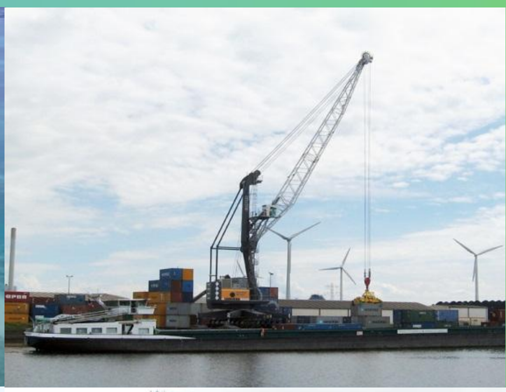
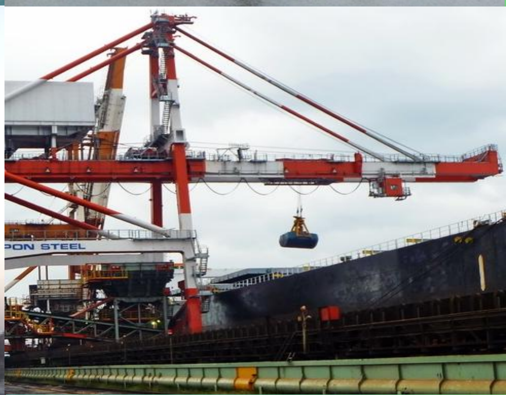
TECHNO ECONOMIC FEASIBILITY REPORT FOR DEVELOPMENT OF PORT AT DUGARAJAPATNAM


Techno-Economic Feasibility Report for Development of Port at Dugarajapatnam

Prepared for

Ministry of Shipping / Indian Ports Association

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July 2016

Quality Information

Client: **Ministry of Shipping / Indian Ports Association**	Contract No. (if any): NA
Project Title: **Techno-Economic Feasibility Report for Development of Port at Dugarajapatnam**	Project No.: **DELD15005**
Document No: **DELD15005-REP-10-0000-CP-1004** SharePoint Ref:	Controlled Copy No:
Document Title: **Development of Port at Dugarajapatnam**	
Covering Letter/ Transmittal Ref. No:	Date of Issue: **5 July 2016**

Revision, Review and Approval Records

B.	Development of Port at Dugarajapatnam - Final	SY 05-07-2016	ASM 05-07-2016	Sanjeev Gupta 05-07-2016
A.	Development of Port at Dugarajapatnam - Draft	SY 09-06-2016	ASM 09-06-2016	Sanjeev Gupta 09-06-2016
Revision	Description	Prepared by/ date	Reviewed by/ date	Approved by/ date

Document Revision Register

Issue no.	Date of issue	Section	Revision Details	Revision By Name & Position
1.	09.06.2016		Draft Report	ASM 09-06-2016
2.	05.07.2016		Final Report	ASM 05-07-2016

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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.

Port at Dugarajapatnam

Andhra Pradesh has only one major port i.e. Vizag Port. Vizag port is constrained with its expansion due to development of city around it. The Ministry of Shipping, Government of India has already notified Greenfield port at Dugarajapatnam in Andhra Pradesh, as the major port under the Port Trust Act.

The proposed port site of Dugarajapatnam lies on the eastern coast of India in the Nellore district of Andhra Pradesh. It has operational non-major port of Krishnapatnam on the north and major ports of Chennai and Ennore on the south. Southern Andhra Pradesh would be the primary hinterland of the port while Karnataka and parts of Telangana would be the secondary hinterland. Considering the location of the proposed site and the presence of other ports in proximity, Dugarajapatnam port would have to compete for the same hinterland with ports of Krishnapatnam, Chennai, Ennore and Katupalli.

Based on the Origin–Destination studies carried out under Sagarmala assignment, it has been assessed that the port has the potential of about 7.8 MTPA in 2020 increasing to 20 MTPA in 2035 with thermal coal being predominant cargo.

The port is expected to divert part of the traffic currently handled by Krishnapatnam port. Rayalseema in Cuddapah district and Raichur can be the potential power plants using Dugarajapatnam for movement of thermal coal. The traffic for both these plants expected to be handled by the proposed port will be ~3.4 MTPA by 2020. Apart from the thermal coal for power based usage, non-power based coal traffic of ~3.5 MTPA is also expected by 2020.

Port Development Plan

It is proposed that the port facilities shall be developed in the phased manner commensurate with traffic growth. Most of the quantity 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. However, as the proposed port has to compete with adjacent ports at Krishnapatnam and Ennore who have capability to handle cape size ships, it would be important that the planning should be such that the port should be able to handle cape size vessels by carrying out capital dredging at appropriate time as per market demand

The proposed port layout comprised of south breakwater of 3340 m and north breakwater of 1240 m. In Phase 1 development of the port, it is proposed to provide 1 Coal and 1 Multipurpose berths and the estimated capital dredging for Phase 1 development is about 21 Mcum and the reclamation quantity is 8.3 Mcum. The stacking area for the bulk cargoes has been proposed in the reclaimed area.

The coal 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.

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 INR 2,472 crores and additional INR 1030 Crores would be needed for the rail/road connectivity to the port, INR 270 Crore for land acquisition for 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 Vizag and other government entities. SPV shall arrange funds, manage and operate the port. The IRR for project proponent model works out to 2.1%.

In the full-fledged concession to operator model 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 INR 2,472 cr is considered and the IRR works out to 8.6% considering the private entity does not do the revenue sharing with the government.

In the Landlord 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, 35% of the revenue share with the SPV which is overall IRR of -3.6% for SPV making the investment totally unviable.

With this in view, Full Fledged Concession to Private Operator could be explored with the following basic conditions so that there is no financial burden on the SPV:

1. The cost of Rs. 720 crores for External road connectivity to the port including the land acquisition be provided by NHAI or Bharat mala project

2. The cost of Rs. 310 crores for External rail connectivity to the port including the land acquisition be borne by South Central Railway or IPRCL

3. The cost Rs. 270 crores for 100 Ha of land acquisition for port be borne by state government or Sagarmala Development Company

Therefore further support from the central government may be sought through viability gap funding (VGF) of 20% and same VGF of 20% be formulated at State level to generate project IRR of 14%. The bidder who seeks minimal VGF shall be selected for port development.

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.

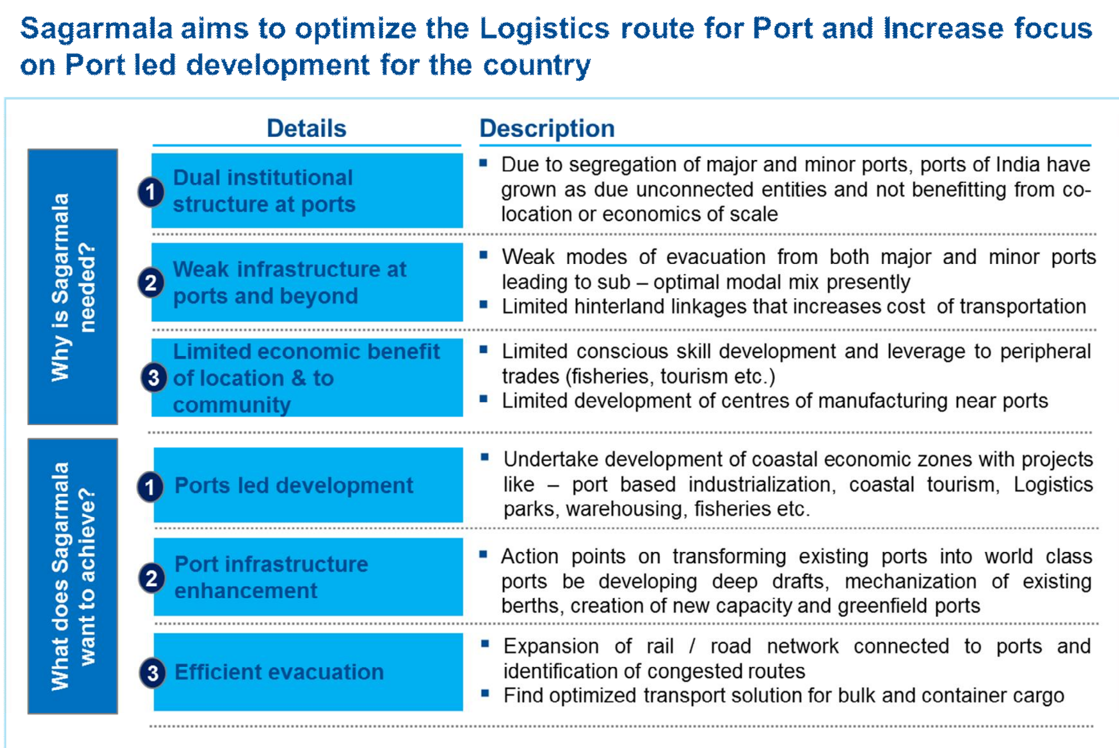


Figure 1.1 Aim of Sagarmala Development

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

We have distilled learnings from our experience in port-led development and examined major engagement challenges to develop a set of governing principles for our approach as shown in **Figure 1.2** below.

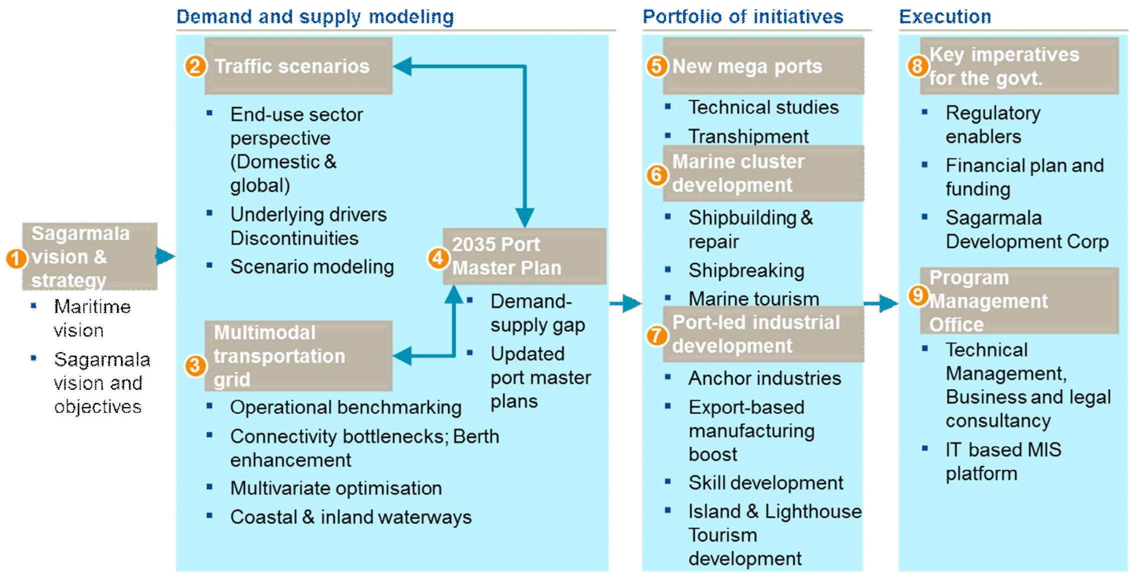


Figure 1.2 Governing Principles of our Approach

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 Development of Proposed Port

Andhra Pradesh has only one major port i.e. Vizag Port. Vizag port is constrained with its expansion due to development of city around it. The Ministry of Shipping, Government of India has already notified Greenfield port at Dugarajapatnam in Andhra Pradesh, as the major port under the Port Trust Act.

Dugarajapatnam is known for port related activities since times immemorial. In the seventeenth century, when the British East India Company decided to build a factory on the east coast, it is believed that Dugarajapatnam was selected as the site in 1626 to develop port facilities since the site is ideally located to develop sea port.

The capacity addition and the productivity improvements achieved by the major ports coupled with growing participation of Private Sector in cargo handling have had a favourable impact on efficiency of cargo handling operations at India's major ports. RITES have already prepared a feasibility report for Development of port at Dugarajapatnam in Andhra Pradesh. However they have assessed very high cost of port development, due to which MoS would like to have a relook at the entire project and accordingly have asked Mckinsey and AECOM to prepare a Techno-economic feasibility report for this site as part of the terms of reference of the Sagarmala assignment.

1.4 Present Submission

The present submission is the Techno-economic Feasibility Report for development of Dugarajapatnam Port, Andhra Pradesh. This report is organised in the following sections:

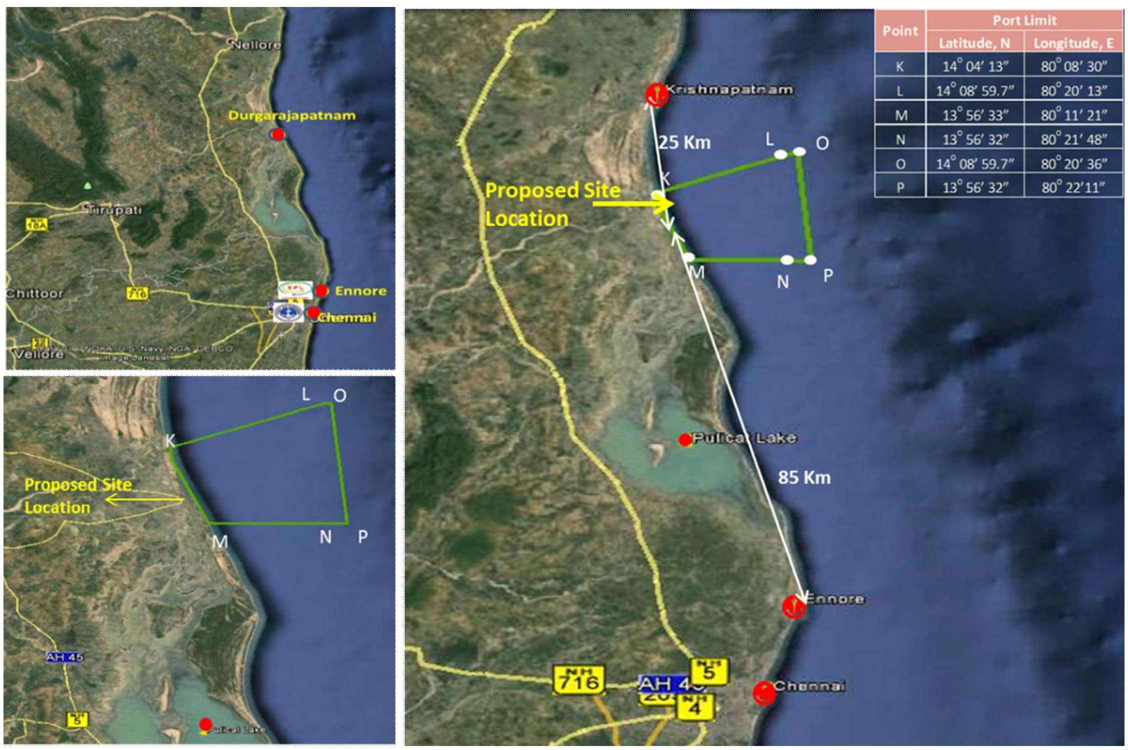
Section 1 : Introduction
Section 2 : Site Information
Section 3 : Traffic Projections
Section 4 : Design Ship Sizes
Section 5 : Port Facility Requirements
Section 6 : Preparation of Dugarajapatnam Port Layout
Section 7 : Engineering Details
Section 8 : Environmental Settings and Impact Evaluation
Section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

2.0 Site Information

2.1 Location of Project Site

2.1.1 General

The proposed Dugarajapatnam port location is as shown in **Figure 2.1**. Dugarajapatnam is a small village with 2388 inhabitants, lie adjacent to Buckingham Canal, very near to sea shore in Vakadu Mandalam of Nellore District of Andhra Pradesh. Important towns like Gudur are at a distance of 40 km and Vakadu at 10 km. It is surrounded heavily with marshy land with tidal influence. Dugarajapatnam is a fishing village on fringe of Pullicat Lake.



Point	Port Limit	
	Latitude, N	Longitude, E
K	14° 04′ 13″	80° 08′ 30″
L	14° 08′ 59.7″	80° 20′ 13″
M	13° 56′ 33″	80° 11′ 21″
N	13° 56′ 32″	80° 21′ 48″
O	14° 08′ 59.7″	80° 20′ 36″
P	13° 56′ 32″	80° 22′11″

Figure 2.1 Location of Project Site

Dugarajapatnam is approximately 40 km from the Krishnapatnam port, 23 km from Srikharikota (ISRO) and 85 km from Ennore. The port is located in the vicinity of Buckingham canal which is the mainstay of inland water transportation plans through National Waterway 4. The port site is located south of the mouth of Swarnamukhi River near Vaggaru at Tupilipalem village. Tupilipalem is located 20 km from Dugarajapatnam.

2.2 Field Survey and Investigations for Dugarajapatnam Port

For planning of the port facilities, RITES in 2013 conducted the following surveys and investigations at Dugarajapatnam as part of the Techno-economic feasibility studies. The following surveys and investigations were conducted at the proposed site.

- Hydrographic survey
- Tide and Current measurements
- Geotechnical Investigation

For the purpose of the current TEFR, the survey data already available for the Dugarajapatnam site have been referred.

2.3 Meteorological Data

2.3.1 Climate

The climate of the region is characterised by two seasonal monsoons viz. north-east and south-west. North-East monsoon occurs between November and January and is characterised by predominant north-easterly winds. During this period the risk of a tropical storm or cyclones is higher than in most months. South-west monsoon extends from June upto September and is characterised by occurrence of rain, with predominantly south westerly winds followed by the north-east monsoon in October-December with predominant north easterly winds.

2.3.2 Winds

During the south-west monsoon period winds are predominantly from the southwestern direction. During the post monsoon seasons winds are mainly north-western to north in the mornings and north-eastern to east in the afternoons. During the rest of the periods winds are mainly from directions between east and south. During summer and monsoon season wind speed is about 9 km/hr while it about 5 km/hr during the rest of the period. During north-east monsoon, wind velocity may go up to 50 km/hr and during cyclonic periods the wind speeds may go up to 105 km/hr.

2.3.3 Rainfall

The region experiences two monsoon viz., south-west monsoon and north-east monsoon. The rainfall during south-west monsoon amounts to 31% of the annual rainfall, while about 50% of the rainfall occurs during the north-east monsoon period. The southern half of the district, particularly the coastal part under which the project site falls, receives rainfall during the early north-east monsoon period also. October and November are the months with highest rainfall. The average rainy days range between 40 and 44 days in a year. The average annual rainfall in the district varies from 1000-1200 mm. The maximum annual rainfall of 1100 mm and above is recorded all along the coastal part of the district.

2.3.4 Temperature

In May, the mean daily maximum and minimum temperatures are 40.1ºC and 27.2ºC respectively. During December, the mean daily maximum and minimum temperatures are 28.7ºC and 20.2ºC respectively. The highest maximum and lowest minimum temperatures recorded at Krishnapatnam are 47ºC and 14.4ºC respectively.

2.3.5 Visibility

Visibility is good throughout the year at Krishnapatnam Port area. On an average, visibility is well above 4 km for 320 days in a year.

2.4 Oceanography

2.4.1 Bathymetry

Based on the hydrographic charts and survey undertaken by M/s RITES in the year 2013; it can be seen that the 6 m contour is very close to the shore, i.e., within 500 m from the shore. The 8 m contour is 1.5 km and 10 m contour is 3.0 km away from the shore. The 12 m contour is 6 km away from the coast. The 12 m contour itself spreads over a width of about 6.75 km that is up to about 12.75 km from the coast. There is a huge shoal formed in the off shore area at 12 m contour. Further offshore, the sea bed is steep, that is, within 5 km from 12 m contour 20 m contour exists. About 16 km away from the coast 20 m contour exists. The bathymetric detail for the proposed Dugarajapatnam is presented in **Figure 2.2**.

