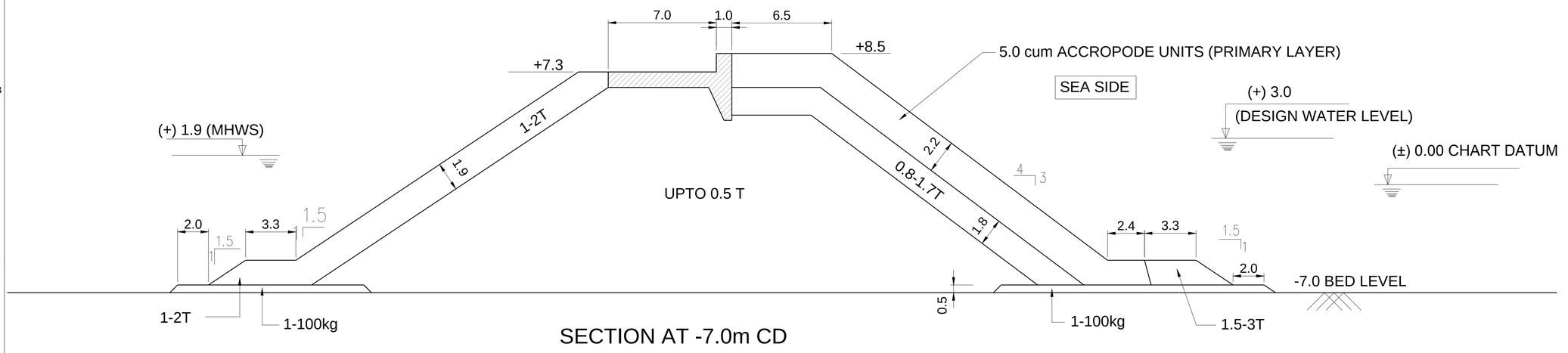


SECTION AT -3.0m CD



SECTION AT -7.0m CD

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE: TYPICAL CROSS SECTIONS OF BREAKWATER

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1008 REV.: 0

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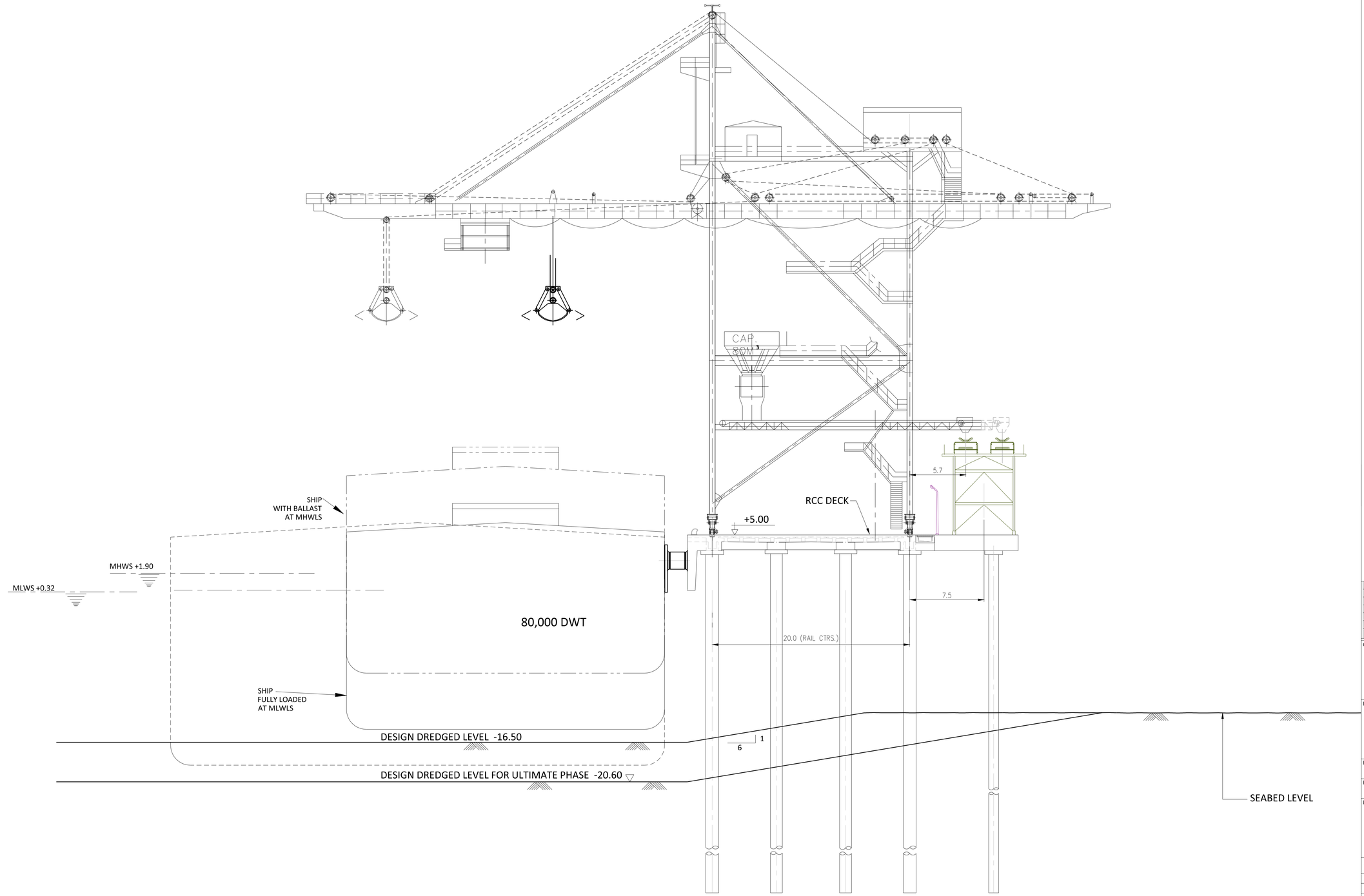
Filename: D:\PROJECTS\BELEKARI\DELD15005-DRG-10-0000-CP-BLR1008.DWG

