Master Plan Report – Final August 2016

MASTER PLAN FOR PARADIP PORT

Master Plan for Paradip Port

Prepared for

Ministry of Shipping
Government of India

Ministry of Shipping/ Indian Ports Association

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August 2016

Quality Information

Client: **Ministry of Shipping/ Indian Ports Association**	Contract No. (if any): NA
Project Title: **SAGARMALA: Master Plan for Paradip Port**	Project No.: **DELD15005**
Document No: **DELD15005-REP-0000-CP-1014** Share Point Ref:	Controlled Copy No:
Document Title: **Master Plan for Paradip Port - Final**	
Covering Letter/ Transmittal Ref. No:	Date of Issue: **25 August 2016**

Revision, Review and Approval Records

D.	Master Plan for Paradip Port - Final	HM 22.08.2016	ASM 22.08.2016	SG 25.08.2016
C.	Master Plan for Paradip Port - Final	RP 01.08.2016	ASM 01.08.2016	SG 03.08.2016
B.	Master Plan for Paradip Port - Final	PM 29.05.2016	ASM 01.06.2016	SG 02.06.2016
A.	Master Plan for Paradip Port - Draft	HM 31.12.2015	ASM 31.12.2015	SG 31.12.2015
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.	02.06.2016		Comments on Draft Master Plan Report	Marshal Praveen (Engineer II)
2.	03.08.2016		Comments on Final Master Plan Report	Ritu Paliwal (Sr. Consultant)
3.	25.08.2016		Comments on Final Master Plan Report	Himanshu Mahajan (Engineer I)

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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.

Sagarmala aims to optimize the Logistics route for Port and Increase focus on Port led development for the country

	Details	Description
Why is Sagarmala needed?	1 Dual institutional structure at ports	▪ Due to segregation of major and minor ports, ports of India have grown as due unconnected entities and not benefitting from co-location or economics of scale
	2 Weak infrastructure at ports and beyond	▪ Weak modes of evacuation from both major and minor ports leading to sub – optimal modal mix presently ▪ Limited hinterland linkages that increases cost of transportation
	3 Limited economic benefit of location & to community	▪ Limited conscious skill development and leverage to peripheral trades (fisheries, tourism etc.) ▪ Limited development of centres of manufacturing near ports
What does Sagarmala want to achieve?	1 Ports led development	▪ Undertake development of coastal economic zones with projects like – port based industrialization, coastal tourism, Logistics parks, warehousing, fisheries etc.
	2 Port infrastructure enhancement	▪ Action points on transforming existing ports into world class ports be developing deep drafts, mechanization of existing berths, creation of new capacity and greenfield ports
	3 Efficient evacuation	▪ Expansion of rail / road network connected to ports and identification of congested routes ▪ Find optimized transport solution for bulk and container cargo

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

The team of McKinsey and AECOM distilled learnings from the experience in port-led development, the major engagement challenge to develop a set of governing principles for our approach is shown in **Figure 1.2**.

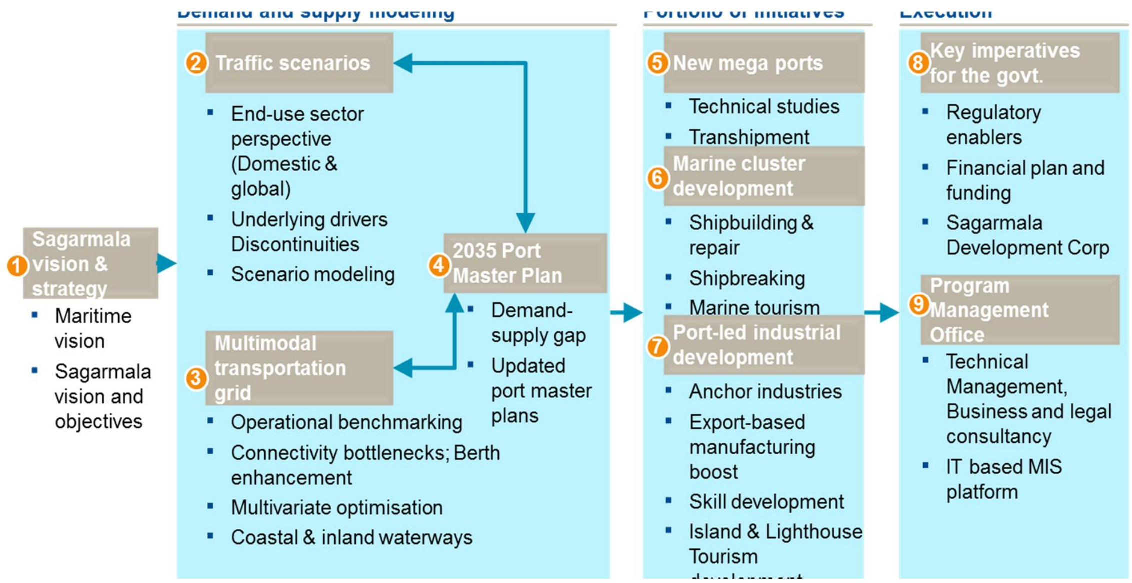


Figure 1.2 Governing Principles of Approach

As indicated above, the origin-destination of key cargo (accounting for greater than 85% of the total traffic) in Indian ports have been mapped to develop traffic scenarios for a period of next 20 years. The forces and developments that will drive change in the cargo flows have also been identified. This would lead to the identification of regions along the coastline where the potential for expansion of existing port exists. The various activities involved in the port led developments are charted in **Figure 1.3**.

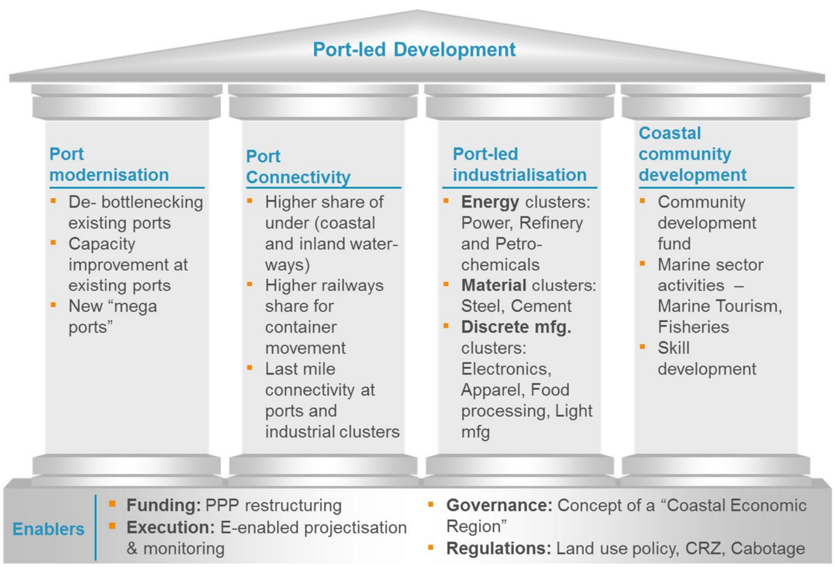


Figure 1.3 Port Led Developments

As part of the assignment, it is also expected to coordinate with the team working on “Benchmarking Operational Improvement Roadmap for Major Ports in India” study (which is being carried out simultaneously along with this assignment) and identify current and future logistic constraints (at the Major Ports) for the top 85% cargo categories based on analysis of current port capacity, productivity levels in comparison to international benchmark and evacuation bottlenecks in the logistics chain. This understanding should be an input in defining the 2035 Master Plan for each port.