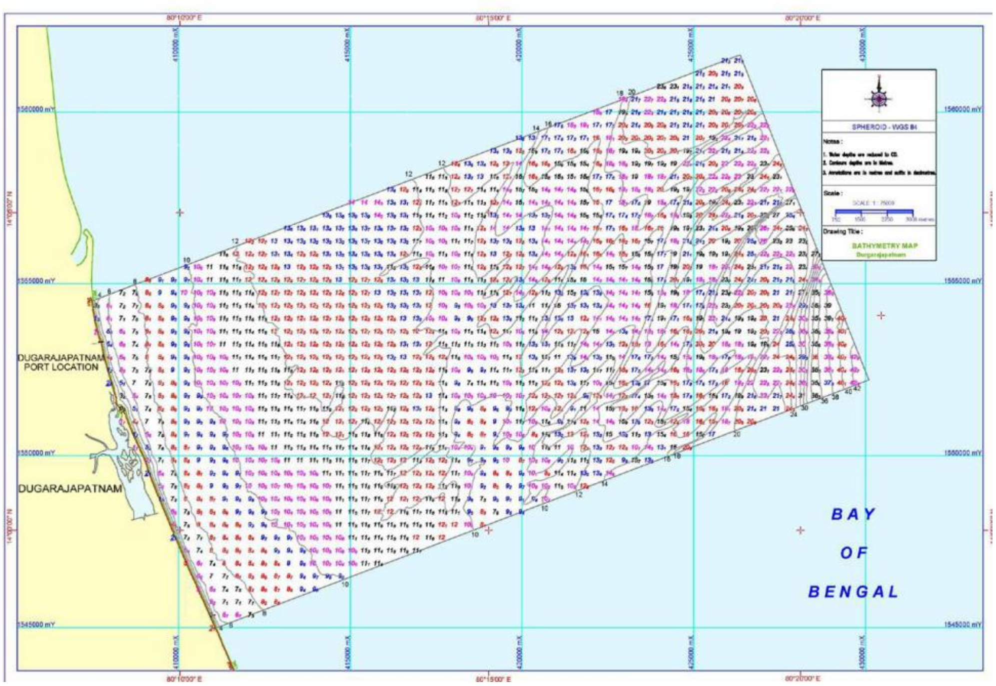


Figure 2.2 Bathymetry Details for Dugarajapatnam

The variation of seabed is as shown in **Figure 2.3**.

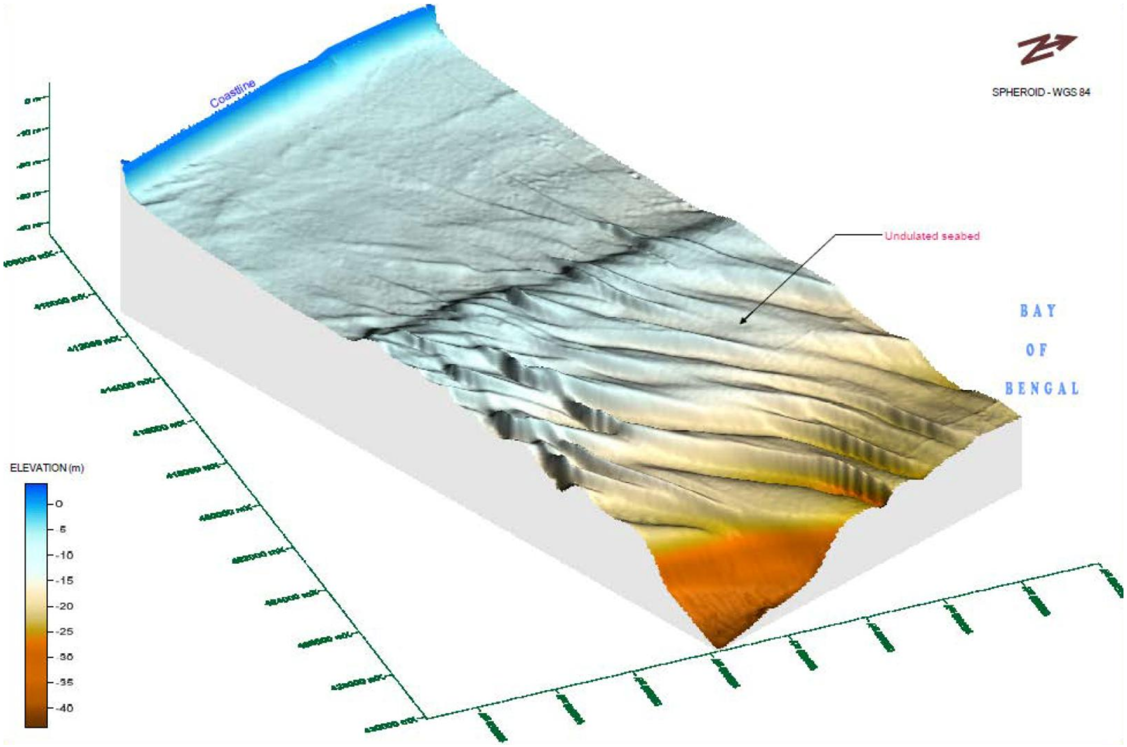


Figure 2.3 Variation of Seabed at Dugarajapatnam

2.4.2 Tides

Tide and current measurement's at the proposed site were carried out by M/s RITES in 2013. Measurements were carried at two locations viz., Tupilipalem sea water intake, just north of proposed port location, and the second one is at Ennore port, south of proposed port.

The tide at Dugarajapatnam is semidiurnal with two high tides and two low tides in a day. The various tidal levels at Dugarajapatnam port with respect to Chart Datum (CD) are as follows:

Highest High Waters (HHW)	:	+1.5	m
Mean High Water Spring (MHWS)	:	+1.2	m
Mean High Water Neap (MHWN)	:	+1.0	m
Mean Sea Level MSL	:	+0.8	m
Mean Low Water Neaps (MLWN)	:	+0.7	m
Mean Low Water Springs (MLWS)	:	+0.5	m
Mean Lowest low water (MLLW)	:	+0.3	m

2.4.3 Currents

The variations of current speed and direction were measured at three locations using Aanderaa Seaguard SW RCM current meters at three locations.

The maximum current velocity is 0.65 m/sec during the ebb tides and 0.61 m/sec during the flood tide.

2.4.4 Waves

2.4.4.1 Offshore Wave Data

To arrive at a suitable design wave for the marine facilities, the offshore significant wave heights for different return periods are calculated by probabilistic analysis.

The wave characteristics such as significant wave height and significant wave period at the offshore location have been extracted and presented in **Table 2.1** and **Table 2.2**.

The frequency distribution of significant wave height, the peak wave period and mean wave direction are shown in **Figure 2.4** and **Figure 2.5**. It is seen from the deep water data that the predominant wave directions in the deep sea off Dugarajapatnam are from SE to E.

Table 2.1 Monthly Max and Avg Values of Significant Wave Heights (m)

Month	Maximum	Average
January	1.04	0.80
February	0.98	0.72
March	1.02	0.62
April	1.03	0.87
May	1.39	0.72
June	1.07	0.75
July	1.22	0.83
August	1.11	0.86
September	1.31	0.88
October	1.34	0.84
November	1.31	1.00
December	1.34	0.93

Table 2.2 Monthly Max and Avg values of Mean Wave Period (s)

Month	Maximum	Average
January	7.1	5.9
February	7.8	5.9
March	7.4	5.9
April	8.4	6.6
May	8.2	6.2
June	8.6	6.8
July	9.8	7.6
August	9.2	7.8
September	9.2	7.7
October	8.0	6.6
November	6.8	6.2
December	6.8	6.1

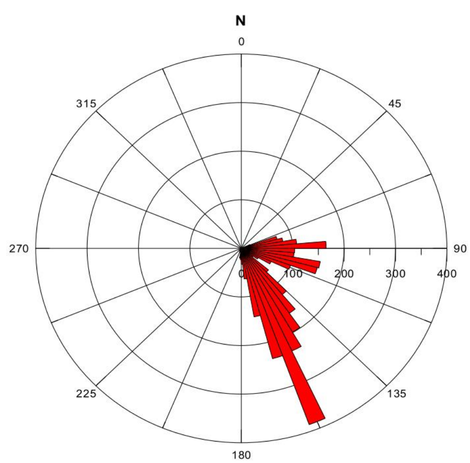


Figure 2.4 Wave Rose Diagram for Typical Annual Year

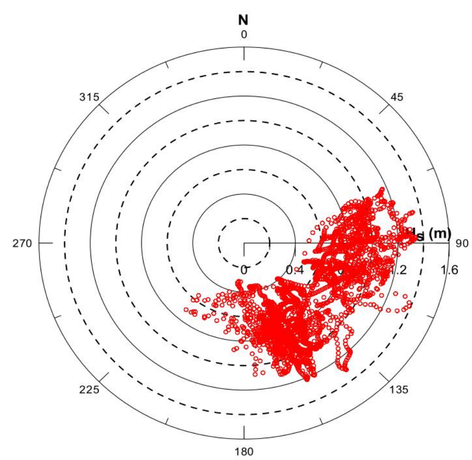


Figure 2.5 Wave Height Rose Diagram for Typical Annual Year

The offshore significant wave heights for different return periods based on wave data are shown in **Table 2.3**.

Table 2.3 Offshore Significant Wave Heights

Return Period T_r (years)	Offshore significant wave heights (m)
1	5.3
50	8.2
100	8.9

2.4.5 Cyclones

In the post monsoon period, storms and depressions originating in the Bay of Bengal pass through the district and neighbourhood causing wide spread heavy rains with gusty winds. Thunder storms occur during the period from March to November, being more frequent during the late half of the south-west monsoon and in the early part of retreating monsoon season.

2.4.6 Geotechnical Data

Detailed geotechnical investigations at the proposed site were carried out by M/s RITES in 2013; they conducted 6 no. of land boreholes and 9 no. of marine boreholes. The boreholes were terminated at a maximum depth of 30 m. The location plan of boreholes is presented in **Figure 2.6**.

Figure 2.6 Location Plan of Land and Marine Boreholes

2.4.6.1 Marine Boreholes

Soil profiles for all the marine boreholes were developed as shown in **Figure 2.7** and **Figure 2.8** to study the distribution of the sub strata. The subsoil strata consists of dense sand followed with the layer of stiff sandy clay and hard clay.

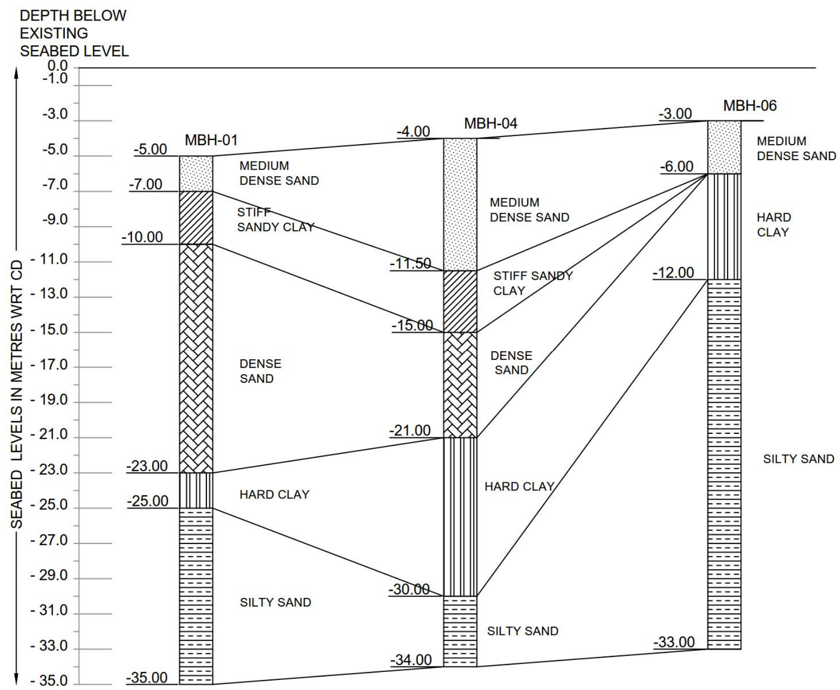


Figure 2.7 Subsoil Profile along MBH1, 4, 6

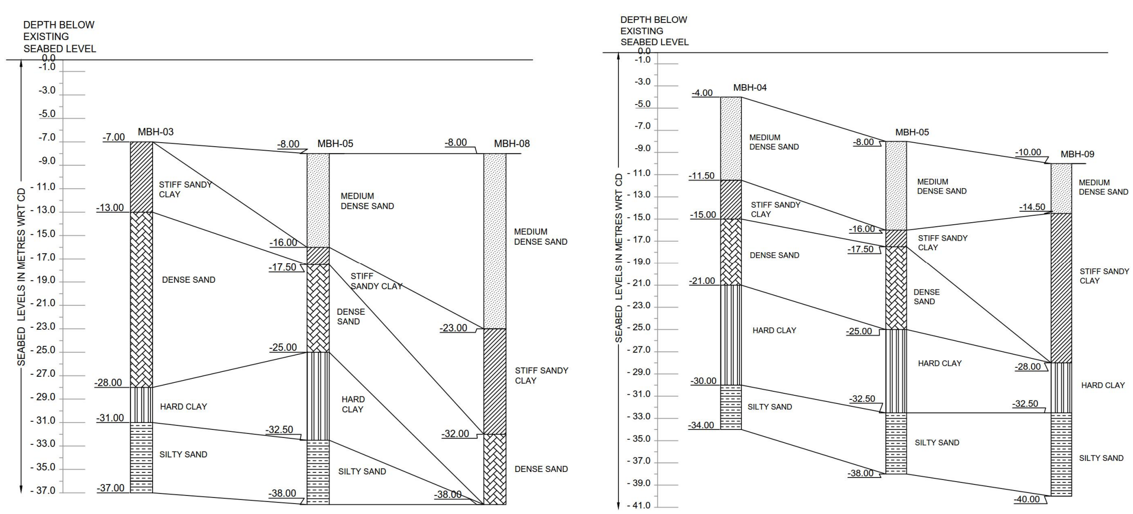


Figure 2.8 Subsoil Profile along MBH3, 5, 8 and along MBH4, 5, 9

2.4.6.2 Land Boreholes

The results of laboratory test conducted on samples collected from the onshore boreholes indicate the presence of 5 soil layers as shown in **Figure 2.9**:

- Dense sand
- Stiff Clay
- Very Dense Sand
- Clayey Sand
- Hard Sandy clay

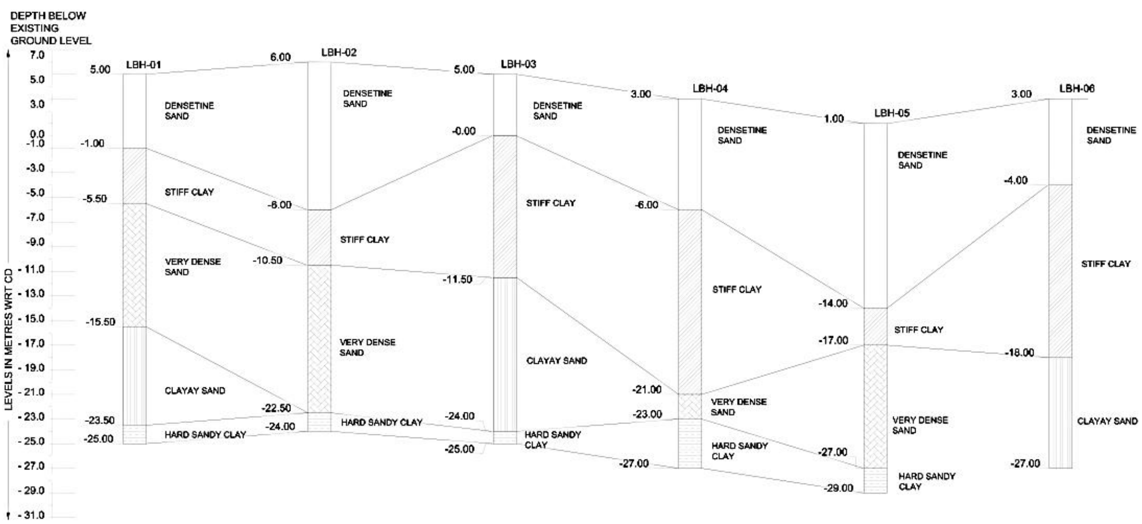


Figure 2.9 Subsoil Profile along LBH1, 2, 3, 4, 5 & 6

2.5 Site Seismicity

Dugarajapatnam is in **Zone III** of Indian Map of Seismic zones (IS-1893 Part-1 2002) which is a moderate risk seismic intensity zone (**Figure 2.10)**.

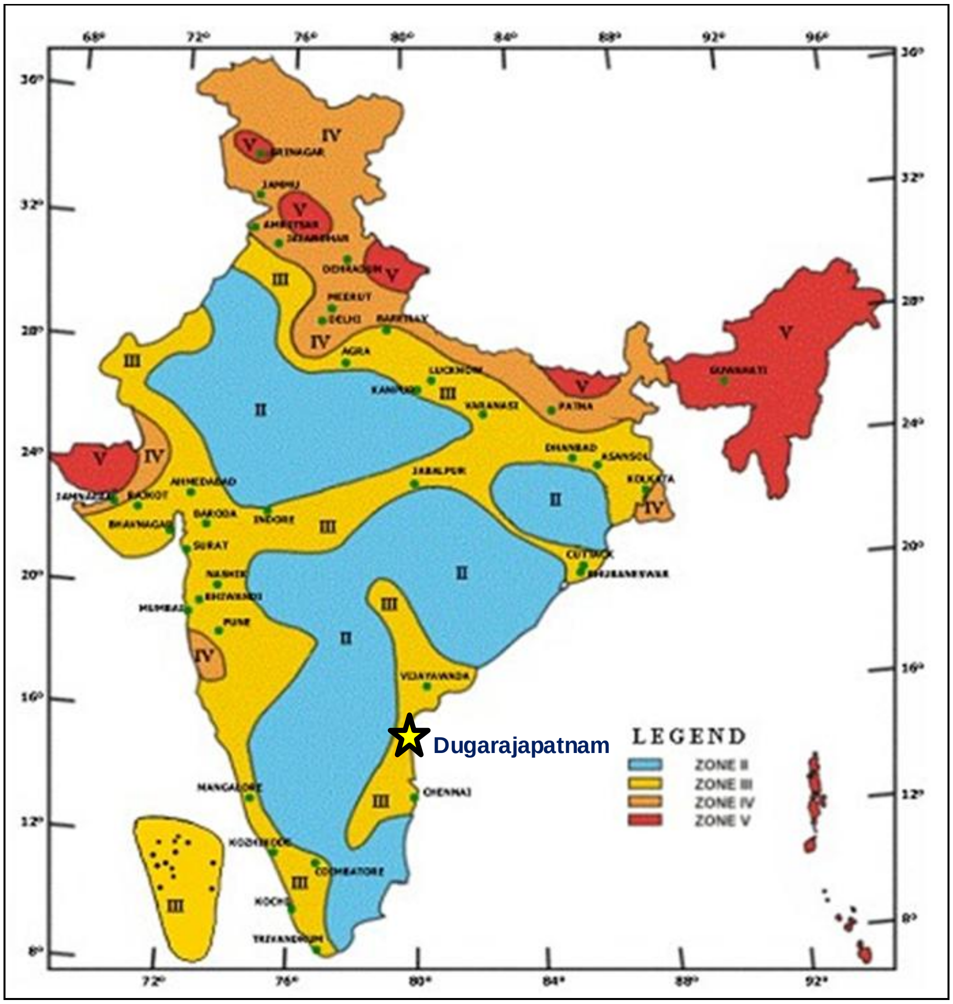


Figure 2.10 Seismic Zoning Map of India as per IS-1893 Part 1 - 2002

2.6 Topographic Information

The topographic survey carried out at the backup area of the proposed port shows that the ground levels vary between 0 to 3 m above MSL. 3 D view of the topography along the coast is as shown in **Figure 2.11**.

All along the coast prawn culture hatcheries are located.