Project Management Initials: Designer: SV Checked: AM Approved: SG ISO A1 594mm x 841mm



NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping
Government of India

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

TYPICAL CROSS SECTION OF BULK BERTH

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

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DELD15005-DRG-10-0000-CP-BLR1009 0

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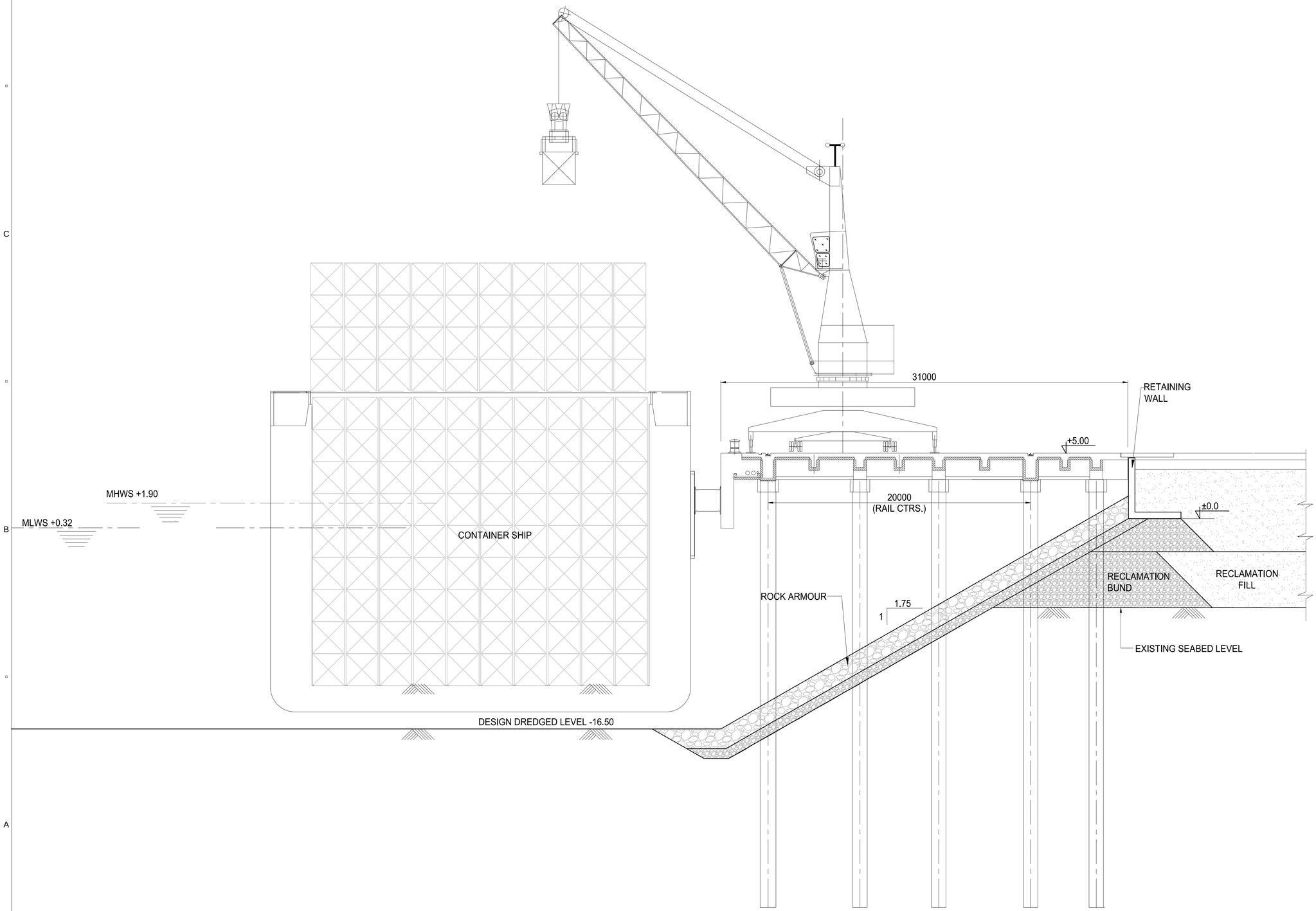
Project Management Initials:
Designer: SV
Checked: AM
Approved: SG
ISO A1 594mm x 841mm



NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

TYPICAL CROSS SECTION OF CONTAINER CUM MULTIPURPOSE BERTH

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

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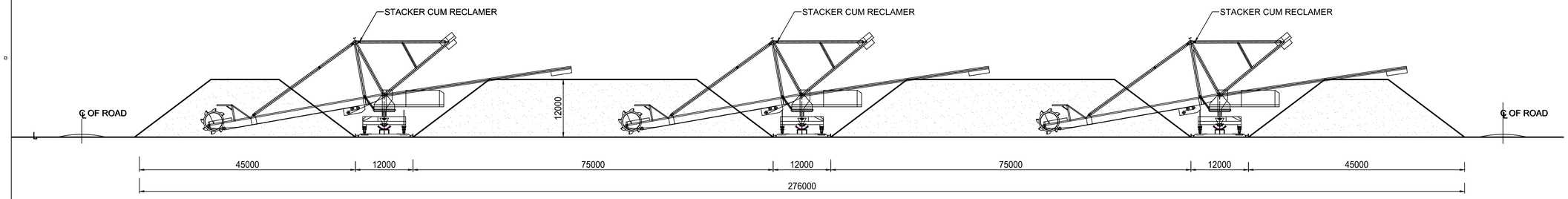
Project Management Initials: Designer: SV Checked: AM Approved: SG ISO A1 594mm x 841mm



TYPICAL CROSS SECTION OF BULK STACKYARD

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping
Government of India

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

TYPICAL CROSS SECTION OF BULK STACKYARD

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1011 REV. 0

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Project Management Initials: Designer: SV Checked: AM Approved: SG ISO A1 594mm x 841mm

Chendiye

HarwaDa

Aversa

Hattikeri

Belekeri

Belambar

Ank

APPROACH CHANNEL

FB

B1

B2

B3

B4

B5

B6

B7

B8

B9

B10

B11

B12

B13

B14

BL

-16.1

-15.4

10

5

2

TURNING CIRCLE 500 DIA

SOUTH BREAKWATER 4780 LONG

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

2 ALL LEVELS ARE IN METRES AND WITH RESPECT TO CHART DATUM.

LEGEND:

FB FAIR BOUY

B1... CHANNEL MARKING BUOY

BL BEACON LIGHT

REV.	DATE	DESCRIPTION	DR.	CH.	APR.
1					

REVISION DETAILS

CLIENT/OWNER:

Ministry of Shipping Government of India

INDIAN PORTS ASSOCIATION

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT BELEKARI

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE: LAYOUT OF NAVIGATIONAL AIDS

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 20-06-2016	Date: 20-06-2016	Date: 20-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-BLR1012 REV. 0

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