Accordingly, this Master Plan report has been prepared taking into consideration the inputs provided on the future traffic and the benchmarking and operational improvements suggested for this port.

1.3 Present Submission

The present submission is the Final report for Development of Master Plan for Paradip Port as part of SAGARMALA assignment. This report is organised in the following sections:

Section 1 : Introduction
Section 2 : The Port and Site Conditions
Section 3 : Details of Existing facilities
Section 4 : Performance, Options for Debottlenecking & Capacity Assessment
Section 5 : Details of Ongoing Projects
Section 6 : Traffic Projections
Section 7 : Capacity Augmentation Requirements
Section 8 : Port Connectivity and Infrastructure
Section 9 : Scope for Future Capacity Expansion
Section 10 : Shelf of New Projects and Phasing

2.0 THE PORT AND SITE CONDITIONS

2.1 Paradip Port as at Present

Paradip Port (20°15‘55.44” N and 86°40‘27.34” E) is one of the 12 major ports in India. It is an artificial, deep-water port on the East coast of India in Jagatsinghpur district of Odisha. It is situated at confluence of the Mahanadi River and the Bay of Bengal. It is about 210 nautical miles south of Kolkata and 260 nautical miles north of Visakhapatnam. The location plan of Paradip Port is shown in the **Figure 2.1**.

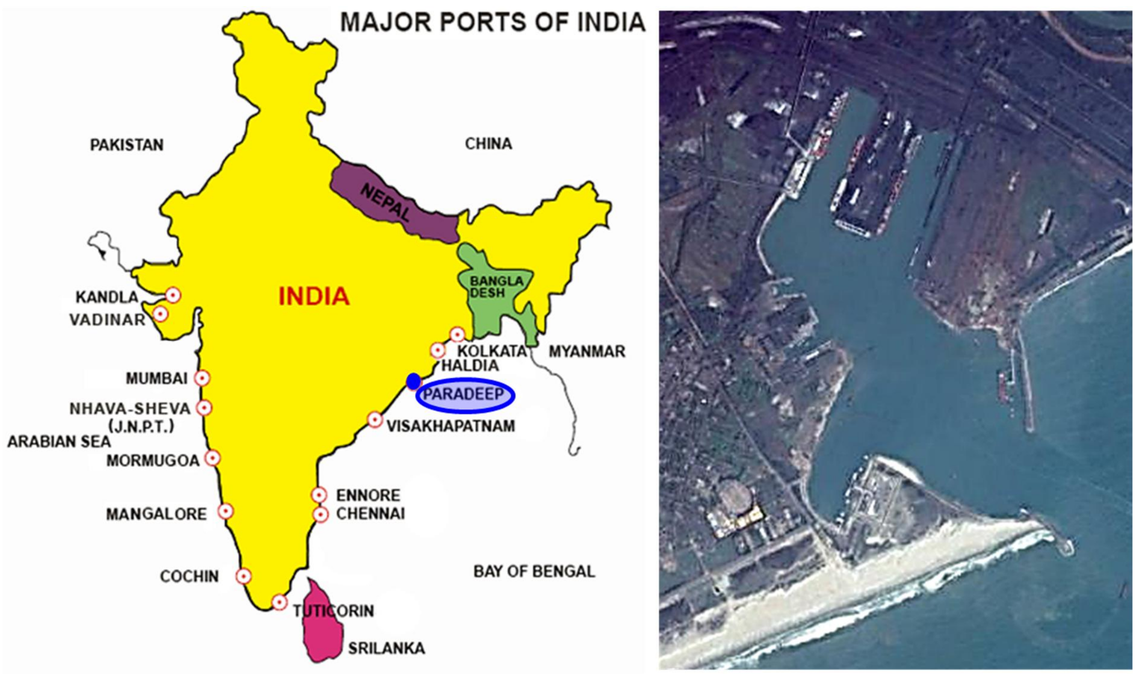


Figure 2.1 Location Plan of Port

2.1.1 Road Connectivity

Paradip Port is connected via road with Cuttack and Chandikhole, which are two of the major cities in Odisha.

- Cuttack and Paradip are connected by SH-12 (2 lanes).
- Cuttack and Chandikhole are connected by NH-5A (4 lanes).

All-important destinations in India whether on the North, West or East could be accessed through any one of the above mentioned Highways as shown in **Figure 2.2**.

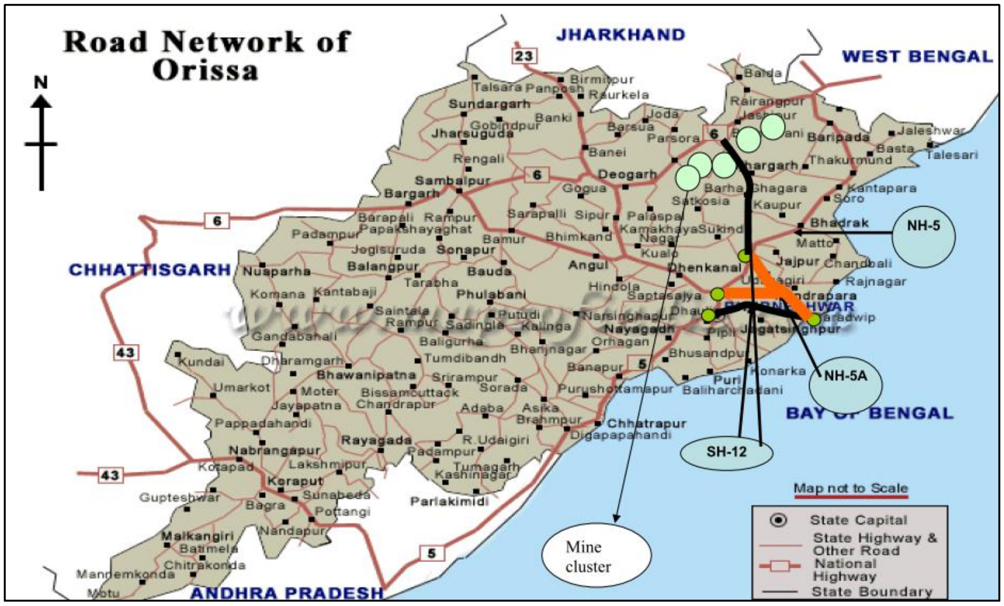


Figure 2.2 Road Connectivity to Paradip

2.1.2 Rail Connectivity

Paradip port Rail network is a part of the East Coast Railway System and is connected to the Hinterland via Cuttack by a broad gauge rail link. Cuttack is around 90 km from Paradip and connects Port to Howrah-Chennai main line. Howrah-Chennai line connects Paradip to Kolkata (route length of about 500km) on the North and Chennai on the South (route length of about 1,340 km). The current rail connectivity to Paradip Port is shown in **Figure 2.3**.