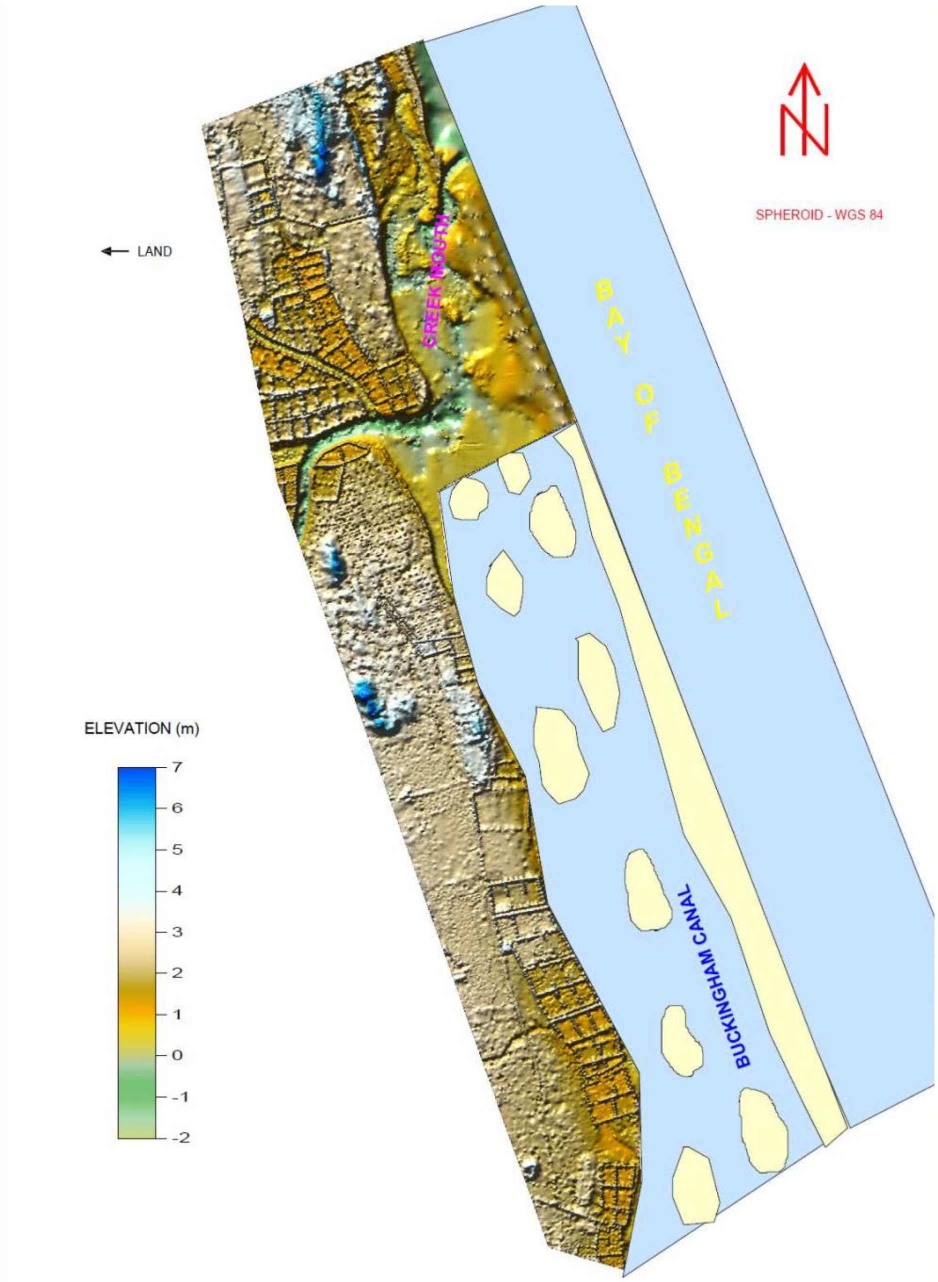


Figure 2.11 Topography of the Backup Area of the Proposed Port

2.7 Connectivity to Port Site

2.7.1 Existing Rail Connectivity

Though the port location does not have any direct connectivity by rail, there is already a proposal to connect this area by a broad gauge single line section between Guduru and Dugarajapatnam (nearly 42 km) by South Central Railways.

Guduru is a prominent railway junction and is a major transportation hub close the proposed port location. The existing rail connectivity to Dugarajapatnam is shown in **Figure 2.12**.

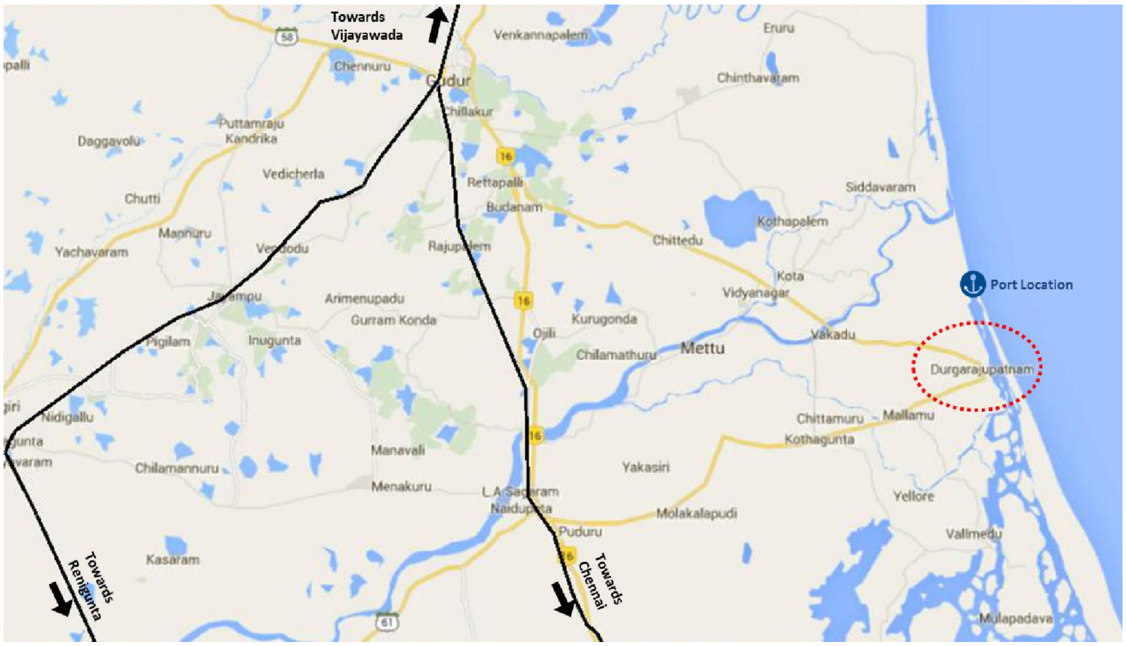


Figure 2.12 Existing Rail Connectivity to Dugarajapatnam Port

2.7.2 Existing Road Connectivity

The port site is connected to national highways by two routes namely Chillakur linking road and Naidupet linking road. The road near Chillakur crossing is 6 m wide (2 lane and 0.5 m carriage width either side) and takes 37 km to connect with NH5. The other district road from Naidupet is 3 m wide (1 lane and 0.5 carriage width on either side) bituminous road and takes 32 km to connect NH5. There are no major bridges along these routes except a bridge of length 400 m at Swarnamukhi river crossing. On development of port, these roads need to be upgraded to suit the port's requirement. On either side of the linking roads to NH5 to port site, most of the lands are paddy farmed and built up area or occupation by habitants are low.

The existing road connectivity to the proposed Dugarajapatnam port is as shown in **Figure 2.13**.

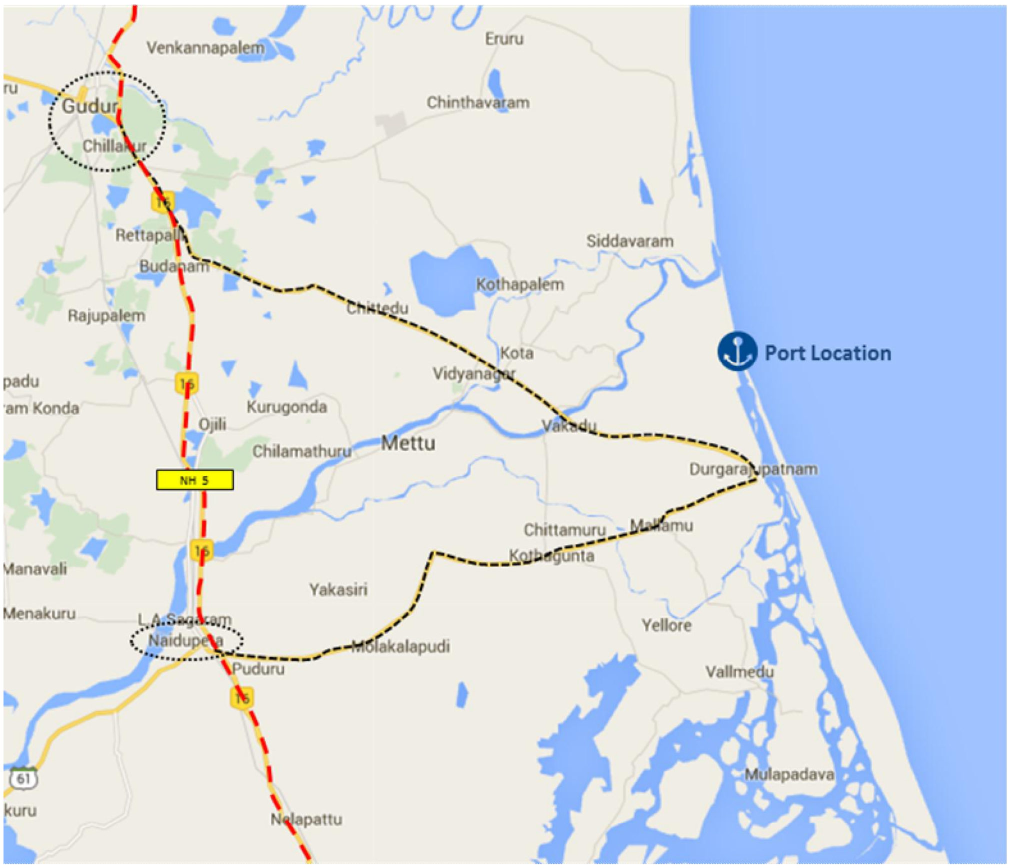


Figure 2.13 Road Connectivity to Dugarajapatnam Port

2.8 Water Supply

Presently, potable water to Dugarajapatnam village is being fed through pipelines from borewells driven near Swarnamukhi River at Vakadu. The required water for Port usage also can be obtained from same source through AP rural water supply board.

2.9 Power Supply

Dugarajapatnam has a 33/11 KV substation having 8 MVA capacity, which is being fed from 132/33 KV substation at Chendodu having 40 MVA (2-20MVA transformers) capacity. As the power requirement for the Port can't be met from these substations, AP govt. may supply from 400/220 KV substation near Kagitalapur (about 50 km from Port) having more than 200 MVA capacity.

The power is received from TCAPL at the main receiving substation at Manubolu (400 kV/220kV), as shown in **Figure 2.14** below.

Figure 2.14 Electrical Substation near Manubolu

3.0 Traffic Projections

3.1 General

The proposed port site of Dugarajapatnam lies on the eastern coast of India in the Nellore district of Andhra Pradesh. It has operational non-major port of Krishnapatnam on the north and major ports of Chennai and Ennore on the south. Southern Andhra Pradesh would be the primary hinterland of the port while Karnataka and parts of Telangana would be the secondary hinterland. Considering the location of the proposed site and the presence of other ports in proximity, Dugarajapatnam port would have to compete for the same hinterland with ports of Krishnapatnam, Chennai, Ennore and Katupalli.

3.2 Major Commodities and their Projections

As per the TOR of the Sagarmala assignment, the consultants are expected to map out the origin-destination of key cargo (accounting for greater than 85% of the total traffic) in Indian ports and develop traffic scenarios for a period of 20 years. Accordingly, based on a macro-level analysis the traffic potential for proposed port at Durgarajapatnam has been assessed by Mckinsey.

Thermal coal and containers would be the key commodities that can be catered to by the proposed port most of which would be diverted away from the existing port of Krishnapatnam.

3.2.1 Containers

The proposed port is expected to attract traffic of ~60,000 TEUs by 2020 primarily from the hinterlands of southern AP, Guntur, Hyderabad and other parts of AP. This traffic would be diverted mainly from the port of Krishnapatnam. Going into the future, this traffic is expected to increase to ~75-94,000 TEUs by 2025 and ~124-168,000 TEUs by 2035.

In the case of a new transhipment hub coming up on the Southern tip of the country the potential traffic is expected to further decline owing to the fact that part of the South AP containers will go directly to the transhipment hub.

Figure 3.1 below shows the hinterlands for the proposed Dugarajapatnam port.

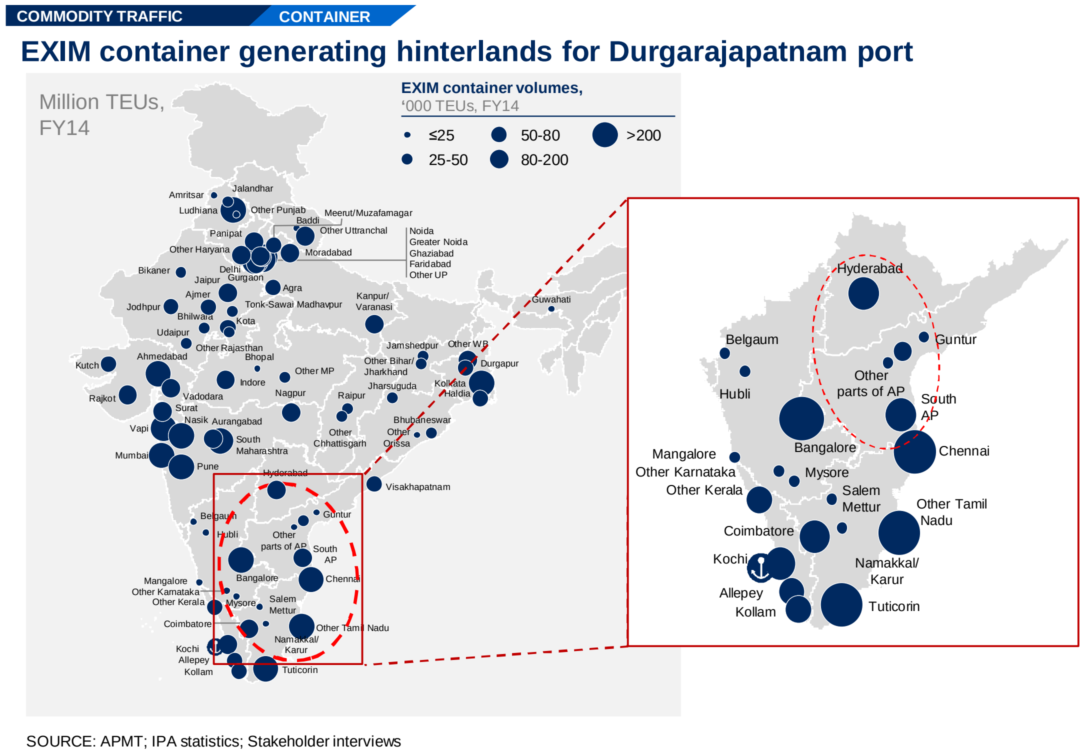


Figure 3.1 EXIM Container Generating Hinterland

3.2.2 Thermal Coal

The port is expected to divert part of the traffic currently handled by Krishnapatnam port. Rayalseema in Cuddapah district and Raichur can be the potential power plants using Dugarajapatnam for movement of thermal coal. The traffic for both these plants expected to be handled by the proposed port will be ~3.4 MTPA by 2020. Apart from the thermal coal for power based usage, non-power based coal traffic of ~3.5 MTPA is also expected by 2020.

The total thermal coal traffic at the port may increase to 8.5-9 MTPA by 2025 and 14-17 MTPA by 2035.

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

Table 3.1 Dugarajapatnam Traffic Projection

Durgarajapatnam Port - Traffic Projections

Units: MMTPA (except Containers)

xx Base Scenario xx Optimistic Scenario

Commodity	2020	2025		2035	
Dry and Break Bulk Cargo					
Thermal Coal (Unloading)	6.9	8.4	9.3	13.8	17.5
Containers and other Cargo					
Containers ('000 TEUs)	61.1	75.1	94.1	124.4	168.5
Total (MMTPA)	**7.8**	**9.5**	**10.7**	**15.7**	**20.0**

Conversion Factor Used for Containers Projections: 1 TEU = 15 Tons

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 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 Dugarajapatnam have been identified as:

- Thermal Coal Import
- Containers

4.2 Dry Bulk Ships

Dry bulk carriers are generally classified into the following groups, viz.

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

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.

4.2.1 Thermal Coal

Presently, the coastal shipping of thermal coal to southern states is carried out using ship sizes limited to Panamax size. However more and more facilities are being built in the southern states to receive vessels up to cape size. The costal shipping in cape size carried offer additional cost advantage for many of the users and it would be prudent the proposed port should also have unloading facilities for cape size ships in the future phases.

4.3 Containers

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	14500 TEU	16000 TEU	Triple E	18300 TEU
Nominal Capacity	1000	2000	4000	6000	9000	14500	16000	18000	18300
LOA (m)	160	200	290	320	350	365	400	400	400
Beam (m)	22	32	32	42	45	50	54	59	59
Loaded Draft (m)	10.0	11.0	13.5	14.0	15.0	16.0	15.5	15.0	15.5

[Source: Lloyds Fairplay database]

In view of its location the port at Dugarajapatnam is expected to handle feeder vessels only and therefore the design ship size for container is likely to be limited to 4,000 TEUs.

4.4 Design Ship Sizes

The principal dimensions of the ships considered for the preparation of the layouts and design of marine structures for the proposed 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)
Dry Bulk	**80,000**	**72,000**	**240**	**32**	**14.5**
	120,000	110,000	260	40	16.5
	200,000	200,000	300	50	18.3
Container	1000 TEUs	700 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, navigational requirements, material handling equipment, storage area for each type of cargo, road and rail access for the receipt and evacuation of cargo, and other utilities and service facilities. 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 depths in approach channel and harbour basin:

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

The major commodity for the proposed port is coal which is likely to move to this site from Paradip/ Dhamra through coastal shipping. Most of the quantity 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.

However, as the proposed port has to compete with adjacent ports at Krishnapatnam and Ennore who have capability to handle cape size ships, it would be important that the planning should be such that the port should be able to handle cape size vessels by carrying out capital dredging at appropriate time as per market demand.

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

5.2.2.1 Bulk Cargo

For bulk cargo like thermal coal, it is proposed to be handled through fully mechanised system comprising 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 Containers

For containers, it is proposed to be handled through mobile harbour cranes. 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

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 for Dugarajapatnam Port Development

S. No.	Berth Type	Commodities Handled at Berths	Import (I) / Export (E)	Total Berth Provided		
				2021	2026	2036
1.	Bulk Import	Coal	I	1	1	2
2.	Multipurpose Terminal	Break Bulk, Containers	I/E	1	1	1

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 40 T bollard pull, 2 pilot launches and 2 mooring launches.

It is proposed to utilise one end of the main berths 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 length of isolated berth for the different design ships are presented in **Table 5.2** below.

Table 5.2 Total Berth Length

Berth Type	Design Ship Size	Design Ship's LOA (m)	Minimum Berth Length (m)
Bulk Berths	80,000 DWT	240	290
	120,000 DWT	260	310
	200,000 DWT	300	350
Container berths	1000 TEUs	160	200
	4000 TEUs	250	300

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,
- 5 days for Containers

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 14 ha. increasing to 28 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

Two substations are envisaged to be provided, one each for container and coal 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

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 Dugarajapatnam, 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.	Bulk Import	20%	80%	20%	80%	20%	80%
2.	Container	80%	20%	80%	20%	80%	20%

5.5.2 Port Access Road

The port would need to be connected to national highway NH5 for evacuation which is approximately 40 km from the port site. There is already an existing access road to the port which connects to NH5 and it would need to be widened from two lanes to four lanes initially and later to six lanes once the throughput picks up in later phases of development.

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 0.30 MLD increasing to about 0.6 MLD in the master plan phase.

5.7 Power Requirements

HT and LT power supply at the port would be required for Handling Equipment, 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 9 MVA increasing to about 16 MVA in the master plan stage. The major requirement is on account of the proposed mechanised cargo handling system at various berths.

5.8 Land Area Requirement for Dugarajapatnam Port

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 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 Land Area Requirement for Dugarajapatnam Port

S. No.	Commodity	Allocated Area (sqm)		
		2020	2025	2035
1.	Storage Space for various Cargoes	1,39,043	1,70,316	2,78,087
2.	Internal Roads and Circulation Space in Storage areas @ 25%	34,761	42,579	69,522
3.	Rail and Road Corridor	1,10,000	1,34,740	2,20,000
4.	Port Building Complexes including parking	5,000	5,151	9,295
5.	Landscaping, Green belt and other for Expansion	50,000	50,000	75,000
	Total Land Area (Sqm)	**3,38,804**	**4,02,786**	**6,51,903**
	Total Land Area (Acres)	**84**	**100**	**161**
	Total Land Area (Hectares)	**34**	**40**	**65**

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 double the area 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 layout for the proposed port at Dugarajapatnam are given below:

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

6.2.1 Potential Traffic

The potential traffic that the proposed 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 Dugarajapatnam Port development.

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 Krishnapatnam port located towards north and Ennore port located towards south are close to this port location and both can cater to the cape size ships, it would be important that the proposed port at Dugarajapatnam be designed for handling cape size ships. However, in the initial stage of development it should at least be able to handle 80,000 DWT design ships. Accordingly, suitable water depths would need to be provided in the initial stages or subsequent years.

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. Based on the information available from the RITES report soil mainly comprise of silty medium sand and clayey sand at some locations. Therefore most of the dredged material shall be suitable for reclamation. The presence of silty sand at about 25 m below bed level indicates good founding strata for piled foundations. Therefore the geotechnical conditions at the proposed site are considered favourable.

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 located along east coast are subject to waves from NE direction during NE monsoons and that from SW direction during SW monsoon period. The orientation of the breakwaters would need to be decided accordingly.

6.2.2.4 Ability to Cater for Littoral Drift

The phenomenon of littoral drift of sediments along the east coast of India is well known. The drift of sediments along the coast is caused by the action of waves impinging on the coastline at an angle, and this slowly drives the material in the direction of the waves. This is predominantly from south to north along the east coast of India, but there is some reverse drift in the NE monsoon season.

6.2.2.5 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. As per the information obtained during site visits, there are no quarries suitable for breakwater rock in the Nellore district and rock have to be brought from at least over 100 km away from Prakasam district. Any additional sources of rock shall need to be identified during detailed study.

6.2.2.6 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.

6.2.2.7 Scope for Expansion over the Initial Development

With the costly basic infrastructure like 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.

6.2.2.8 Flexibility for Development in Stages

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

6.2.2.9 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. Same is the case for reducing the area required to be reclaimed in the initial phase.

6.2.2.10 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.

It is understood that based on the RITES report the state government is in process of acquiring land as shown in **Figure 6.1**.

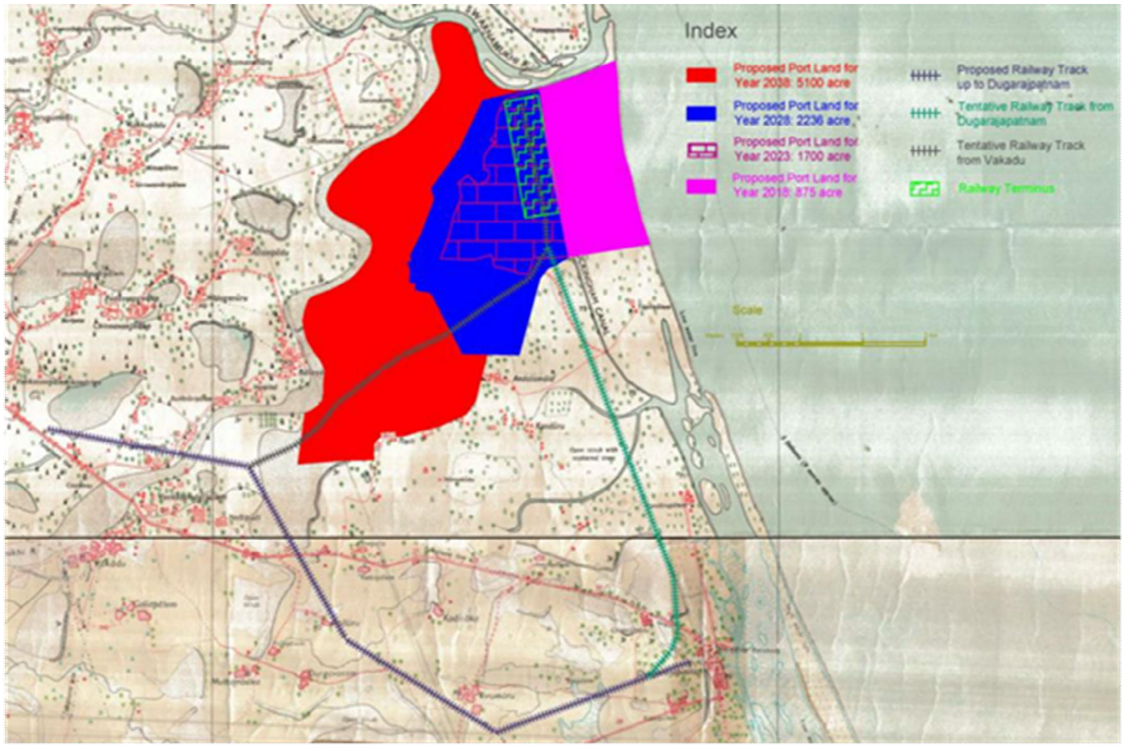


Figure 6.1 Demarcation of Land to be Made Aavailable for Port

Based on the studies carried out by RITES, it has been proposed for the land acquisition of 875 acres. However, in view of the much lower projected traffic and reduced requirements of facilities, so much land would not be required for the port facilities. The port layout would be developed with minimum land acquisition.

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 port location or suitable layout of port.

It is noticed that 12 km out of 15.4 km demarcated as port limits are coming under proposed Pulicat Lake Bird Sanctuary (PLBS) and its eco-sensitive zone. This area has been defined as 'No Development Zone' and no new industrial activity or construction can be undertaken in this zone.

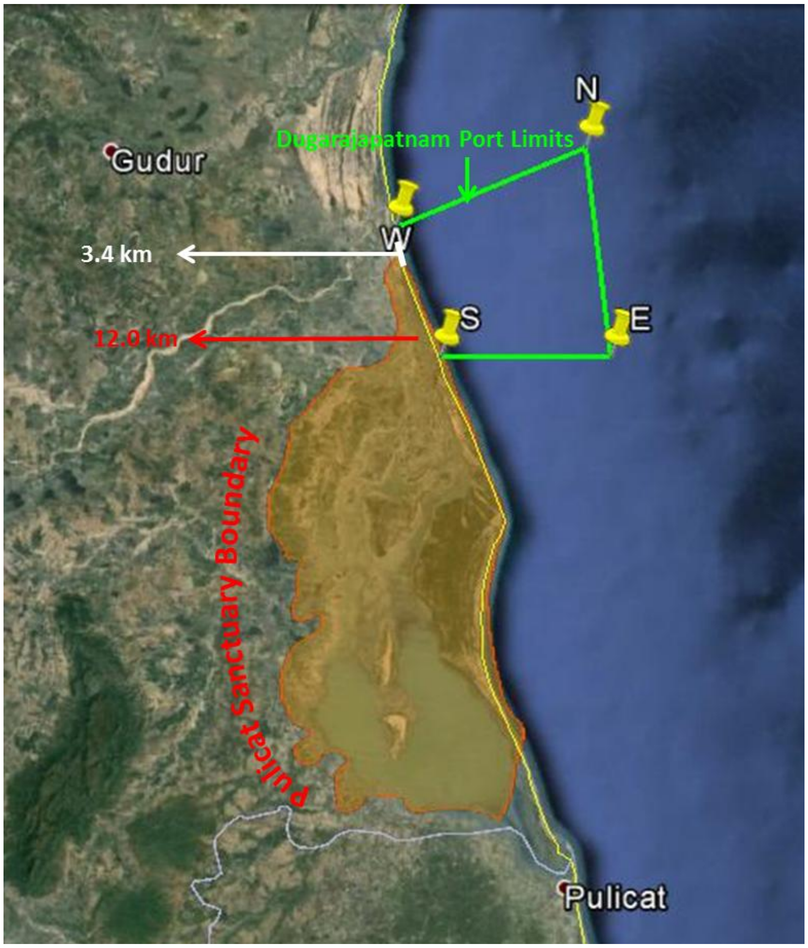


Figure 6.2 Pulicat Lake Boundary Limits

Boundary of proposed PLBS and its eco-sensitive area is to be de-notified in order to take this project forward.

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 the navigational channel 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=1.0 m to Hs=1.5 m depending on 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 ships due to wave action that will hamper the ship-shore handling operations. This limit varies with the handling system for 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
Containers	0.5 m	0.5 m
Break bulk	1.0 m	0.8 m

6.3.2 Breakwaters

The purpose of breakwater is to provide tranquil conditions inside the port in operating conditions. The predominant wave attack is from SE and E directions. This would require two breakwaters to provide round the year wave tranquillity within the harbour. Final layout and alignment of the breakwaters shall be decided based on the wave tranquillity studies and the length shall be kept minimum to limit the overall capital expenditure.

6.3.3 Berths

The estimated number of berths for the various phases of development has been worked out and is presented in the **Table 6.2** below.

Table 6.2 Berth Requirement Estimation

S. No.	Berth Type	Commodities Handled at Berths	Import (I) / Export (E)	Total Berths Provided	
				2020	2035
1.	Bulk Import	Coking Coal	I	1	2
2.	Multipurpose Terminal	Break Bulk/ Container	I/E	1	1

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 advantage, 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		0.0
		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		
	- 3> H_s > 1 and l = L	all	0.5			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	0.1	0.1
	- rough and hard		0.2	0.2		
(h)	**Depth of Waterway**					
	- ≥ 1.5T (inner and outer waterway)		0.0	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				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
TOTAL ADDITIONAL MANOEUVRING WIDTH FACTOR W_i				**2.9**	**2.1**
PIANC Table 5.4 - Additional Width for Bank Clearance					
- Gentle underwater Channel slopw (<1:10)	fast	0.2			
	mod	0.1			
	slow	0.0			
- sloping channel edges and shoals	fast	0.7			
	mod	0.5		0.5	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}				**0.5**	**0.5**
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	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				**1.6**	**1.4**
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	**Inner**
one way straight channel			
Cape Size Bulker		**270**	**230**
Panamax Size Bulker		**173**	**147**
one way curved channel			
Cape Size Bulker		**279**	**239**
Panamax Size Bulker		**179**	**153**
two way straight channel			
Cape Size Bulker +Panamax Size Bulker		453	381
two Panamax Size Bulker		365	307
two way curved channel			
Cape Size Bulker +Panamax Size Bulker		**468**	**396**
two Panamax Size Bulker		**376**	**319**

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)	Channel Width (m)				Loaded Draft (m)
		Straight Channel		Curved Channel		
		One Way	Two Way	One Way	Two Way	
200,000	50	270	570	280	590	18.3
80,000	32	175	365	180	376	14.5

The channel length for handling 2,00,000 DWT ships works out to approximately 17 km and therefore the transit time of the ships in the channel will be about 1.15 hours at 8 knots speed. Allowing for time required for tugs attachment, manoeuvre and tug return for next ships as 1 hour, maximum of 10 ship movements per day (5 in and 5 out) could be accommodated with one set of tugs. Taking an average of about 8 ship movements per day in the channel, a one way channel can handle about 1,460 ship calls per year using one set of tugs. Considering the much lower 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.

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

Table 6.5 Dredged Levels at Port for the Design Ships

Ship Size (DWT)	Draft (m)	Approach channel outside breakwater (m CD)	Inner channel and manoeuvring area (m CD)	At Berths (m CD)
80,000	14.5	16.7	16.0	16.0
200,000	18.3	21.0	20.1	20.1

It may however be noted that above values are arrived at considering the design ship navigates the channel and harbour basin during low water levels and therefore without the advantage of tide. However, in case the port is designed for cape size ships, the number of calls of such ships would be limited in the initial years and therefore a tidal advantage of at least mid-tide level of +0.8 m above CD could be considered. This would enable phasing of the capital expenses on the dredging. This aspect can however be dealt during execution stage.

6.3.5 Elevations of Backup Area and Berths

Considering the Highest high water level as +1.5 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 proposed as +5.0 m CD. The finished levels of onshore areas will be kept at around +4.7 m CD.

6.3.6 Scheme for Littoral Drift Management

When a breakwater is constructed protruding out from the coastline it creates a barrier to the natural drift. Therefore the drift material will accumulate against the breakwater as shown in **Figure 6.3** below:

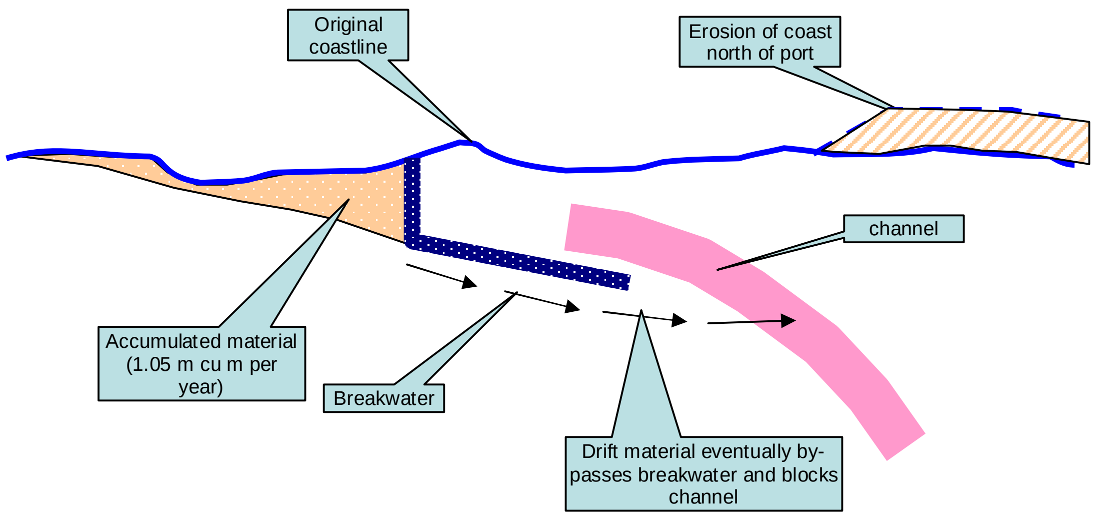


Figure 6.3 Diagramatic Illustration of Littoral Drift

Figure 6.3 shows what can be expected to happen if no action is taken to deal with the drift. The coastline north of the port is starved of the material which has occurred naturally in the past. The consequent erosion of the coastline north of the port would certainly be environmentally unacceptable.

Therefore it is necessary to collect the material and deposit it north of the port as part of an essential environmental management plan. Three possible methods of dealing with this problem for the proposed port are illustrated diagrammatically in **Figure 6.4** to **Figure 6.6**.

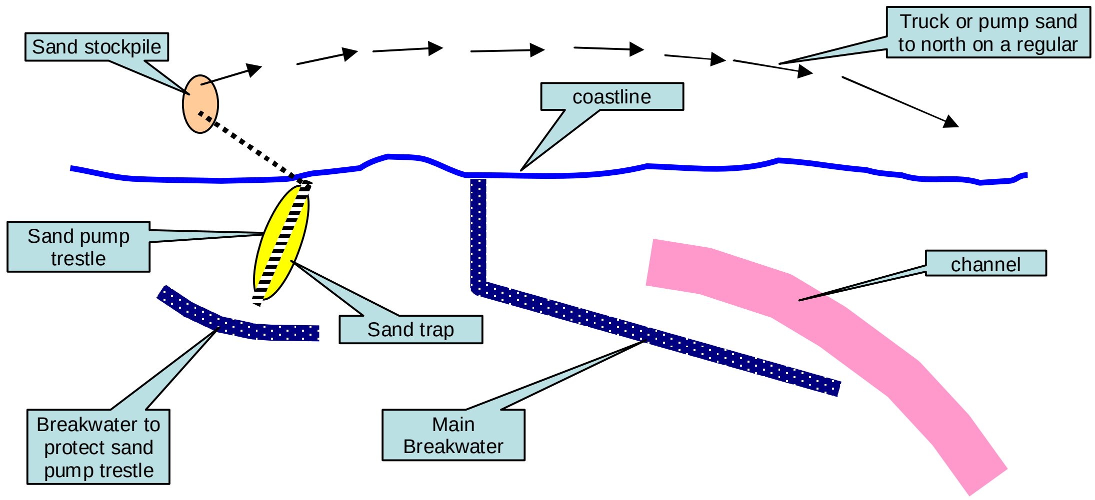


Figure 6.4 Littoral Drift Management Scheme 1

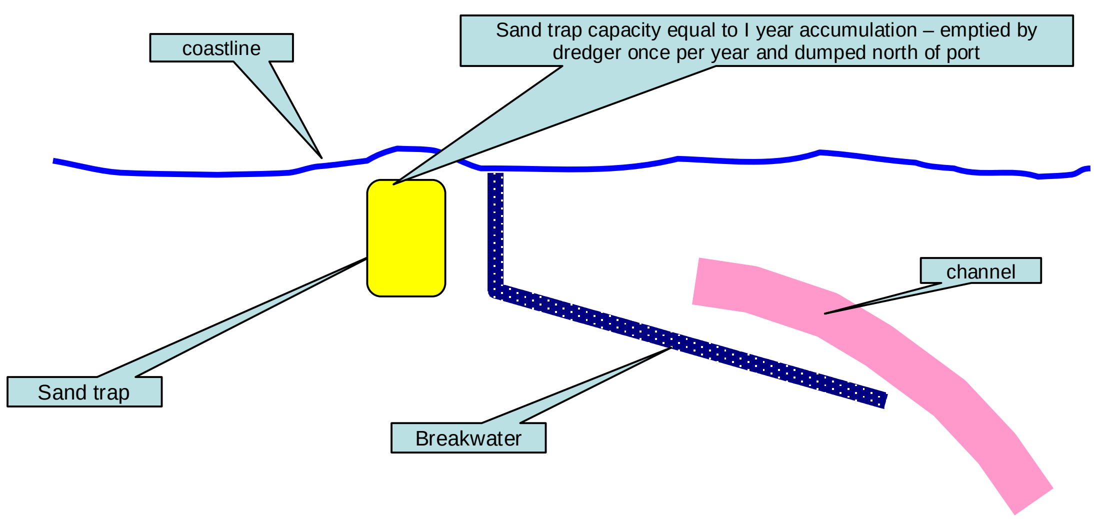


Figure 6.5 Littoral Drift Management Scheme 2

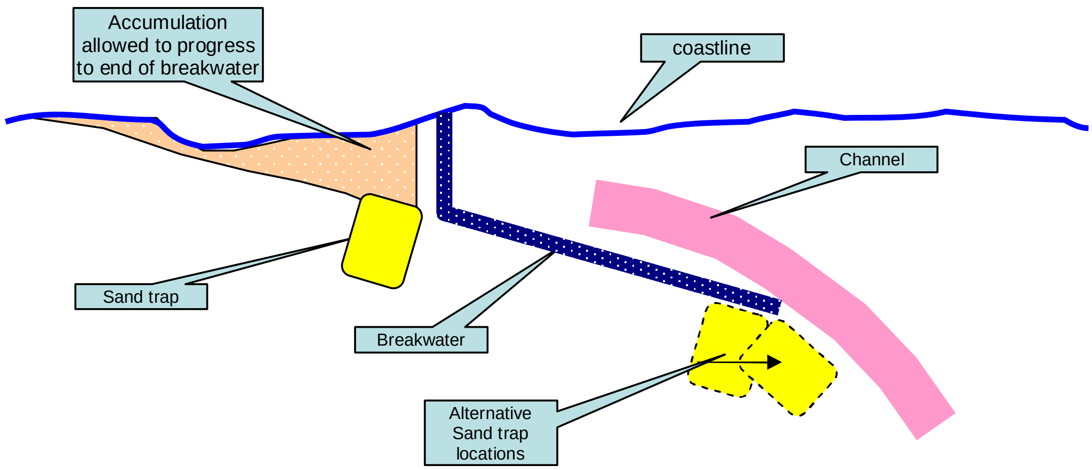


Figure 6.6 Littoral Drift Management Scheme 3

The drift occurs mainly between the high water line and -6.0 m contour. In all three schemes, therefore, the aim is to interrupt the accumulation of material in this zone.

In scheme 1, a sand trap is provided south of the port in the location of the existing 0-6 m contours i.e. before any accumulation of material has occurred. A sand pump mounted on a trestle removes the material monthly and pumps it round to the north, or alternatively to a stockpile ready for trucking to the north. The trestle and sand pump need to be protected by an island breakwater, and for this reason the scheme incurs a high capital cost. Its only advantage is that it can replenish the northern side on a regular monthly basis.