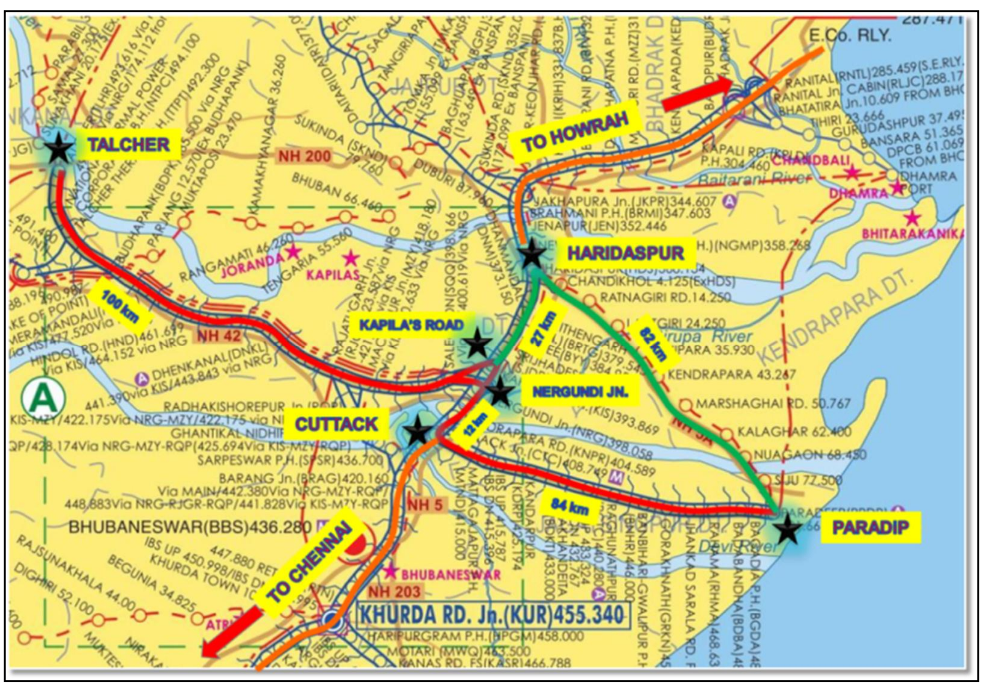


Figure 2.3 Rail Connectivity to Paradip

2.2 Site Conditions

2.2.1 Meteorology

The climate at Paradip is governed by the monsoon. In the months of June to September, the south-west monsoon occurs, followed by the north-east monsoon in October- December. The later period is often indicated as the post-monsoon period. January-February is the winter period and March-May is usually the hot weather period.

2.2.1.1 Winds

Monthly Wind Rose diagrams for Paradip Port are presented in **Figure 2.4**. The predominant wind direction during the months of March to September is South – Southwest and the highest wind speed during this period was recorded to be 18 m/s. During the period November to January the predominant wind direction changes to North-Northeast. The months of October and February are observed to be transition months, where a marked variation in the wind direction was observed. The Wind Rose diagram at Paradip Port is presented in **Figure 2.4**.

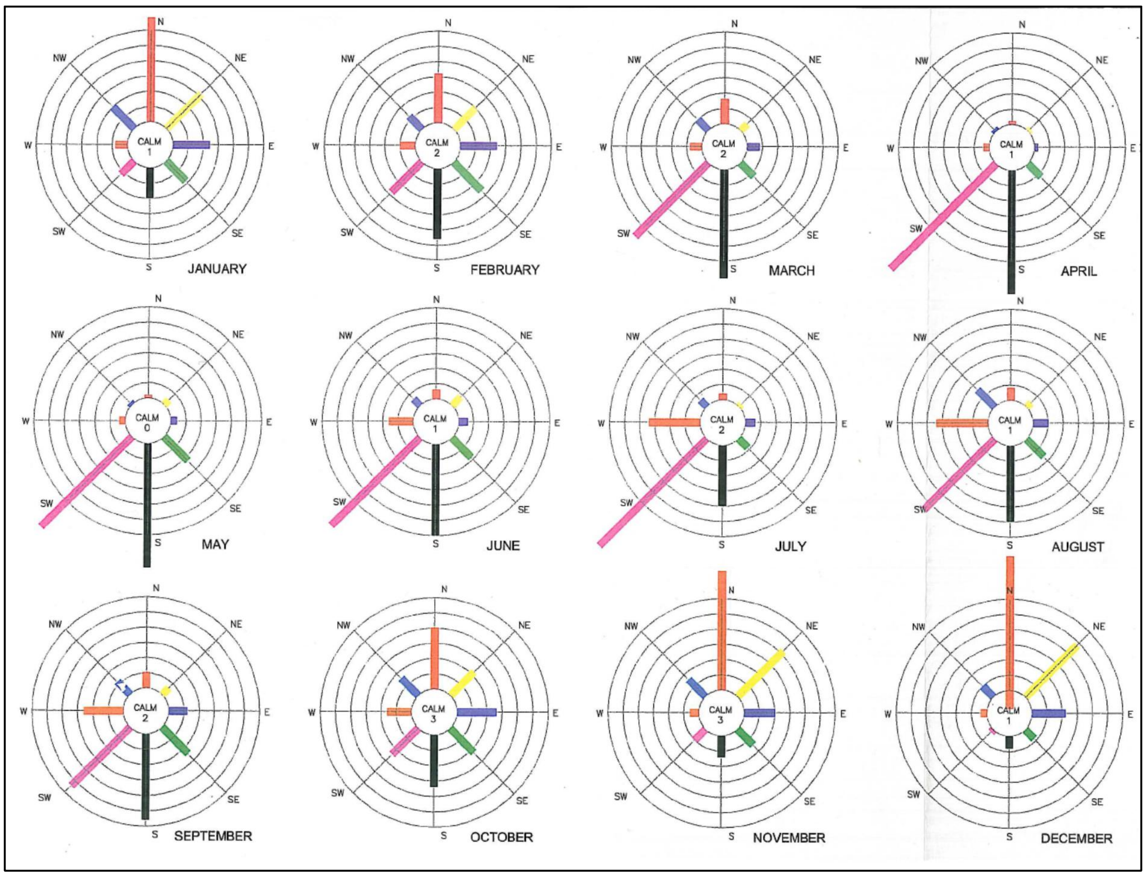


Figure 2.4 Wind Rose Diagram

2.2.1.2 Rainfall

Annual average rainfall at Paradip is about 1,400 mm per annum, about 75% of which is received during the South-Western Monsoon season, i.e., between June and September. October contributes to about 8% of the annual rainfall as presented in **Table 2.1**.