In scheme 2 a sand trap is provided in the same location as in scheme 1. This sand trap would have enough capacity to hold an entire 1 year's accumulation of drift material, and it would be emptied by a dredger annually. The annual dredged material would be deposited by the dredger on the northern side by rain-bowing technique or any other suitable method. The capital cost is much less than scheme 1, being merely an extension of the capital dredging contract by 1-1.5 million cubic metres.

In scheme 3 the coastline is allowed to advance to the end of the breakwater before any measures are taken to collect the drift material. Thereafter the scheme is the same as scheme 2, with a sand trap provided between the new high water mark and the new -6.0 m contour. This scheme creates valuable additional land and would be considered acceptable provided that during the few years taken for the southern beach to advance, suitable measures can be taken to protect the northern beaches, which could be by way of constructing groynes or dumping any surplus material.

It is therefore suggested that breakwaters are extended upto 6 m contour so that no material from littoral drift is directly accumulated at the channel but fully blocked by the breakwaters.

6.4 Alternative Marine Layouts

Two basic layouts for the port development have been considered for the Dugarajapatnam Port. These are discussed below:

Alternative Layout 1 involves offshore harbour option where the harbour area is located away from the shore. This alternative is envisaged to involve higher cost for breakwaters but less for dredging. Also it would be possible to utilise all the dredged material to create additional area by way of reclamation. The channel orientation at the harbour entrance is from NNE 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 channel orientation from SE direction was also planned but was not found suitable in view of presence of shoal towards the south direction. This alternative is shown in **Drawing DELD15005-DRG-10-0000-CP-DRP1001** and **DRP1002**.

Alternative Layout 2 is a coastal harbour option with most of the berths located close to the shore. As compared to Alternative 1, this alternative would result in shorter breakwater length but higher dredging quantities. The channel orientation is similar to as that of Alternative 1. This alternative is shown in **Drawing DELD15005-DRG-10-0000-CP-DRP1003** and **DRP1004**.

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, Navaids, Utilities, Buildings etc. are of negligible cost difference for both alternative layouts. Therefore, for cost comparison for these two 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 for Alternative Layouts

Item	Phase 1 Development		Master Plan Development *	
	Layout 1	Layout 2	Layout 1	Layout 2
Breakwaters	917	526	917	526
Dredging	310	401	1143	1249
Reclamation	411	125	665	179
Total	**1,638**	**1,051**	**2,648**	**1,953**

* It is assumed that dredging for cape size ships shall be carried out for master plan layout

In order to further optimise the alternative layout 1, the option with a single offshore breakwater was also considered but it was not found to be cost effective and therefore did not pursued further.

From the above table, it is observed that cost of development is much lower in case of layout 2-Nearshore option.

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

Alternate	Estimated Rock Quantity (MT)	Estimated Construction Time (months)
Alternative 1	6.21	33
Alternative 2	3.53	22

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. Considering a patch of state government land right opposite the waterfront, it is required that limited land could be reclaimed utilising the suitable dredged material for the required cargo storage and operational areas.

6.5.4 Expansion Potential

It is observed that alternative layout 1 offer higher number of berths as compared to alternative 2. However, considering the traffic projections the number of berths available in alternative 2 is much higher than required at the master plan stage.

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.	**Soil Profile**	The soil characteristic would dictate the cost of dredging and marine structures.	The soil comprises of medium silty sand and thus forms reasonable founding strata for breakwaters and piled foundation.	Same as Alternative 1.
2.	**Material for Reclamation Fill**	The borrowed fill material would be costly due to distant location of quarries.	Most of the dredged material is suitable for reclamation.	Optimal use of dredging and reclamation material.
3.	**Protection to the berths from waves and swell**	The predominant wave direction is from E and SE	The proposed breakwaters provide adequate tranquility to the berths	Same as Alternative 1.
4.	**Ability to cater to Littoral drift**	The scheme should be able manage littoral transport so as to minimize the shoreline changes	A sand trap would need to be provided outside the south breakwater	Same as Alternative 1.
5.	**Suitable location of back-up land for storage of cargo and port operations**	The storage area should located so as to provide faster receipt / 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.
6.	**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 in the land proposed to be acquired for port development	Same as Alternative 1.
7.	**Environmental issues related to development**	Presence of Pulicat Lake Bird Sanctuary	Proper EMP needs to be prepared to avoid any impact of proposed development.	Same as Alternative 1.
8.	**Potential Reclamation Area**	The higher reclamation area could be used to meet the storage and operation requirements of master plan stage	284 Ha	88 Ha

S. No.	Factor Description	General	Alternative 1	Alternative 2
8.	**Capital Cost of Phase 1 Development**	Optimized capital cost for the initial phase development so as to increase the project viability	Base case	Much Lower than alternative 1
9.	**Expansion Potential**	Maximum number of berths possible in the harbour so as to meet the demand at least for master plan horizon	Total 11 berths possible	Total 8 berths possible

6.7 Recommended Master Plan Layout

It could be observed from above that alternative layout 2 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.

In order to minimise the overall project cost in terms of land acquisition and reclamation, this layout was further optimised and a new alternative layout i.e. recommended layout has been developed as shown in **Drawing DELD15005-DRG-10-0000-CP-DRP1005**.

6.8 Phasing of the Port Development

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 (DWT)	*80,000*	*80,000*
• Containers *(TEUs)*	*4,000*	*4,000*
Number of berths (Total length of berths in meters)		
• *Bulk Import Berths*	*1(350m)*	*2(750)*
• *Multipurpose berths*	*1(300m)*	*1(300m)*
Navigational Areas		
• *Length of Approach Channel (m)*	*18,000*	*16,500*
• *Width of Approach Channel (m)*	*175*	*270*
• *Diameter of Turning Circle (m)*	*550*	*600*
Breakwaters		
• *South Breakwater (m)*	*3,340*	*3,340*
• *North Breakwater (m)*	*1,240*	*1,240*
Design Draft of the Ship (m)	14.5	18.3
Dredged Depths at Port (m below CD)		
• *Approach Channel*	*16.7*	*21.0*
• *Manoeuvring Areas*	*16.0*	*20.1*
• *Berths*		
o *Breakbulk*	*16.0*	*16.0*
o *Bulk*	*16.0*	*20.1*
Incremental Dredging Quantity (million cum)	*21.0*	*42.4*
Incremental Reclamation Quantity (million cum)	*8.3*	*3.63*
Total Reclamation Area (Ha)	*88*	*144*

The recommended Phase 1 development of Dugarajapatnam Port is indicated in **Drawing DELD15005-DRG-10-0000-CP-DRP1006**.

7.0 Engineering Details

7.1 Mathematical Model Studies on Marine Layout

These layouts have been duly checked after carrying desk based assessment for the wave tranquillity within the harbour. Mathematical model studies for wave penetration shall be carried out on the selected layout but it is unlikely to result in any change in the orientation of the berths and breakwater.

7.2 Onshore Facilities

The main consideration, in locating the facilities has been to minimise the land acquisition. Therefore the onshore facilities have been located in the reclaimed land. The areas for cargo handling and port operations have been segregated.

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

7.3 Breakwater

7.3.1 Basic Data for design of Breakwater

7.3.1.1 Design Wave Height

The probable significant wave heights off Dugarajapatnam coast for different return periods have been discussed in Section 2. From this, the offshore design wave height is chosen as 8.9 m and the period as 11.4 s. Applying mathematical model MIKE 21 to this offshore wave data, results in shallow water wave height of 4.5 m at the breakwater location at -7m CD. However, since the MIKE 21 model underestimates the shallow water wave heights for extremely flat bottom conditions, the design wave height is adopted as 5 m.

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.

Considering the extreme wave heights, their return periods, depths in which the breakwaters are located, the importance of the breakwaters (i.e. functional requirements) and the judgment for allowing the risk factor, the following design conditions are adopted for the south as well as north breakwaters:

- No damage for actual predicted wave heights

  Or
- Corresponding breaking wave height in that water depth, whichever is critical

7.3.1.2 Design Water levels

The storm surge of 1.5 m is expected at this site based on the desktop study. With storm surges the meteorological conditions causing the rise in water levels are sometimes but not always the same as those causing maximum wave attacks. In some cases the two conditions will be independent variables; in others they can be positively or negatively related. The combined probability of the storm causing design wave height at structure along with maximum storm surge is considered to be negligible. It is therefore proposed to use +3.0 m CD (Mean High Water Springs i.e. +1.5 m CD plus 1.5 m storm surge), as the design high water level for the breakwater design.

- Other 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.

Both the breakwaters would be constructed simultaneously.

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 10,000 T/day by end on dumping method. An additional 3,000 to 5,000 T/day of rock 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 Core-loc or Xblock.

7.3.2 Breakwater Cross Sections

Hudson formula is used for calculating the weight of armour unit

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

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 values for K_D considered for design of revetment is 2.8.

7.3.3 Geotechnical Assessment of Breakwaters

The seabed level at the breakwaters varies from +3.0 m CD nearshore to a maximum of -10.0 m CD. The crest level of breakwater at the maximum depth is about +9 m CD.

The stability of the breakwater foundation needs to be analysed for the subsoil conditions. This would be more relevant for the sections in deeper water. Based on the subsoil data, dense sand up to -6 m CD under layered by stiff sandy clay up to -9 m CD and therefore likely to provide reasonably good founding strata for the breakwater. There is unlikely to be requirement for any soil replacement which would increase the cost estimates for breakwater significantly though wider toe may need to be provided at some locations to provide stability. However, any shortfall in the stability found at the detailed engineering stage could be managed by increasing the toe width and/or depth.

7.3.4 Rock Quarrying and Transportation

7.3.4.1 Location of Quarries

It is understood that there are no quarries located suitable for breakwater construction in Nellore district. The rock for the construction of breakwater works need to sourced out from the quarries located at distant places in Praskasam district which are approximately 120 to 150 km from the proposed site.

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-DRP1006**. 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 container berth away from the shore and backup area to which the connection shall be by approach trestle.

The bulk import berths and that multipurpose cum container berth is oriented at 59° N.

7.4.2 Deck Elevation

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

7.4.3 Design Criteria

7.4.3.1 Design Ships

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 7.1** below:

Table 7.1 Characteristics of Design Ships

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

7.4.3.2 Design Dredged Level

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

7.4.3.3 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 50 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 7.2 Details of Berthing Energy, Fender and Berthing Force Applied at Berths

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

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.

7.4.3.4 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.

7.4.3.5 Materials and Material Grades

Concrete of minimum grade M40 and high corrosion resistant thermo-mechanically treated bars of Fe 500 grade shall be used for berth construction.

7.4.4 Proposed Structural Arrangement of Berths

7.4.4.1 Bulk Berths

The access from berth to the backup area is provided through a 15 m wide approach trestle. The berth shall be provided with a conveyor system which will carry the coal from the berth and transfer to the conveyor provided over the approach 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 30 m. The total length of the one bulk berth is taken as 300 m.

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 6.0 m c/c in the longitudinal direction. The piles will be founded in dense clay 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-DRP1007**

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 6.0 m c/c in the longitudinal direction. The piles will be founded in dense clay 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 typical cross section of Container cum Multipurpose berth is as shown in **Drawing DELD15005-DRG-10-0000-CP-DRP1008**

The berth is connected to the shore by means of 1350 m long and 15 m wide approach trestle to back up area. The approach trestle shall be supported over three rows of 1.1 m diameter bored cast in situ piles. The structural arrangement of the approach trestle would be similar to that of the container and multipurpose berth.

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 **21 Mcum**. The soil is likely to comprise of loose to dense fine sand. At some area stiff sandy clay is also expected. 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

Based on the RITES model studies the total littoral transport of about 1.5 Mcum per annum from south to north would be obstructed by the south breakwater, this shall result in accretion on the south of the south breakwater. Most of the material shall be accumulated in the proposed sand trap from where it could be periodically dredged and transported to nourish the shoreline to the northern side of the port.

7.6 Reclamation

It is proposed that the area behind the bulk and container cum multipurpose berths shall be reclaimed to provide the space transit storage and area along the shore line to create the backup area for storage and operation.

The required reclamation quantity of **8.3 Mcum** in Phase 1 development can be carried out using suitable material obtained out of 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 using Rock/ boulders. Thereafter the reclamation levels within the bunds are raised in suitable stages, to prevent overloading of the underlying subsoil. Part of 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 +1.2 m above CD. Between the elevations +1.5 to +4.5 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. The ground improvement of the reclaimed area would be carried out using band drains and placing of surcharge as per design requirements.

7.7 Material Handling System

7.7.1 Bulk Import System

7.7.1.1 General System Description

A fully mechanized ship unloading system is planned at the coal berth. The system is designed for a rated capacity of 4,400 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 (if needed)
- Connected Conveyor system

7.7.1.2 Ship Unloaders

The coal 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. The system details are shown in **Figure 7.1**.

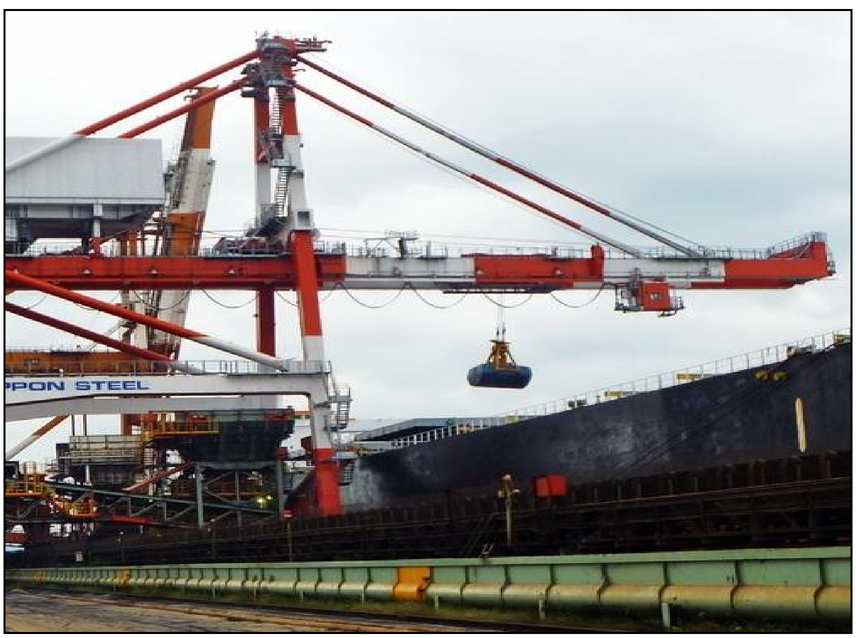


Figure 7.1 Typical Gantry Type Ship Unloader

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 4,400 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 two stacker-cum-reclaimer units at the stackyard. One of the equipment shall be used to receive coal from the ship and stacking in the yard and simultaneously other equipment can be utilised to reclaim the coal from stackyard for transfer 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 4,400 TPH.

The stacker cum reclaimer will have limit switches and controls to restrict the stockpiles to their planned boundaries. The equipment shall be used to stack coal to 15 m height and 50 m wide stockpiles.

Figure 7.2 Typical Stacker cum Reclaimer

7.7.1.5 Wagon Loading

It is proposed to provide rapid loading system for loading of the rakes. The system comprise of one concrete/steel silo with a capacity to hold 800 T of coal fed from the stackyard by a conveyor system. The cylindrical shaped silos have a conical discharge chute with gate system, load cells to automatically discharge coal/limestone into a moving rake. The silos have necessary chute level sensors, heat sensors, and raw water sprinkling system for efficient, safe and clean operations.

Figure 7.3 Typical in-motion Wagon Loading System

The diesel loco hauls the empty rake which passes under the silos. As the first wagon of the empty rake which is in motion comes under the silo discharge chute, the wagon loading starts through the chute with the quantity of loading automatically getting controlled by load cells and the speed of movement of the rake. The diesel locos and track side equipment with creep control devices provided for maintaining slow speeds required will ensure correct loading of each wagon.

7.7.2 Container Handling System

7.7.2.1 Mobile Harbour Crane

The projected container traffic is in the initial phase of development is only 61,000 TEUs per annum which increases to 124,000 TEUs per annum in the year 2035. In view of the limited throughput in the initial years it is proposed to initially 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 7.4 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 using appropriate grab or hook attachment.

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 7.5** shows an E-RTG in operation.

Figure 7.5 Typical E-RTG for Yard Operation

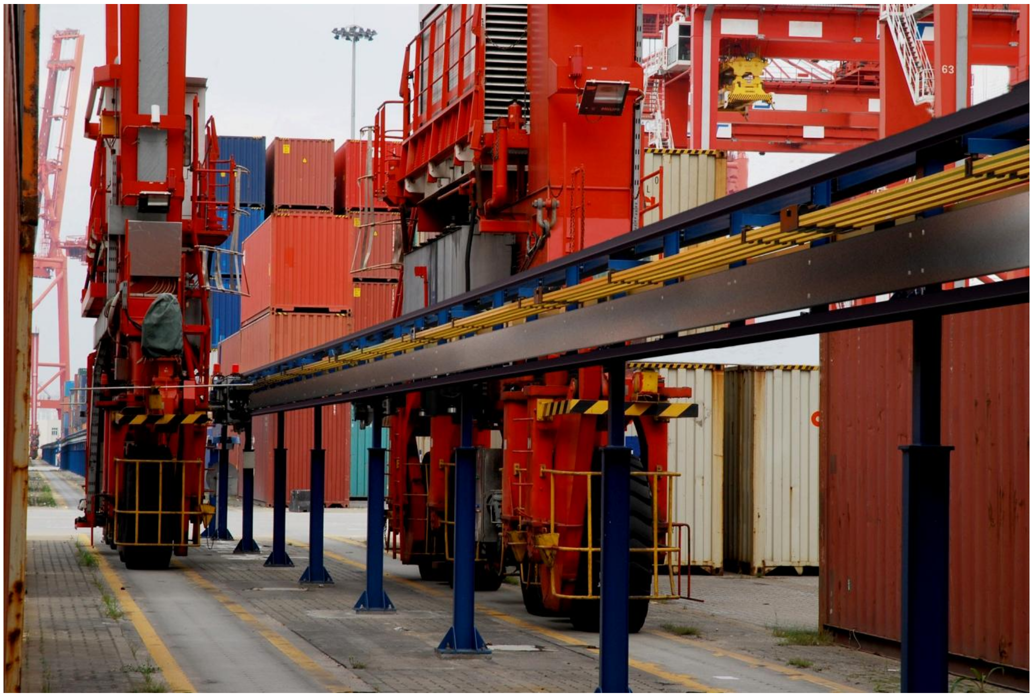


Figure 7.6 Typical Details of Electric Buss Bar Arrangement for E-RTG

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 7.7 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 7.8 Snapshot of Typical Reach Stacker Handling

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

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 7.9 Typical ITV for Handling Containers

7.8 Road Connectivity

7.8.1 External Road Connectivity

During the study, it is observed that there is a single lane existing road which can provide the connectivity in between port and National Highway 5. AECOM team travelled on this road and the existing conditions are given in the following photographs:

Single Lane road to Dugarajapatnam from NH 5

Single Lane road Junction with NH 5

Road Crossing Swarnamukhi near Burlavaripalem

M/s. RITES carried out the alignment of the external road connectivity to NH 5 which is 42 km from the port site. Currently, there exists a single lane road from Chillakuru near Guduru on NH 5 to Dugarajapatnam port and this road need to be widened.

There are no major bridges along the proposed road except a bridge of length 400 m is required at Swarnamukhi river crossing. The Swarnakukhi barrage road caters to 2 lane traffic. By the north side of the barrage another road bridge of 4 lanes is proposed. Additional land, Right of Way (ROW), requirement for widening existing 2 lanes to six lane road is worked out to 180 ha. As per National Highway standards, 3 culverts/ km are considered in the proposed 6 lane road. On either side of the existing road connecting NH 5 to Dugarajapatnam, most of the land is with paddy fields, built up area and occupation by habitants are less.

The proposed rail alignment will cross the existing road to Dugarajapatnam between the villages Nellipudi and Kodivaka. A road cross over bridge is required at this rail crossing (**Figure 7.10**).

Figure 7.10 Proposed Road Connectivity to Dugarajapatnam Port

As per the RITES assessment, the cost of widening of existing 2 lane road to 6 lane is about INR 720 crores including INR 240 crores for land acquisition for the corridor.

7.8.2 Internal Roads

The main approach road to the port shall be located parallel to the rear of the backup area. The road leading to container terminal shall widen out near the terminal gates where security checks will be undertaken and to provide queuing space for trucks. Within the terminals internal roads shall be planned based on the cargo handling and storage plans with one way circulations to avoid any criss crossings.