Table 2.1 Average Monthly Distribution of Rainfall

Month	Average Rainfall (mm)	Maximum Rainfall (mm)	Minimum Rainfall (mm)
January	10.0 - 12.0	27.7	0.0
February	36.0 - 40.0	76.7	6.1
March	48.0 - 50.0	177.4	15.0
April	38.0 - 42.0	67.2	16.0
May	42.0 - 44.0	139.9	4.2
June	235.0 - 245.0	451.6	81.6
July	268.0 - 276.0	577.9	135.3
August	308.0-316.0	362.4	235.8
September	245.0-255.0	331.4	15.3
October	116.0-120.0	331.4	15.3
November	12.0-14.0	41.1	0.0
December	36.0-40.0	134.2	0.0

2.2.1.3 Air Temperature

The mean maximum and minimum temperature were observed to be 35.96° C and 13.30° C respectively. The maximum temperature at Paradip ranges between 28.6° and 35.8° C, while minimum temperature varies between 13.3° to 22.5° C. Month wise Maximum and Minimum Temperature at the port vicinity is presented in **Table 2.2**.

Table 2.2 Maximum and Minimum Temperature-Monthwise

Month	Mean of Maximum Temperature (°C)	Mean of Minimum Temperature (°C)
January	29.52	13.30
February	30.44	15.54
March	31.38	19.12
April	33.94	20.96
May	35.82	22.54
June	34.52	22.44
July	35.96	22.50
August	33.20	21.26
September	34.14	24.88
October	33.94	22.00
November	33.42	17.66
December	28.68	13.62

2.2.1.4 Visibility

Generally, the visibility in the region is very good; visibility in the monsoon normally deteriorates during rains and occasional squalls. Visibility is recorded at Paradip daily at 08:30 hrs and at 17:30 hrs and records are available since 1975. Normally lowest range of visibility occurs at sunrise or at sunset and as the times of recording at Paradip observatory are fixed, lowest values are not available. Records are maintained in coded form (WMO code 4377) as approved by World Meteorological Organization. On analysis, the records maintained by I.M.D. for a particular year (1985) 87% of the readings were in scale 96.6% in scale 95 and 7% in scale 97. For other years it was comparable. Only one reading over the years was in scale 92. From these records it may be stated that during day light hours between 08:30 hrs and 17:30 hrs visibility at Paradip does not present any problem for navigation.

2.2.1.5 Relative Humidity

The average humidity ranges from nearly 84% in August to about 71% in December.

2.2.2 Oceanography

2.2.2.1 Tides

The tides at Paradip are semi-diurnal in nature with a tidal range, relative to the Chart Datum (CD), as follows:

Highest High Water Level (HHWL)	+ 3.50 m
Lowest Low Water Level (LLWL)	+ 0.40 m
Mean High Water Springs (MHWS)	+ 2.58 m
Mean Low Water Springs (MLWS)	+ 0.71 m
Mean High Water Neaps (MHWN)	+ 2.02 m
Mean Low Water Neaps (MLWN)	+ 1.32 m

The above levels are with respect to chart datum, which is approximately the level of Lowest Astronomical Tide.

2.2.2.2 Currents

The flood and ebb currents during spring tides were reported to be of the order of 0.6 knots (0.3 m/s) and during the neap tides 0.45 knots (0.23 m/s). Maximum currents reported did not exceed 1.2 knots (0.6 m/s).

2.2.2.3 Cyclone

Paradip Port is a cyclone prone area and is affected by the cyclones developing in the Bay of Bengal. During cyclonic conditions wind speeds may exceed 248 kmph as recorded during the 1999 super cyclone.

2.2.3 Geotechnical Data

Borehole data collected by Paradip Port trust indicates that the seabed sub-strata generally comprises of silty clay with average N value of 15 up to 7.0 m depth below seabed. Soil below 7.0 m to 14 m consists of silty sand with average N value of 15. Below 14m soil consist of clayey silt and sand up to a depth of 30 m with average N varies in the range of 20 to 30.

3.0 DETAILS OF EXISTING FACILITIES

3.1 General

Paradip Port presently handles commodities such as iron ore, thermal coal, coking coal, fertilizers and other break bulk cargo. The port also handles substantial quantities of POL through SBMs and pipelines. The total area available with the port is 6,521 acres and is located south of Atharabanki Creek. The dock area, surrounded by a boundary wall is about 1,500 acres.

The Port of Paradip is an artificial lagoon type harbour protected by two rubble mound breakwaters and is connected to deep water by a dredged channel. The details are as mentioned in **Table 3.1** below. The locations of various berths are shown in the following **Figure 3.1**.

Figure 3.1 Existing Facilities at Paradip Port

The features of the existing harbour are as follows:

Table 3.1 Details of Breakwater, Channel & Turning Basin

Breakwaters	
• North breakwater	538 m long on the north- eastern side of the port
• South breakwater	1,217 m long on the south-eastern side of the port
Approach channel	
• Length	2,020 m
• Width	190 m
• Depth	18.7 m below CD
Entrance Channel	
• Length	500
• Width	160
• Depth	17.1 m below CD
Turning Basin	
• Diameter	520 m
• Depths	17.1 m below CD

3.2 Existing Docks and Quays

Paradip port is having two docks namely Eastern and Central dock with 14 Berths (**Figure 3.1**). These docks are located at the lee of the Northern Breakwater. The Central Dock has three multipurpose berths, 1 multipurpose berth and 2 fertiliser berths, while the Eastern dock has 3 general cargo berths, 2 coal berths, 1 iron ore berth and 1 oil berth on the lee of north breakwater. In addition to 14 berths, the port has three Single Point Moorings which are dedicated to Indian Oil Company Ltd (IOCL). **Table 3.2** provides details of all the berths at Paradip Port.

Table 3.2 Berthwise Details

S. No.	Berth Name (No. of berths)	Length (in m)	Dredged Depth (m)	Present Capacity (MTPA)	Cargo Handled
1.	North Oil Jetty(1)	350	13.5	7.50	POL import/export
2.	Coal Berths (2)	520	14.5	21.00	Thermal coal exports
3.	Iron Ore Berth (1)	210	13	6.39	Iron ore exports
4.	East Quay (3)	686	11.0 -13.0	9.69	Dry bulk cargo imports/exports
5.	Southern Quay (1)	265	13.0	4.76	Multi cargo import / export
6.	Central Quay – 3 (1) (Licensee - Essar)	230	15.0	6.55	Dry bulk cargo import/ export
7.	Central Quay -1, 2 (2)	525	15.0	12.10	Multi cargo import / export
8.	Fertilizer Berth – I (1) (Captive – PPL)	250	15.0	3.47	Fertilizer RM, edible oil import
9.	Fertilizer Berth – II (1) (Captive – IFFCO)	250	15.0	4.03	Fertilizer RM, edible oil import
10.	Multipurpose cargo berth (1)	235	15.0	3.45	Dry and liquid bulk cargo import/export
11.	RO-RO Jetty (1)	50	5.50	1.00	Project Cargo import
12.	SPM (3) (Captive IOCL)		23.0	37.00	Crude import
13.	New South Oil Jetty	350	17.0	10.00	Crude import/ product exports
			Total	**126.94**	

3.2.1 Eastern Quay (EQ)

It has a quay length of 686 m and contains three berths viz. EQ 1, EQ 2 and EQ 3. EQ 1 and 2 can handle 45,000 DWT vessels with a draft of 11 m and East Quay III can handle 60,000 DWT vessels with a draft of 12.0 m. All quays are multi-purpose berths handling thermal coal, coke, fertilizers, and other bulk cargos.

3.2.2 Central Quay (CQ)

Central Quay has three berths (CQ 1, CQ 2, CQ 3) with length of 755 m and a draft of 14.5 m and it can accommodate vessel sizes of 60,000 – 65,000 DWT. Out of these CQ1 and CQ2 berths are multipurpose berths whereas CQ 3 berth is mechanised berth with one ship loader and connected conveyor system for handling ore pallets.

3.2.3 South Quay (SQ)

South Quay is a single berth having 13.0 m draft and 265 m of quay length. It is also a multi-purpose berth and handles iron ore, POL and coking coal.

3.2.4 Fertilizer Berth (FB)

There are two fertilizer berths (FB I and FB II), with a quay length of 250 m each and depth of 15.0 m. These berths are captive facilities and handle fertilizer and fertilizer raw material (FRM) for Paradip Phosphate Ltd. (PPL) and Indian Farmers Fertilizers Cooperative Ltd. (IIFCO). These berths together handle nearly 7.5 million tonnes of cargo and can accommodate vessels up to 65,000 DWT.

3.2.5 Iron Ore Berths (IOB)

The iron ore berth is one of the oldest berths of Paradip Port and is located in the eastern dock. It has a dredged depth of 13.5 m and the length of 210 m. It is a fixed jetty having a R.C.C. deck supported on steel tubular piles and connecting shore arms. There are four mooring dolphins two on either side having dimensions 7.5 m × 9.5 m and 9.5 m × 10.5 m.

The berth is equipped with a mechanised ore loading system with twin wagon tipplers, conveyor system, stackers, reclaimers and one ship loader.

The iron ore loading stream comprises:

- 1 Shiploader with rated capacity of 3,000 TPH.
- 2 bucket wheel type Reclaimers with rated capacity of 3,000 TPH each.
- 2 Stacker cum Reclaimer with rated capacity of 3000 TPH each
- 2 Rotary type wagon tipplers with rated capacity 1,500 TPH each (each tippler is capable of tippling 25 wagons/hr).

3.2.6 Coal Handling Berths (CB)

The Port has two mechanized coal jetties at the northern end of Eastern Quay with State-of-the-Art equipment. Each jetty has a dredging depth of 14.5 – 15.0 m and 260 m length. It can accommodate vessel sizes up to 60,000 to 75,000 DWT. These berths are also equipped with a mechanical coal handling facilities for unloading of coal from the trains, stacking, reclaiming and loading coal into the bulk carriers. This terminal has a Merry-Go-Round (MGR) system for unloading of BOBRN wagons (2×4,000 TPH capacity).

The salient features of the handling plant are given below:

- 2 Stackers with rated capacity of 4,000 TPH each.
- 2 Reclaimers with rated capacity of 4,000 TPH each.
- 2 Ship loaders with rated capacity of 4,000 TPH each.
- 2 Track hoppers at RRS with capacity of 4 Wagons/table.

3.2.7 POL Jetty

The port has an oil jetty of 350 m length with dolphin to dolphin facility, located in the lee of the north breakwater. This berth handles petroleum, oil and lubes (POL). The draft at this berth is 13.5 m and handles tankers up to 65,000 DWT with Length Overall (LOA) up to 260 m.

3.2.8 New Oil Jetty

The port has commissioned new oil jetty with 360 m length with dolphin to dolphin facility, located in the southern dock of the harbour. This is a captive jetty commissioned by IOCL for loading of products and unloading of crude oil. Two Unloading Arms for Crude & eight Loading Arms for products are also installed at Jetty top. One crude pipeline, eight product pipelines (Motor Spirit, High Speed Diesel, Naphtha, Dual Purpose Kerosene, Propylene and Propylene vapour) and 3 utilities pipelines are laid from South Oil Jetty to IOCL Paradip Refinery.

3.2.9 General Cargo/ Multi-Purpose Berths

Eight General Cargo/ Multi-Purpose Berths have been constructed along the western face of Eastern Dock, eastern face of Central Dock and on the Southern face of the pier.

3.3 Equipment for Breakbulk Cargo

Apart from the mechanized Coal and Iron handling plants the port has the following equipment for efficient and smooth loading/unloading of its operations:

- Mobile Crane 75 T
- Pay loader 13.5 Cum
- 2 Pay loaders 4.7 Cum

It is important to mention that besides these, other private equipment are permitted time to time wherever necessary.

The port has a 500 TEU capacity container yard served with two railway sidings and 15 reefer plug points. The port has one 75 T and one 30 T Mobile crane, 2 spreaders of 40 feet and 20 feet to handle containers in the yard.

3.4 Single Point Mooring Terminals

Total 3 Single point moorings (SPM) with capacity 37 MTPA are provided at the Paradip port to handle the captive crude oil for IOCL. All the SPMs are located towards the southern side of the existing port in about 30 m water depth, about 20 km away from shore, and connected to shore by means of submarine pipelines. The location plan of the SPMs and the pipelines is presented in **Figure 3.2**.