7.9 Rail Connectivity

7.9.1 External Rail Connectivity

Though proposed port location does not have any direct connectivity by rail, there is already a proposal to connect this area by a broad gauge single line section between Guduru and Dugarajapatnam (nearly 42 km) by South Central Railways. Similar to the road alignment, M/s. RITES carried out the rail connectivity alignment study. Number of lines may be enhanced in future depending upon the requirement to facilitate rail borne traffic estimated to be handled at the Port. The proposed rail connectivity to Dugarajapatnam is shown in **Figure 7.11**.

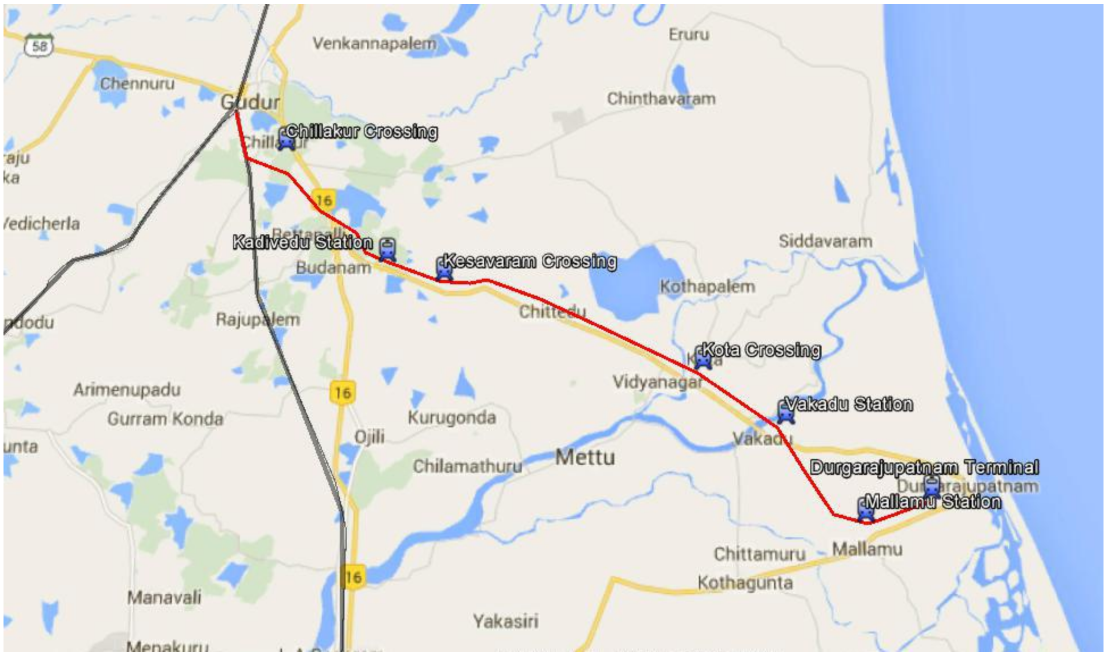


Figure 7.11 Proposed Rail Connectivity to Dugarajapatnam Port

Guduru is a prominent railway junction and is a major transportation hub close the proposed port location.

7.9.2 Internal Rail Links

The internal rail lines will be developed so that the rakes 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. The exchange yard is proposed in the reclamation area within the port boundary.

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 9 MVA. This is expected to go up to 16 MVA over the proposed master plan horizon.

7.10.1.3 Source of Power Supply

Power supply to Dugarajapatnam Port can be tapped from the 400/220 KV substation near Kagitalapur (about 50 km from Port) having more than 200 MVA capacity. It is proposed that the transmission lines be tapped off and extended up to the proposed location of the main receiving substation.

7.10.1.4 Incoming Supply – System Requirements

The HT power shall be brought at 33 KV till the boundary of the proposed port, where the main substation shall be located. This outdoor switch yard will have two numbers of 33 KV transformers with 9 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 to two secondary substations; one for the bulk terminal and other for container cum multipurpose terminal. The distribution of power in the respective terminals shall be through these secondary substations.

Both the substations will be equipped with 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.

7.10.1.6 Standby Power Supply

It is proposed to install one diesel generator of 2 MVA at each of the two substations. 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 7.3** below:

Table 7.3 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 m 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 & Lighting 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 Dugarajapatnam Port will have the following objectives:

- Establish one common IT infrastructure that is based on large 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 Dugarajapatnam Port 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 Dugarajapatnam Port has been worked out in the **Table 7.4** below:

Table 7.4 Estimated Water Demand for Dugarajapatnam Port

S. No.	Consumer	Water Demand (KLD)	
		Phase 1	Master Plan
1.	Raw Water (KLD)	261	507
2.	Potable Water (KLD)	33	52
Total Water Demand at Port (KLD)		**294**	**559**

7.10.4.2 Sources of Water Supply

The water requirement for Dugarajapatnam port shall be sourced from AP Rural Water Supply and Sanitation Department. Alternatively providing a desalination plant at the port can also be explored during the implementation stage.

7.10.4.3 Storage of Water

The water supply from the main header shall be fed to the underground water tank of 600 cum located at the port boundary which is equivalent to about 2 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).

The water from the main sump would be pumped to secondary sump of 300 cum capacity located near the stackyard and. The sump shall be split into three compartments of 100 cum, 100 cum and 100 cum. The compartment of 100 cum will retain water permanently for firefighting; the compartment of 100 cum will be used for water supply to buildings, ships and greenery, where a small filtration unit shall be provided. The third compartment of 100 cum will provide water for dust suppression system in the bulk terminal.

The secondary sump for the container terminal shall be split into two compartments i.e. one to retain water permanently for firefighting and other for water supply to buildings and greenery.

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 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 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 26 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 a minimum of four harbour tugs of 40 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 would 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 Dugarajapatnam Port are given in **Table 7.5** below.

Table 7.5 Harbour Craft Requirements

S. No.	Harbour Craft	Number
1.	Tugs 40 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 17 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 nm. In addition some buoys are proposed in the harbour basins as well. IALA maritime buoyage system as per region A, in which Dugarajapatnam 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 being 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 each breakwater head would 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. In Dugarajapatnam Port case, 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 Fire Fighting 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 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 and 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 Vagarru, Tupilipalem. 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.

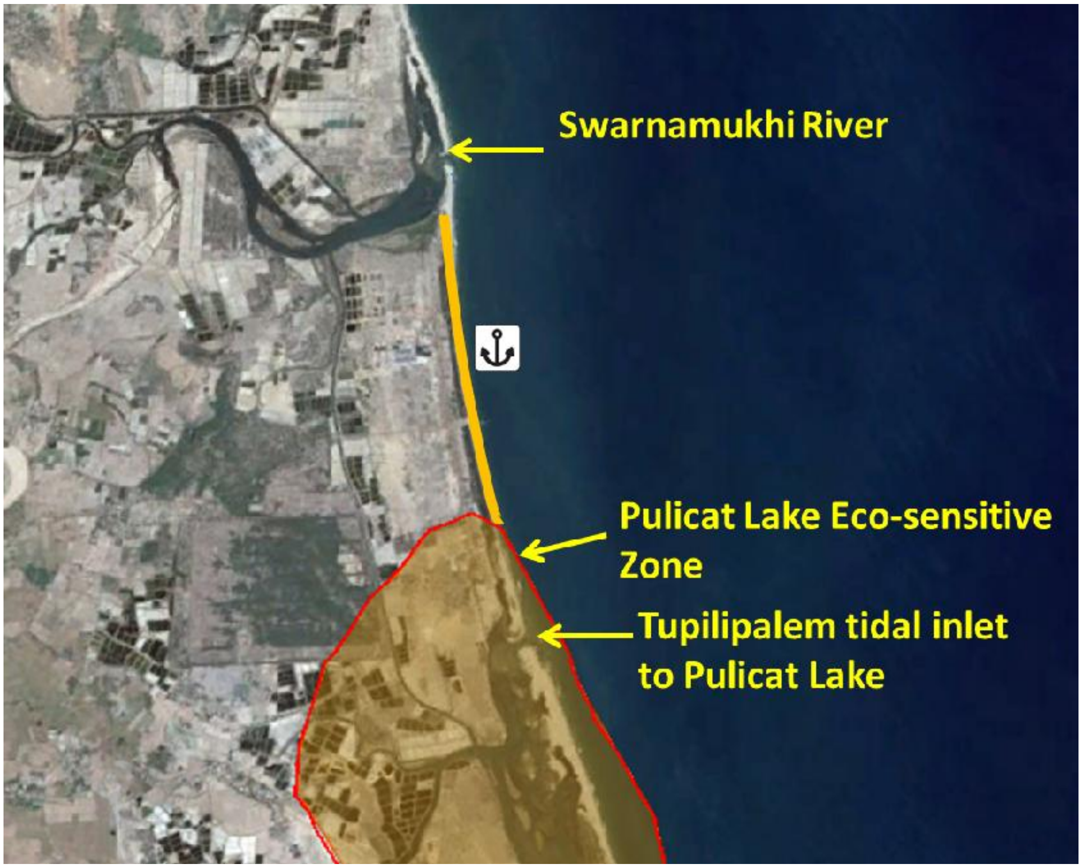
8.2 Site Setting

A Greenfield port is planned to be developed on the coast near the Tupilipalem village. The waterfront identified for port development is devoid of any habitation but has some commercial activities like salt manufacturing and aqua culture.

The proposed site is bound with River Swarnamukhi on the north and eco-sensitive zone boundary of Pulicat lake on the south. Buckingham Canal runs on the west of the proposed site (**Figure 8.1**).

Pulicat Lake is the second largest brackish water lagoon after Chilika Lake of Orissa. Three major Rivers which feed the lagoon are Arani river, Kalangi river and Swarnamukhi river. It is connected to the sea through three tidal inlets, one each at Tupilipalem, Rayadoruvu and Pulicat villages respectively, from north to south. The sea mouths are not simply a passage of water into lake but a bio-corridor for survival of both aquatic fauna and avian fauna. Thus, any development near the tidal inlet shall be planned carefully avoiding impacts on the eco-system of the area.

The coast at the proposed port location is demarcated as medium to low accretion zone (**Figure 8.2**).



Proposed site with Casurina Plantation in the back drop

Flat terrain and vegetation on the landward site

Figure 8.1 Location of the Proposed Site

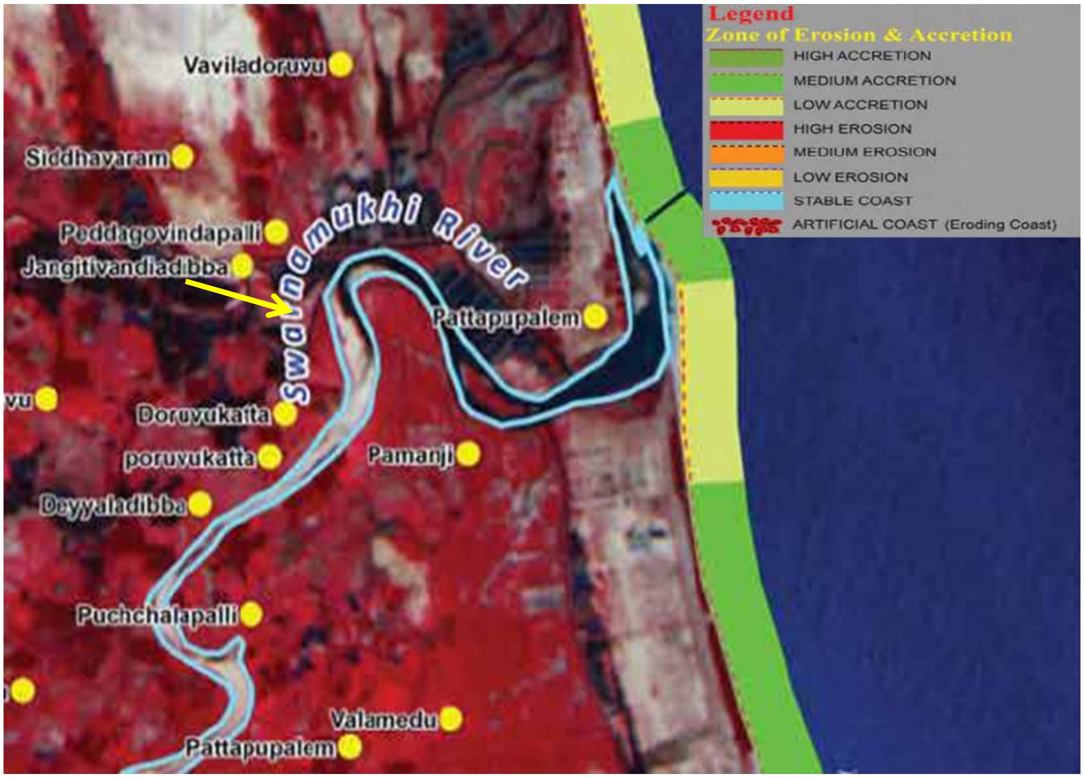


Figure 8.2 Coastal Stability Map Proposed site (Source: http://www.ncscm.res.in/)

8.3 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 • Permission for tree felling	No forest land is involved in the project.	MoEF & CC; Department of Forest, GoAP
3.	Wild Life (Protection) Act, 1972	• To protect wildlife in general and National Parks and Sanctuaries in particular • Permission for working inside	Pulicat Lake Bird Sanctuary is within 10 km radius	Chief Conservator of Wildlife, Wildlife Wing, Forest Department,

S. No.	Act/Rule/ Notification, Year	Relevance	Applicability	Implementing Agency
		or diversion of sanctuary land		GoAP; 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	Andhra Pradesh 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	Andhra Pradesh Pollution Control Board
6.	Noise Pollution (Regulation and Control) Rules, 1990	• Standard for noise	Yes, construction machinery to conform to noise standards	Andhra Pradesh 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.	Andhra Pradesh 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, GoAP
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.

8.4 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 of Storage 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

Environmental aspects	Pre-construction/ Land Acquisition/Construction		Operation	
	Activities	**Potential Impacts**	**Activities**	**Potential Impacts**
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
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

8.5 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.

8.5.1 Impacts on Land and Soil

The sea shore of the proposed Site has a thick patch of Casuarina vegetation. The Casuarina plantation in the areas acts as wind-breaker and as a shield during cyclonic conditions. Moreover, this plantation also protects erosion of the shoreline.

The proposed port is planned on reclaimed land between shoreline to 11 m depth. Only a limited amount of land (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 off to designated solid waste collection point.

8.5.2 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 AP Rural Water Supply and Sanitation Department, 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 26 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 APCB 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.

8.5.3 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 Andhra Pradesh 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.

8.5.4 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.

8.5.5 Impacts on Ecology

The proposed site is an accretion zone, further to this construction of breakwater will advance accretion on the southern side of the port. This will negatively impact the tidal mouth of the Pulicat Lake, i.e., Tupilipalem whereby closing this inlet. This tidal inlet plays a significant role in maintain right balance of sea water and salinity in the lake which is essential for the brackish eco-system of the lake.

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 measures shall be taken to ensure the maintenance of tidal inlet, regular dredging shall be undertaken.
- 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.

8.5.6 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.

8.6 Impacts during Operation Phase

8.6.1 Impact on Land and Shoreline

At present the proposed coast falls under accretion zone but with the construction of breakwaters, the southern side of the port will experience higher accretion while north of breakwaters will have erosion.

Higher accretion on the south will negatively impact the tidal mouth of the Pulicat Lake, i.e., Tupilipalem whereby closing this inlet. This tidal inlet plays a significant role in maintain right balance of sea water and salinity in the lake which is essential for the brackish eco-system of the lake.

Mitigation Measures

- All measures shall be taken to ensure the maintenance of tidal inlet, regular dredging shall be undertaken.
- Regular inspection shall be held to anticipate the need of the dredging of the inlet.
- A sand trap shall be provided on the south of the proposed port facility.
- Sand bypassing must be adopted so as to nourish the eroding coast on the north of the facility.

8.6.2 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.

8.6.3 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 stackyard & 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 stockyard 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.

8.6.4 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.

8.6.5 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.

8.6.6 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.

8.7 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

8.8 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 $ = INR 65/-
- Provision towards contingencies, engineering and establishment has been included separately.

The 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 9.1** has been worked out. The same is furnished below in **Table 9.1**. The capital costs given for each phase are for the facilities created during that particular phase only.

Table 9.1 Block Capital Cost Estimates (INR in Crores)

A. Port Development Cost Only

S. No.	Item	2020	2035	Total
1.	Project Preliminaries and Site Development	60	15	75
2.	Dredging	421	940	1,361
3.	Reclamation	137	239	376
4.	Breakwater	526	-	526
5.	Berths	298	90	388
6.	Buildings	29	9	38
7.	Stackyard and Other Backup Area	37	37	73
8.	Internal Roads and Railway	35	55	90
9.	Equipment	463	458	921
10.	Utilities and Others	134	62	195
11.	Navigational Aids	10	1	11
12.	Total (1+2+3+4+5+6+7+8+9+10)	**2,149**	**1,905**	**4,054**
13.	Contingencies @ 10%	215	190	405
14.	Engineering and Project Management @ 5%	107	95	203
Incremental Capital Cost (Rs. In Crores)		**2,472**	**2,191**	**4,662**

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

S. No.	Components	2020	2035	Total
1.	**Project Cost**	**2,472**	**2,191**	**4,662**
2.	**External connectivity including land acquisition**			
	Rail	**310**		**310**
	Road	**720**		**720**
3.	**Cost of Land for Port Development (100 Ha)**	**270**		**270**
	Total Cost (INR in Crores)	**3,772**	**2,191**	**5,962**

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 375 in the ultimate 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 - INR 4.50 per unit plus INR 225 per kVA of demand rate per month
- Water Charges - INR 50 per kilolitre
- Diesel - INR 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. 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 Operation and Maintenance Costs

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

Table 9.2 Annual Operation and Maintenance Costs (INR in Crores)

S. No.	Item	2020	2035
1.	REPAIR AND MAINTENANCE COSTS	39.3	28.5
2.	OPERATION COSTS	75.0	76.1
3.	**TOTAL**	**114.3**	**104.6**
4.	Contingencies (Rites, @ 10%-Aecom)	11.4	10.5
5.	Administrative Expenses @ 5%	5.7	5.2
Incremental O & M Costs (Rs. In Crores) per annum		**131**	**120**

The above O&M cost 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 Dugarajapatnam Port comprises of construction of breakwaters, capital dredging for approach channel and manoeuvring basin, reclamation of the terminal areas, 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 Breakwaters

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 3.54 million tonnes of rock is required for the construction of breakwaters. The major quantity of rock required for armour and sub armour layers would be obtained from identified quarry sites located about 120 to 150 km from site.

It is proposed to construct the breakwaters 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 of greater than 5 m^3 size up to about -4m CD. 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 10,000 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 22 months duly accounting for weather downtime.

9.3.3 Dredging and Reclamation

The overall dredging quantity is estimated to be about 21 Mcum. Once the breakwaters construction have reached 8 m contour, the dredging activity can commence and reclamation bunds shall be built to receive the suitable material from the dredging operations. The overall duration of the dredging and reclamation is expected to be 28 months.

9.3.4 Berths

As berths are not proposed to be contiguous to the land, construction of berths would be independent of the dredging. The construction of berths could be started either by launching the gantries from the shore or partly completed reclaimed area. However adequate breakwater shelter would be needed to avoid any downtime in construction. 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 24 months.

The construction of berths sites would commence after the dredging in the berth pockets has been completed and adequate shelter to the berth area is provided by the completed portion of breakwater. As the berths and approach trestle are continuous, it is possible to construct the piles using travelling gantries from the shore. 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.

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 Dugarajapatnam port is likely to take over 36 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 Dugarajapatnam Port is shown in **Table 9.3**.

Table 9.3 Implementation Schedule for Development of Port at Dugarajapatnam

Year: 2016 (Aug–Dec), 2017 (Jan–Dec), 2018 (Jan–Dec), 2019 (Jan–Dec), 2020 (Jan–Dec), 2021 (Jan–Dec)

S.No.	Task Description
A	**Appointment of Consultant for DPR Preparation**
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 VPT**
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

- 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
    - Coal - Rs. 300 per tonne
    - 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. (Visakhapatnam 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. 3,772 crores for Phase 1 port development. The project IRR in this scenario works out to about **2.1%**.