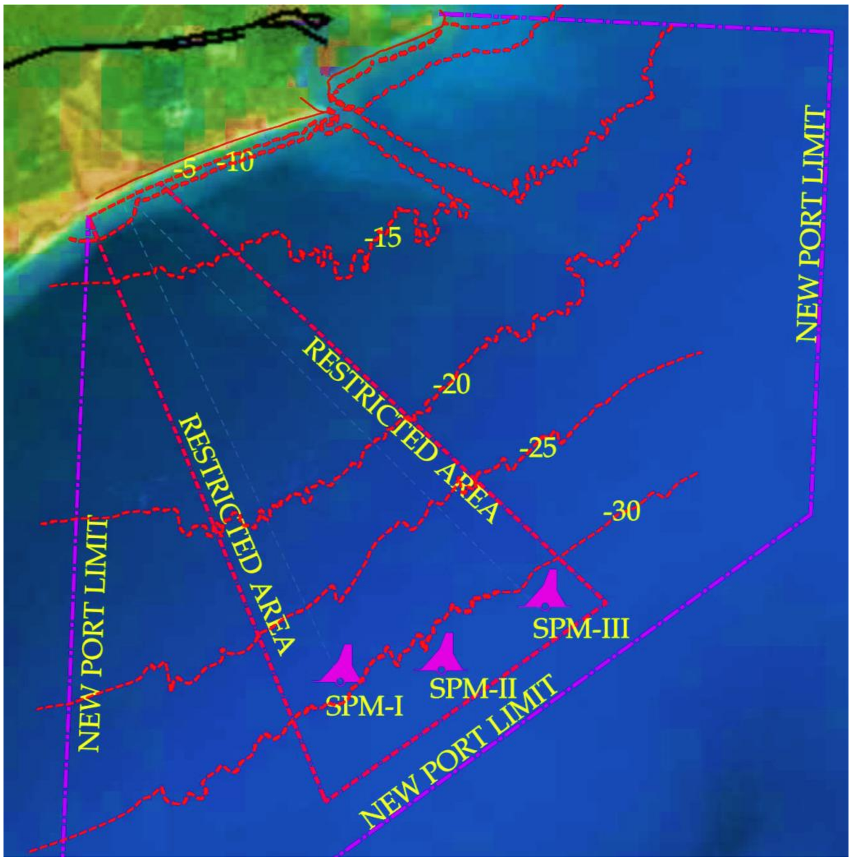


Figure 3.2 Location of SPMs

3.5 Storage Facilities

The port operations are supported by extensive storage arrangements. In addition to the open stackyard, there are four Transit Shed and two Warehouses outside the Port area as detailed in **Table 3.3** and **Table 3.4**

Table 3.3 Details of the Storage Facilities

Description of Storage Area	Area (m^2)	Capacity (T)
Warehouse No. I	1,711	4,000
Warehouse No. II	6,000	14,000
Open Stack Yard No. I	8,50,000	15,00,000
Open Stack Yard No. II	1,00,000	1,75,000

Table 3.4 Details of Open Areas for Stacking

Open Area	Area (m^2)
Rail Sidings	8,22,200
Mechanical Ore	1,05,000
Mechanical MCHP	1,22,200
Without Siding	7,45,000
Covered	9,111
Concreted	1,01,000
Others	93,915
Total	**19,98,426**

3.6 Port Railways

Paradip Port trust has its own railway system. The route length is 7.5 km and track length is 88 km. At present, there are 7 no's of locomotives as follows:

1,400 BHP	04 (DLW-WDS-6)
1,350 BHP	02 (DL-WDS-6A/D)
3,100 BHP	01 (DLW-WDG-3A)

The port has railways sidings capable of handling 19 full rake lengths and 11 half rake lengths. The rail terminal consists of 15 yard lines and 25 sidings inside its main terminal. The port has an open and closed wagon handling facility for coal handling (bottom discharge) and wagon tipplers facilities for iron ore handling. However, the existing rail network doesn't have signalling, so shunting and rail operations are being done manually.

3.7 Pilotage and Towage Facilities

The pilotage is compulsory for all vessels having capacity of more than 200 T Gross Tonnage. The ports has 3 tugs having BP more than 35 T and 2 port tugs having BP more than 50 T. Mooring boats are also available for passing the mooring lines to berth or jetty.

3.8 Repairing Facility

The port has a 500 T slipway along with workshop for repair and maintenance of port crafts and barges. A wet basin is provided for port crafts close to slipway. The dry dock is also available, which is 75 m long, 15 m wide and 11 m deep to repair crafts.

4.0 PERFORMANCE, OPTIONS FOR DEBOTTLENECKING & CAPACITY ASSESSMENT

4.1 General

The total cargo handled through the existing facilities, during the past 5 years is presented in the following **Table 4.1**.

Table 4.1 Cargo Handled during Last 5 Years (MTPA)

Commodity	2010-11	2011-12	2012-13	2013-14	2014-15
POL	12.85	15.09	16.47	17.70	17.98
Iron Ore	13.85	6.55	1.83	5.59	2.18
Thermal Coal	13.28	16.40	21.40	25.03	30.13
Coking Coal	6.20	5.51	4.91	7.04	7.87
Fertilizer Raw material (Dry)	4.23	4.55	4.00	3.93	4.38
Fertiliser	0.18	0.28	0.14	0.12	0.05
Container	0.06	0.11	0.17	0.10	0.07
Container (TEUs)	3,527	7,853	13,072	8,675	4,312
Others	5.39	5.76	7.63	8.49	8.35
Total (MT)	**56.03**	**54.25**	**56.55**	**68.00**	**71.01**

4.2 BCG Benchmarking Study

BCG, as part of their benchmarking study, looked into the operation of the berths and has suggested various measures for improving the performance.

Paradip Port Trust (PPT) has potential to handle additional cargo volume but it is constrained by the low productivity. In order to improve the overall productivity and performance, BCG has suggested the following measures:

Mechanized Coal Handling Plant (MCHP)

- Productivity can be increased by changing berthing policies, productivity norms and reduction in non-working time (NWT).
- Five Major customers, who have exported ~95% of volume at MCHP, have used only 70% of the storage yard, while remaining five smaller customers exported ~5% of volume have used

30% of the storage yard. This imbalance can be amended by rationalization of the land. For this they have suggested two options i.e.,

  - Creating a common pool of land area of about 20,000 m2 at MCHP for the use of smaller players.
  - Cargo of smaller players to be moved to IHP consequently releasing the 36,000 m2 of storage yard that is being used by smaller players.

- According to BCG second option is preferred as it will help effective utilization of MCHP while also storing cargo in the IHP land area will also improve the utilization of IHP land.
- Development of additional merry-go-round at MCHP to handle additional rakes after debottlenecking the MCPH berth and yard.

Iron Ore Handling Plant (IHP)

Iron Ore Handling Plant (IHP) in PPT is dedicated for iron ore export. However, due to fall in demand of exporting iron ore, IHP had very low overall occupancy of ~42%. IHP is capable of handling export thermal coal from productivity varying 8000 T/day to 17,000 T/day. Therefore using IHP as additional thermal coal terminal will increase thermal coal handling capacity at the port. This is however, subject to assumption that iron ore traffic would continue to remain low in future as well.

Conventional Berths

Conventional Berths CQ1, CQ2, EQ1, EQ2, EQ3, SQ and MPB handles cargo using HMCs combined with loaders and dumpers for evacuation. Together, these berths handled ~23 MT of cargo. These conventional berths have high berth occupancy~ 80-85% but low productivity and high non-working time (~30%) In order to overcome the issues they have suggested the following measures:

- Existing HMCs have low availability, inadequate HMC hours compared to berth requirement and hence need for additional new HMCs.
- Productivity norms needs to be established at PPT and this shall increase the cargo volume by 6 MT.
- Cargo evacuation from the wharf is delayed due to low productivity arising from high cargo storage, high cargo stack height and very slow dumper (conventional) unloading. Thus creation of addition storage yard with siding would ease congestion and storage constrains
- Norms for Storing cargo in port land with in custom area needs to be established which will lead to increase in efficiency of using port land.
- PPT does not have adequate no. of dumpers to meet higher productivity requirement of HMCs for evacuation cargo. Dumper evacuation from wharf to the yard should match the HMC productivity rate this mains to addition of new dumpers. They have estimated ~340 dumpers considering 30min waiting at stockyard.
- Mechanization of EQ 1-3 and CQ 1-2 to cater additional cargo (both import and export) However development should be staggered to prevent a sudden unavailability of conventional berths to handle import cargo at PPT.

The recommendations of BCG report for improvement of port operations are presented in **Appendix 1**.

4.3 Capacity Assessment of Existing Facilities

4.3.1 General

The cargo handling capacity of port facilities is based on many factors like the vessel size, fleet mix, equipment provided and the possible handling rates, time required for peripheral activities, capacity of stackyard, number of users, grades, capacity of evacuation system etc.

4.3.2 Capacity of Berths

4.3.2.1 General

The capacity of existing berths is calculated assuming the mix of cargo being currently handled at these berths and the corresponding parcel sizes.

Another factor that is important in arriving at the berth capacity is the allowable Berth occupancy which 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. For limited number of berths and with random arrival of ships, the berth occupancy levels have to be kept low to reduce this detention. The norms generally followed for planning the number of berths in modern port to minimise the pre-berthing detention are given in **Table 4.2**.

Table 4.2 Recommended Berth Occupancy

No. of Berths	Recommended Berth Occupancy Factor
1	60 %
2	65 %
3 & above	70 %

The available berths and the cargo handled at each of the berths during last year are presented in **Table 4.3** below:

Table 4.3 Cargo handled at Berths during FY 15-16

CARGO	OJ	IOB	EQI	EQII	EQIII	SQ	CQI	CQII	CQIII	CBI	CBII	FBI	FBII	MPB	SPM	SPMII	SPMIII	TOTAL
EXPORT																		
C. COAL		84,696	97,913	43,247	6,000		55,300	13,037	24,800					25,900				3,50,893
CH. CON					2,021													2,021
CH. ORE					22,000													22,000
CONTAINER			24,331	9,901	11,035	6,990	3,589	174						265				56,285
FE. CR		16,865	46,649	19,738	8,225			2,600	12,600									1,06,677
I PAL									22,78,683					55,000				23,33,683
IORE		1,20,597	59,775	50,550	25,750		30,380		49,413					1,65,565				5,02,030
L/S				11,525														11,525
HSD	2,73,649																	2,73,649
M. SPIRIT	2,10,295																	2,10,295
NAPTHA	1,03,726																	1,03,726
SKO	74,876																	74,876
PIGI			75,000						26,999					44,000				1,45,999
PROJECT MAT.				509														509
S. COAL		69,822	63,050				69,020							9,350				2,11,242
T. COAL		64,562								1,15,03,772	1,21,87,284							2,37,55,618
TOTAL EXPORT	**6,62,546**	**3,56,542**	**3,66,718**	**1,35,470**	**75,031**	**6,990**	**1,58,289**	**15,811**	**23,92,495**	**1,15,03,772**	**1,21,87,284**	**-**	**-**	**3,00,080**	**-**	**-**	**-**	**2,81,61,028**
IMPORT																		
A. COAL		16,200	85,986	1,32,770	37,001									35,800				3,07,757
B. LUMPS									15,000									15,000
C. COAL		82,367	4,56,645	8,32,089	11,30,612	14,33,719	13,64,395	16,71,337						1,63,515				71,34,679
COKE BREEZE			44,066		20,300													64,366
CONTAINER			24,398	9,654	8,286	8,248		9,733						4,830				65,149
DOLOMITE			10,600	88,129	69,934	68,183	25,209							62,906				3,24,961
AMMONIA												2,91,427	339790	40,701				6,71,918
MOP												53,000	27500					80,500
P. ACID												2,70,313						2,70,313
ROCK PHOS												10,50,034	2491954					35,41,988
SUL. ACID												3,57,550	606602					9,64,152
SULPHUR												2,36,810	501787					7,38,597
GYPSUM			51,000	17,000	1,46,517	2,44,468		20,000						1,48,700				6,27,685
H. COAL			33,036	37,349	89,539	1,14,930	46,500	92,598						20,000				4,33,952
H.R. COILS			19,155															19,155
I. PAL														52831				52,831
L. COKE				22,121	18,538	21,930	9,574							38,500				1,10,663
L/S		1,06,177	1,97,473	4,75,991	6,39,743	6,01,154	2,40,697	74,990						9,52,650				32,88,875
M. COKE		11,326	34,199	70,696	73,074	22,850	35,860	43,500						34,123				3,25,628
N. C. COAL					98,578		55,100	30,900										1,84,578
OLIFLUX			34,555				1,44,248	82,389										2,61,192
ALKYLATE	11,473														34,40,493	78,34,385	68,32,105	1,81,18,456
CRUDE OIL																		-
HSD	1109392																	11,09,392
M. SPIRIT	563248																	5,63,248
SKO	113493																	1,13,493
P.COKE		2,001	75,561	64,190		75,044	10,000	42,500						1,82,181				4,51,477
PCI COAL				24,201	60,188	54,236	1,02,762	1,85,802										4,27,189
PROJEECT MAT			8,628	4,207		527												14,253
PYROXENITE			27,691	10,865		20,360	34,170	58,140						64,541				2,15,767
S.COAL		73,230	5,96,681	8,33,372	8,34,029	10,87,187	13,30,040	16,89,813	41,924					8,23,178				73,09,454
S.COIL			19,658															19,658
STEEL BAR			10,826	5,427			5,341							5,151				26,745
STEEL SLAB			14,331		24,585									6,150				45,066
TOTAL IMPORT	**17,97,606**	**2,91,301**	**17,44,489**	**26,28,061**	**32,50,924**	**37,52,836**	**34,03,896**	**40,01,702**	**56,924**	**-**	**-**	**22,59,134**	**39,67,633**	**26,35,757**	**34,40,493**	**78,34,385**	**68,32,105**	**4,78,98,137**
TOTAL TRAFFIC	**24,60,152**	**6,47,843**	**21,11,207**	**27,63,531**	**33,25,955**	**37,59,826**	**35,62,185**	**40,17,513**	**24,49,419**	**1,15,03,772**	**1,21,87,284**	**22,59,134**	**39,67,633**	**29,35,837**	**34,40,493**	**78,34,385**	**68,32,105**	**7,60,59,165**

4.3.2.2 MCHP

Based on the above considerations of berth occupancy, capacity of MCHP has been calculated as shown in **Table 4.4**.