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. 2,472 crores only. However, in this case also the project IRR for the private developer works out to **8.6%** only 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 Visakhapatnam Port Trust and other government entities which may include Andhra Pradesh 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	Port	Concessionaire	Total
1.	PROJECT PRELIMINARIES AND SITE DEVELOPMENT	47	13	60
2.	DREDGING	421	-	421
3.	RECLAMATION	125	12	137
4.	BREAKWATER	526	-	526
5.	BERTHS	-	298	298
6.	BUILDINGS	24	5	29
7.	STACKYARD AND OTHER BACKUP AREA	2	35	37
8.	INTERNAL ROADS AND RAILWAY	25	10	35
9.	EQUIPMENTS	-	463	463
10.	UTILITIES AND OTHERS	83	50	134
11.	NAVIGATIONAL AIDS	10	-	10
12.	Total (1+2+3+4+5+6+7+8+9+10)	**1,263**	**886**	**2,149**
13.	Contingencies @ 10%	126	89	215
14.	Engineering and Project Management @ 5%	63	44	107
Incremental Capital Cost (Rs. In Crores)		**1,453**	**1,019**	**2,472**

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

Components	Port	Concessionaire	Total
Project Cost	**1,453**	**1,019**	**2,472**
External Infrastructure			
Rail	**310**	**-**	**310**
Road	**720**	**-**	**720**
Cost of Land for Port Development (100 Ha)	**270**	**-**	**270**
Total Cost	**2,753**	**1,019**	**3,772**

To achieve the project IRR of 15% the PPP operator needs to share 35% of revenue with the SPV. However, the low traffic and therefore the low revenue will lead to the project IRR of -3.6% for the SPV making the investment totally unviable.

10.5 Conclusions and Recommendations

With the current traffic and estimated competitive tariff, the IRR for the project is very low in all the possible development options. Therefore the project is commercially not viable.

However, Dugarajapatnam has been notified as a major port under the act and thus all possible opportunities are explored for its development. With this in view Option 2 - Full Fledged Concession to Private Operator could be explored with the following basic conditions so that there is no financial burden on the SPV:

1. The cost of Rs. 720 crores for External road connectivity to the port including the land acquisition be provided by NHAI or Bharat mala project
2. The cost of Rs. 310 crores for External rail connectivity to the port including the land acquisition be borne by South Central Railway or IPRCL
3. The cost Rs. 270 crores for 100 Ha of land acquisition for port be borne by state government or Sagarmala Development Company

As explained in para 10.3 the project IRR for the PPP operator works out to 8.6% only. Therefore further support from the central government may be sought through viability gap funding (VGF) of 20% and same VGF of 20% be formulated at State level to generate project IRR of 14%. The bidder who seeks minimal VGF shall be selected for port development.

11.0 Way Forward

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

1. Formation of SPV for development of the project
2. Appoint a transaction advisor for project structuring and preparation of tender document
3. Coordination with the NHAI and Indian railways for providing road and rail connectivity to site.
4. Coordination with state government for land acquisition
5. Approvals from SFC/ EFC/ PIB/ PPPAC/ CCEA
6. Appointment of consultant for Preparation of EIA report and approval of MoEF
7. Coordination with various agencies for getting project approvals as mentioned in **Figure 11.1**.

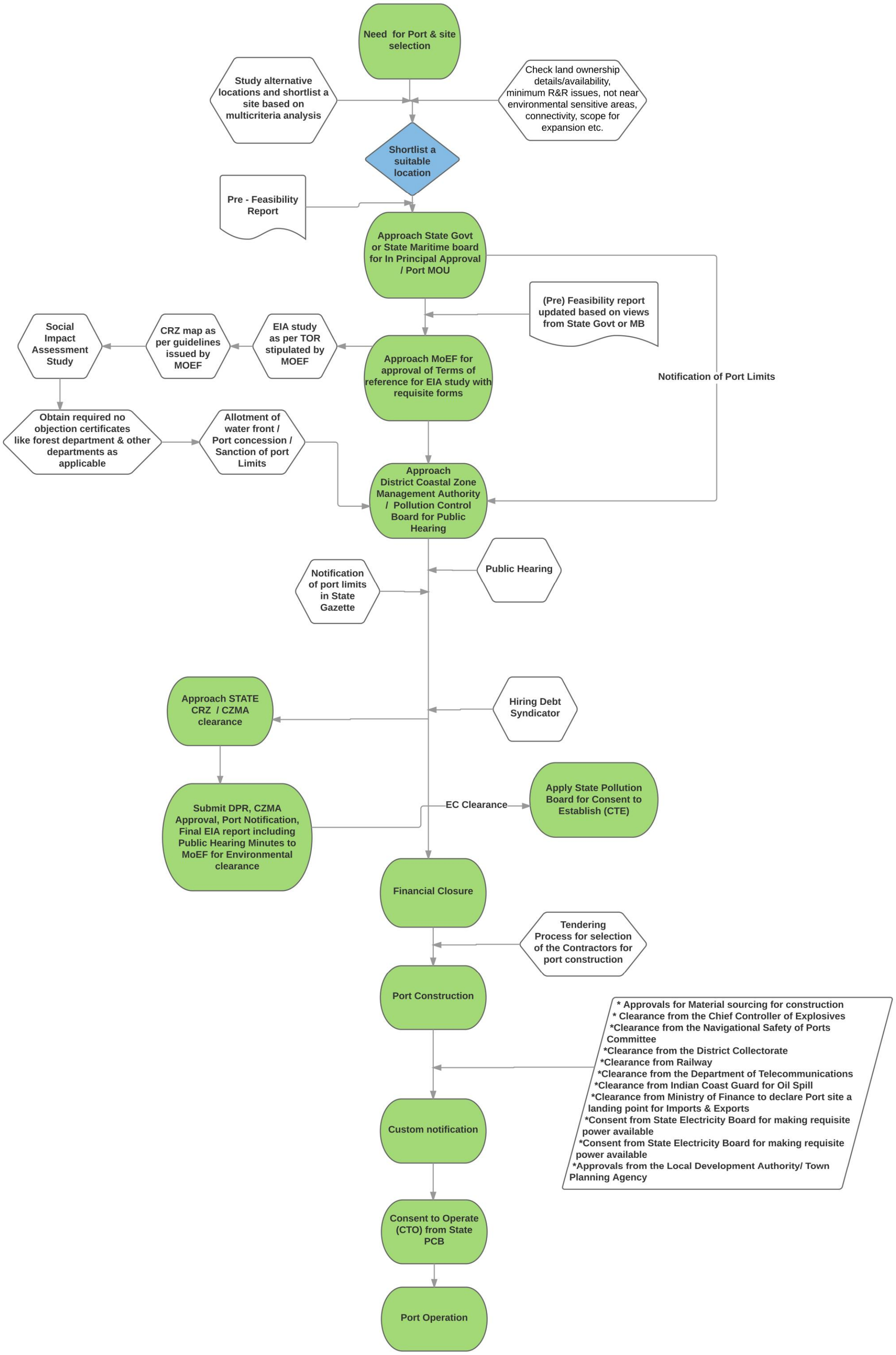


Figure 11.1 Process for the Greenfield Port Development

Drawings

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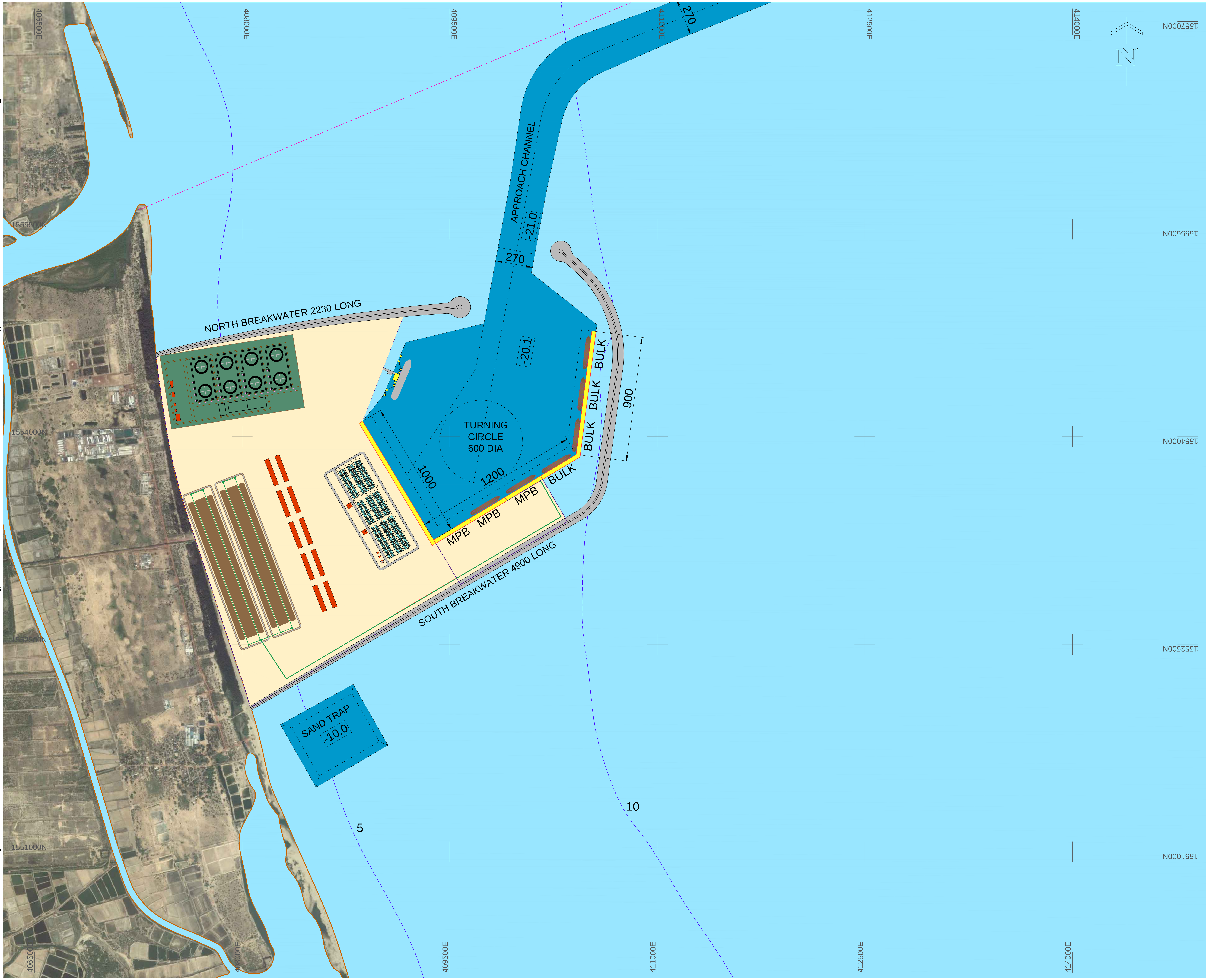

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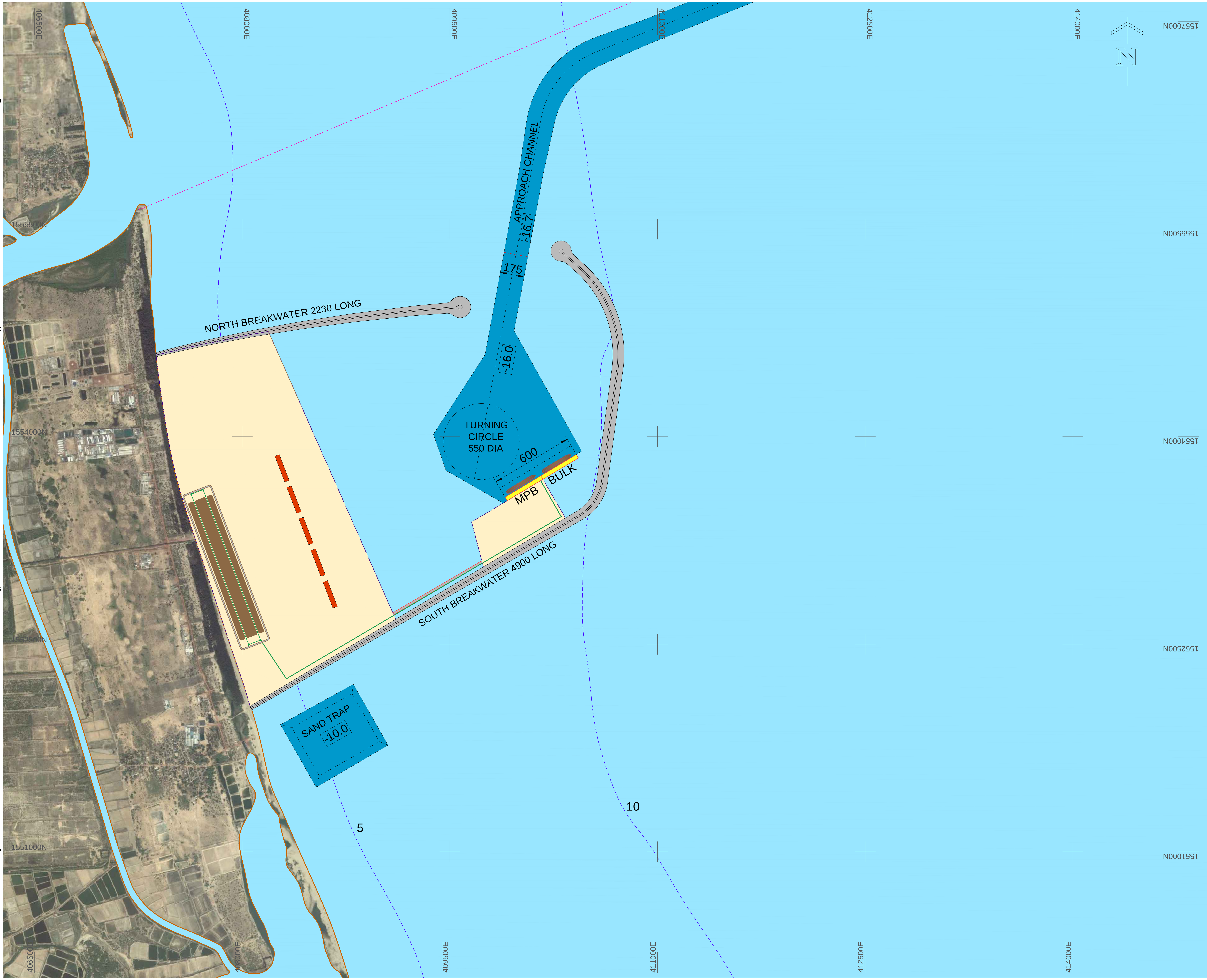

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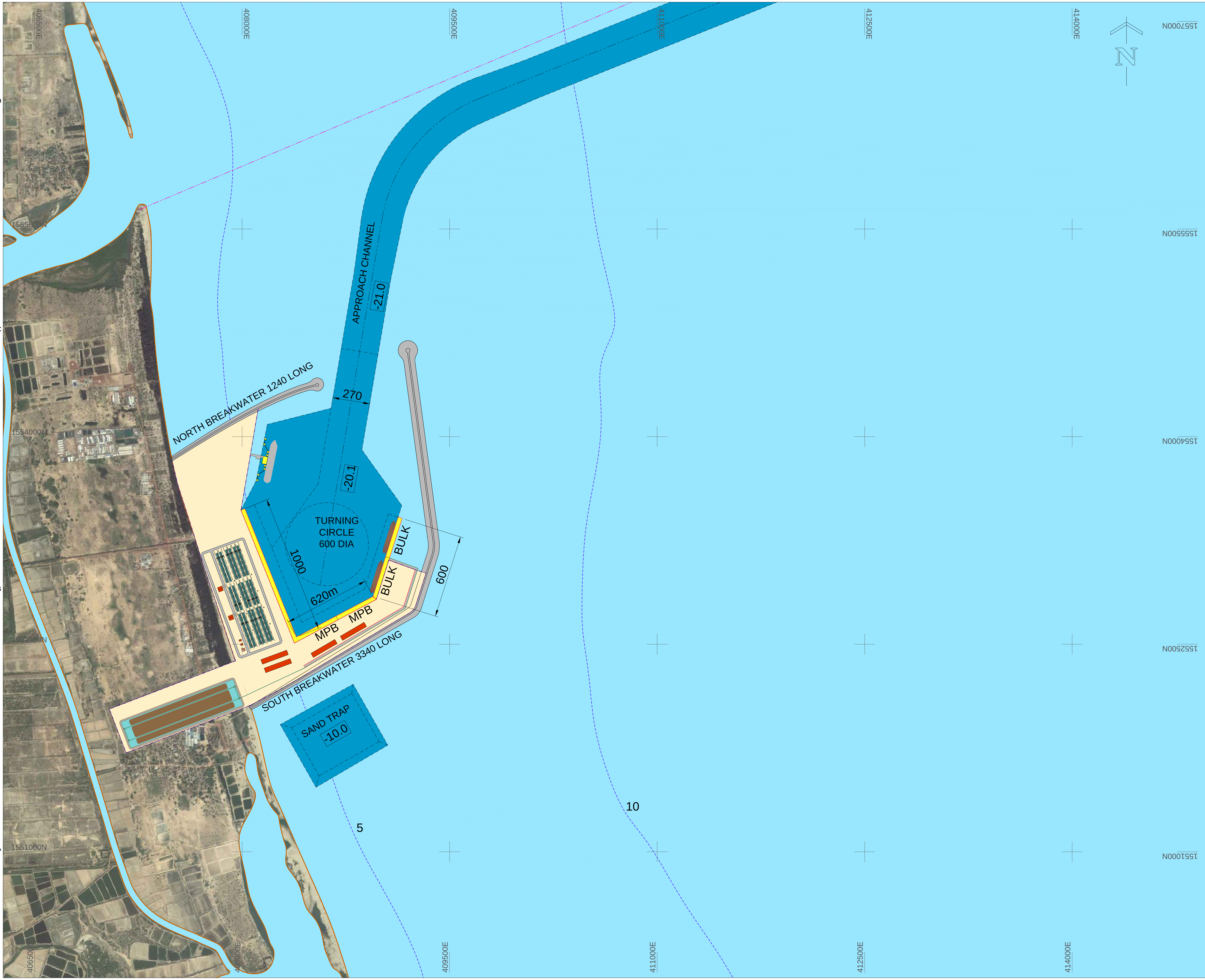

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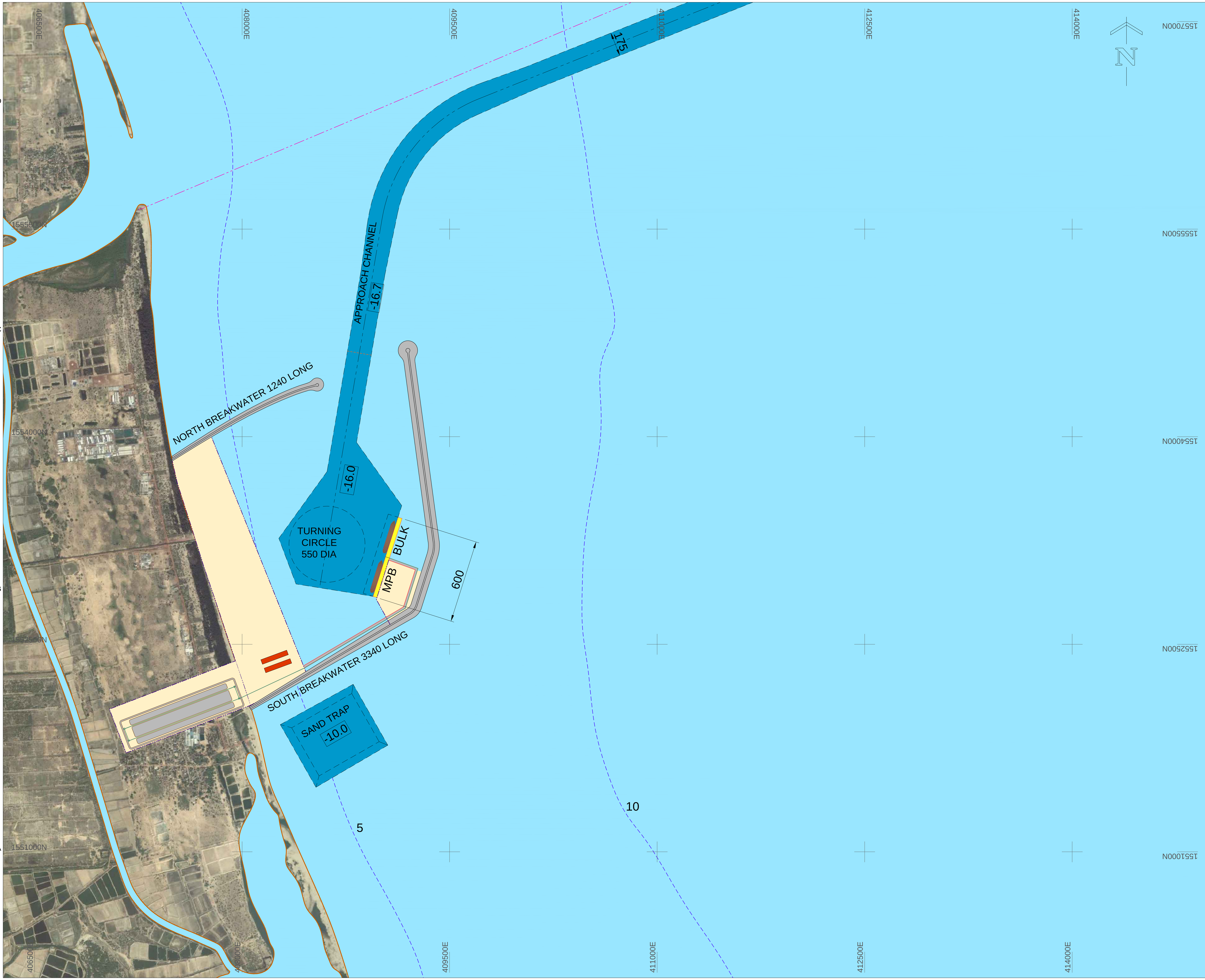

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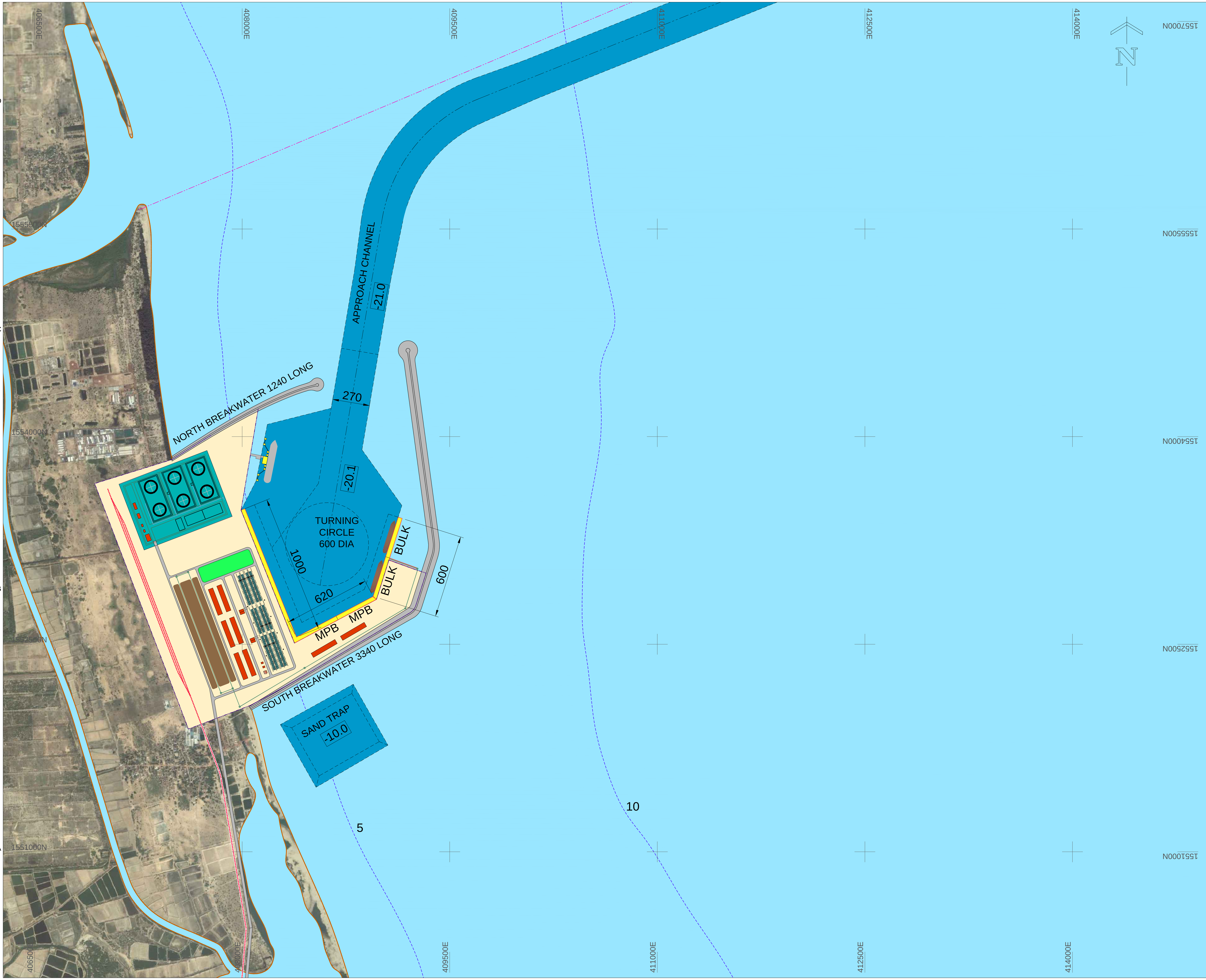

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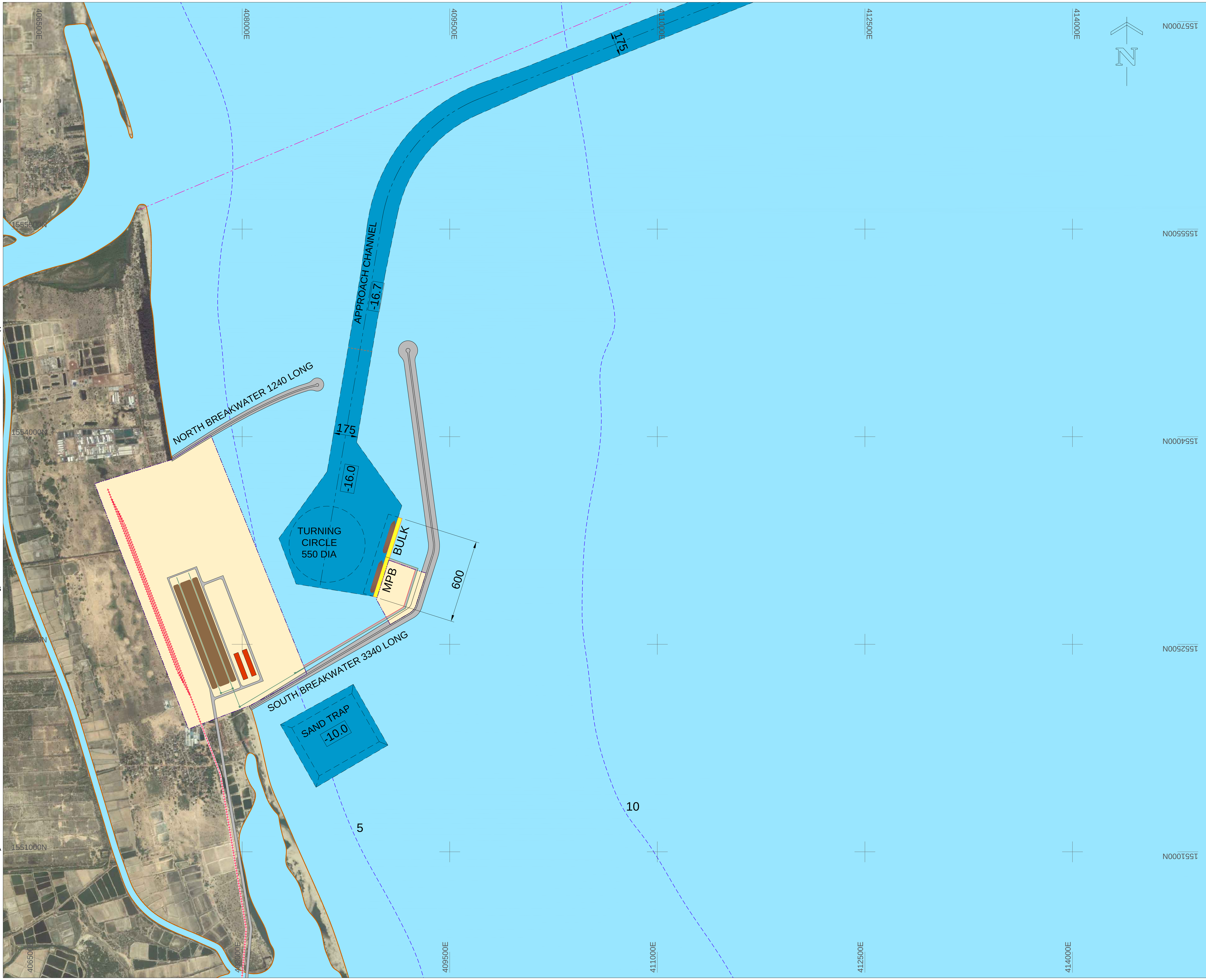

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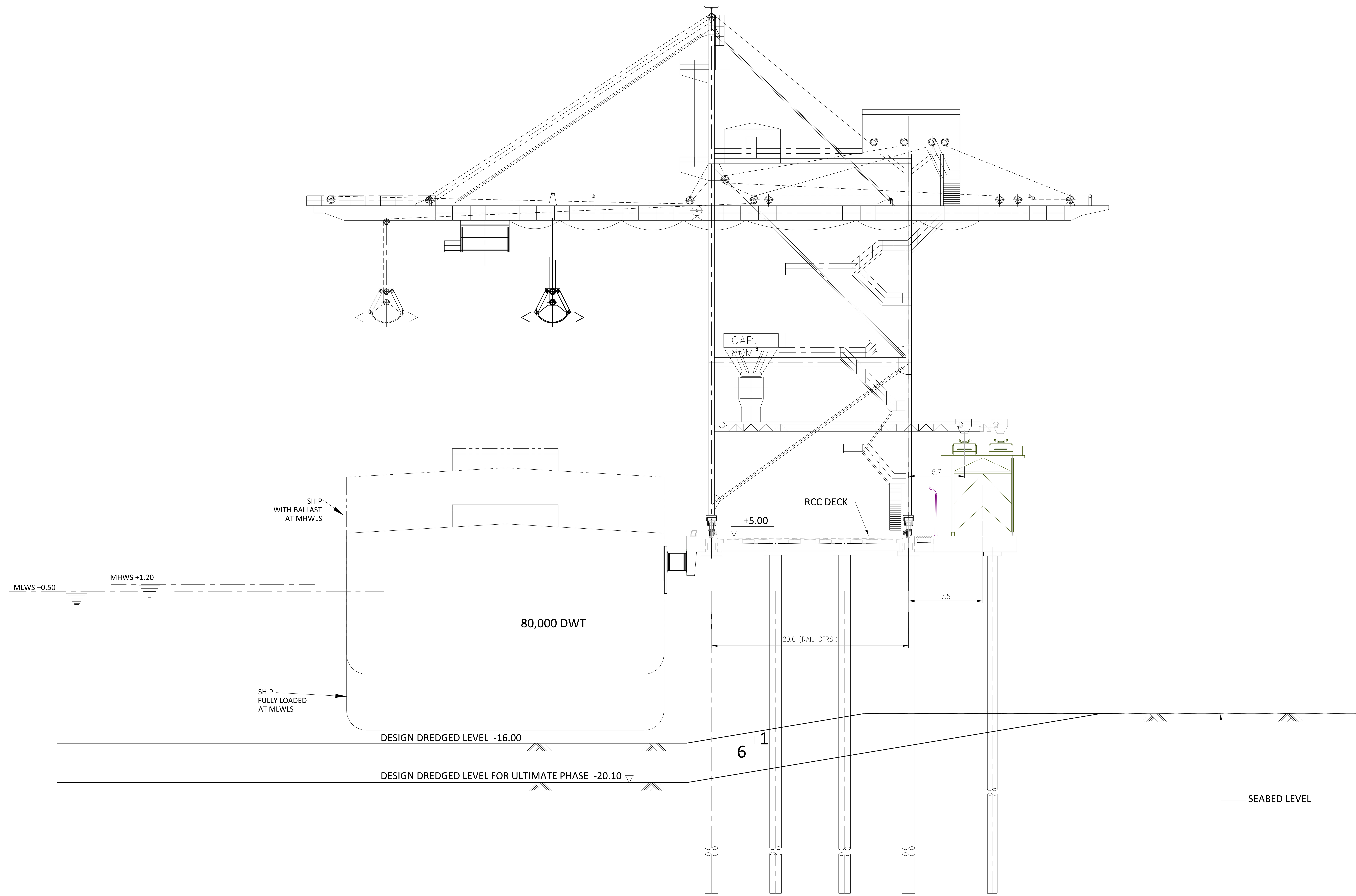

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Sign:	Sign:	Sign:
Date: 08-06-2016	Date: 08-06-2016	Date: 08-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-DRP1007

REV.: 0

AECOM

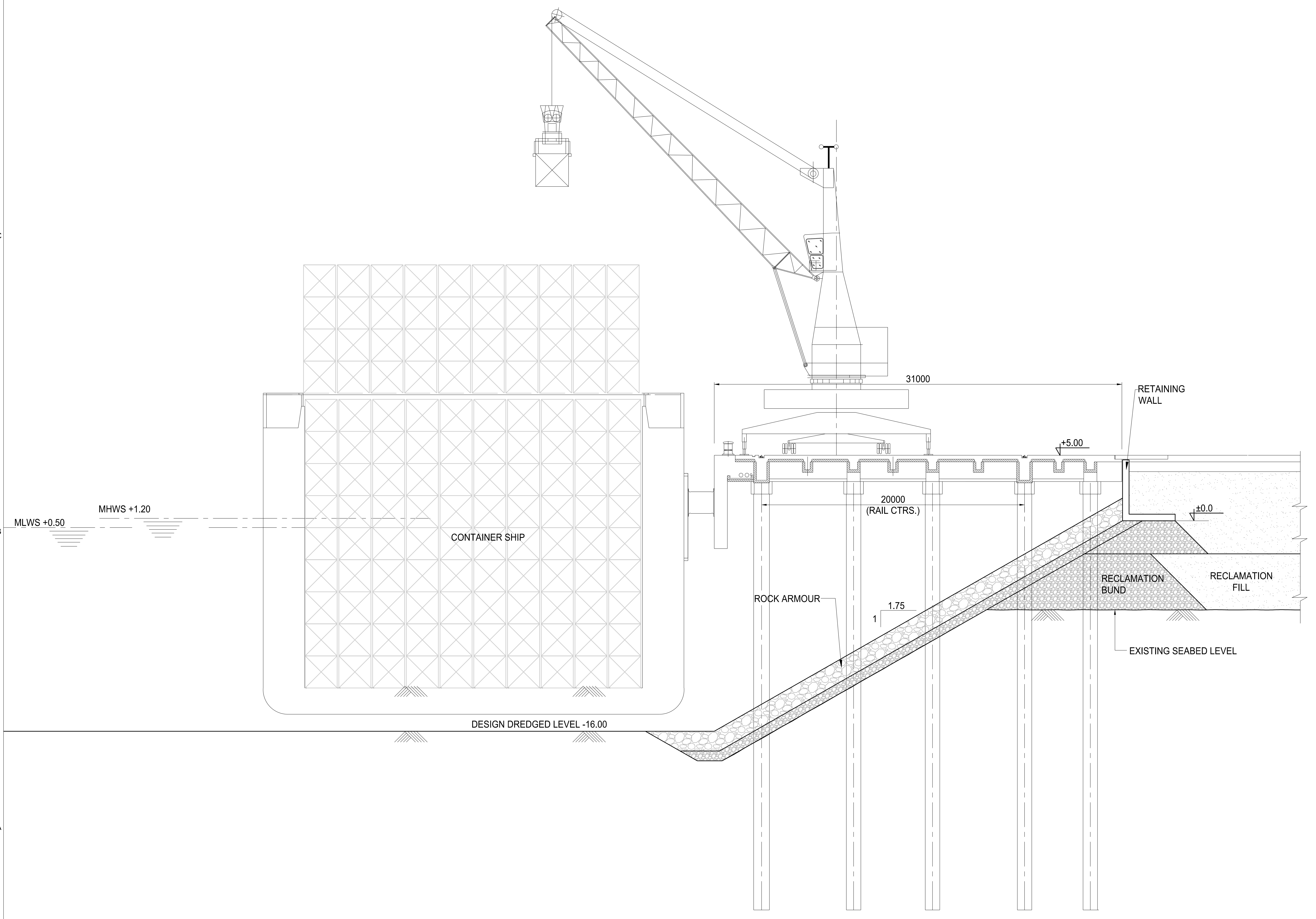
AECOM India Pvt. Ltd.

ISO A1 594mm x 841mm

Project Management Initials: Designer: SV Checked: AM Approved: SG

Last saved by: VERMAS2(2016-06-09) Last Plotted: 2015-10-29
Filename: D:\PROJECTS\DURGRAJAPATNAM REPORTS\DELD15005-DRG-10-0000-CP-DUG1007.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; Indian Ports Association

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT DUGARAJAPATNAM

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: 08-06-2016	Date: 08-06-2016	Date: 08-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-DRP1008 REV. 0

AECOM India Pvt. Ltd.

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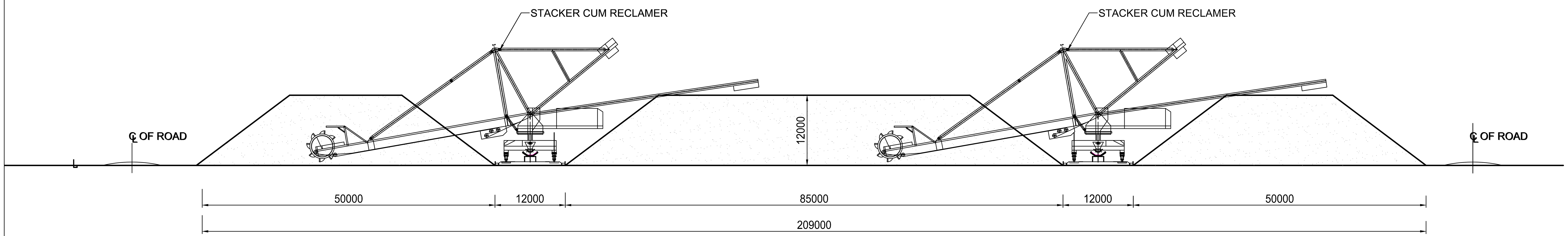
Filename: D:\PROJECTS\DURGRAJAPATNAM REPORTS\DELD15005-DRG-10-0000-CP-DUG1008.DWG

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:

PROJECT:

SAGARMALA - TEFR FOR DEVELOPMENT OF PORT AT DUGARAJAPATNAM

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

TYPICAL CROSS SECTION OF BULK YARD (IMPORT)

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 08-06-2016	Date: 08-06-2016	Date: 08-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-DRP1009

REV.: 0

AECOM India Pvt. Ltd.

ISO A1 594mm x 841mm
Approved: SG
Checked: AM
Designer: SV
Project Management Initials:
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Filename: D:\PROJECTS\DURGRAJAPATNAM REPORTS\DELD15005-DRG-10-0000-CP-DUG1009.DWG

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 DUGARAJAPATNAM

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE: TECHNO ECONOMIC FEASIBILITY REPORT

DRAWING TITLE:

LAYOUT OF NAVIGATION AIDS

SHEET 1 OF 1

Sign:	Sign:	Sign:
Date: 08-06-2016	Date: 08-06-2016	Date: 08-06-2016
Name: SV	Name: AM	Name: SG
Designed by	Checked by	Approved by

DRAWING NUMBER: DELD15005-DRG-10-0000-CP-DRP1010

REV. 0

AECOM

AECOM India Pvt. Ltd.

ISO A1 594mm x 841mm

Approved: SG

Checked: AM

Designer: SV

Project Management Initials:

Last saved by: VERMAS2(2016-06-08) Last Plotted: 2015-10-29

Filename: D:\PROJECTS\DURGRAJAPATNAM REPORTS\DELD15005-DRG-10-0000-CP-DUG1010.DWG