Table 4.4 Capacity of MCHP

S. No.	Particulars	Unit	Cargo
			Coal
1.	Traffic	MTPA	21.08
2.	Average Parcel size	T	60,000
3.	No. of Ship Calls per Annum	No.	351
4.	Handling Rate	TPD	60,000
5.	Time Required at Port Per Ship		
a.	Handling Time	Days	1.00
b.	Berthing / Deberthing & Miscellaneous Time	Days	0.17
	Total Time per Ship	Days	1.17
6.	Total Berth Days Required	Days	410
7.	Berth Days Available per Berth	Days	350
8.	Berth Occupancy	%	
	Number of Berths		
	1		117%
	2		59%
	3		39%
9.	**Capacity of Berths at 70% Occupancy considering 2 berths**		**25.20**

It may be noted that the above berth capacity has been calculated based on the international norms which are recommended to keep the waiting time of ships to minimum and also optimal equipment utilisation while allowing for scheduled maintenance. Theoretically, the berth capacity could be much higher if higher berth occupancy of 80 to 85% is adopted.

The stacking capacity of the existing coal stackyard for MCHP has been calculated as shown below in **Table 4.5**:

Table 4.5 Stacking Capacity of the Existing Coal Stackyard for MCHP

Parameters	Units	Stack type 1	Stack type 2
Bulk Density	T/cum	1	1
Angle of Repose	degrees	37	37
Overall Length	m	200	200
Overall Width	m	65	65
Height of Stack	m	10	10
No. of Yards	Nos.	5	5
Capacity of Stockpile		4,83,387	4,83,387
Total Stacking Capacity	**T**	**9,66,775**	

It may be seen that the stacking capacity calculations shown above considers a number of stockpiles (10 no.) for various users and/or various grades of cargo. Additional numbers of stockpiles would further reduce the stacking capacity.

Considering the standard 70% utilisation of yard and dwell time of 10 days (export cargo), the capacity of terminal based on the stacking capacity works out to about 25 MTPA, which matches the berth capacity. As could be seen that the dwell time of cargo i.e. the average time cargo is stacked at the yard between receipt and despatch has a significant bearing on the capacity of the stackyard.

Currently, there are two set of track hoppers to receive the coal rakes for coastal exports, the turnaround time achieved is about 10 rakes per day per hopper, which allows for the capacity of cargo receipts to be about 25 MTPA, considering effective 350 days for rail working per annum.

It is therefore observed from the above that the optimal capacity of MCHP is limited to about 25 MTPA only. Theoretically these berths can handle more cargo at higher berth occupancy but higher waiting time for ships is also likely the strain the equipment and would not provide adequate time for their scheduled maintenance.

4.3.2.3 Conventional Berths

Conventional Berths CQ1, CQ2, EQ1, EQ2, EQ3, SQ and MPB handle cargo using HMCs combined with loaders and dumpers for evacuation. These 7 berths handle variety of cargo of different characteristics and brought in ships in different parcel sizes. Mainly bulk cargo like coking coal, thermal coal, fertilizers, iron ore, iron pallets, limestone, gypsum and also containers are handled at these berths using ship’s gear or using mobile harbour cranes.

The capacity of the berth handling multiple commodities is governed by the type of cargo handled, average parcel sizes and the possible handling rate that could be achieved for that particular cargo. Berth capacity calculations of a typical multipurpose terminal are shown in **Table 4.6** below:

Table 4.6 Berth Capacity of a Typical Multipurpose Berth

S. No.	Particulars	Unit	MHCr		Ship's Gear	
			Bulk	Break Bulk	Bulk	Break Bulk
1.	Traffic	MTPA	4.00	4.00	4.00	4.00
2.	Average Parcel size	T	45,000	15,000	45,000	15,000
3.	No. of Ship Calls per Annum	No.	89	267	89	267
4.	Handling Rate	TPD	20,000*	8,000	12,000	6,000
5.	Time Required at Port Per Ship					
a.	Handling Time	Days	2.25	1.88	3.75	2.50
b.	Berthing / De-berthing & Miscellaneous Time	Days	0.25	0.25	0.25	0.25
	Total Time per Ship	Days	2.50	2.13	4.00	2.75
6.	Total Berth Days Required	Days	222	567	356	733
7.	Berth Days Available per Berth	Days	350	350	350	350
8.	Berth Occupancy	%				
	Number of Berths					
	1		63%	162%	102%	210%
	2		32%	81%	51%	105%
9.	**Capacity of Berths at 70% occupancy**		**4.41**	**1.73**	**2.76**	**1.34**

* The value would reduce with reduction in vessel size and for export cargo (where the handling rate is lower than import cargo)

As could be observed from above that capacity of multipurpose berth is affected significantly by the type of cargo handled at the berth and the equipment for ship handling. As the mix of cargo are being handled in all the multipurpose berths with higher proportion of bulk, the average capacity of each berth of all the 7 available multipurpose berths for the purpose of planning could be considered as about 2.75 MTPA.

For berths EQ1 to 3, which handled various cargo in different throughputs the specific berth capacity calculations have been carried out as presented in **Table 4.7**.

Table 4.7 Berth Capacity Assessment for Berths EQ1 to EQ3

S. No.	Particulars	Unit	Cargo					
			Coal	Iron Ore and Pellets	Gypsum	Limestone	Other Cargo	Containers
1.	Traffic	MTPA	4.18	0.35	0.46	0.97	0.74	0.05
2.	Average Parcel size	T	45,000	40,000	30,000	40,000	40,000	5,000
3.	No. of Ship Calls per Annum	No.	93	9	15	24	18	10
4.	Handling Rate	TPD	15,000	18,000	12,000	15,000	10,000	5,000
5.	Time Required at Port Per Ship							
a.	Handling Time	Days	3.00	2.22	2.50	2.67	4.00	1.00
b.	Berthing / Deberthing & Miscellaneous Time	Days	0.25	0.25	0.25	0.25	0.25	0.25
	Total Time per Ship	Days	3.25	2.47	2.75	2.92	4.25	1.25
6.	Total Berth Days Required	Days	302	22	42	71	79	12
			527					
7.	Berth Days Available per Berth	Days	350					
8.	Berth Occupancy	%						
	Number of Berths							
	1		151%					
	2		75%					
	3		50%					
9.	**Capacity of Berths at 70% occupancy**		**9.34**					

It could be observed that the capacity of the three berths combined is about 8.31 MTPA and it would vary depending upon the proportion of cargo handled.

Similar calculations undertaken for CQ1 and CQ2 indicate their total capacity as 6.43 MTPA at 70% berth occupancy. The capacity would be higher if these berths were to handle a single commodity say coal where higher unloading rates could be achieved.

4.3.2.4 Liquid Berths

The capacity of the liquid berths is governed by the type of product handled, pumping rate of the tankers, size of the pipelines provided and distance of tank farms. A berth handling liquid cargo in smaller tankers would have lower capacity as compared to the berth handling crude oil as shown in **Table 4.8**.

Table 4.8 Typical Capacity Calculations for Oil Terminal

S. No.	Particulars	Unit	Type of Cargo	
			Crude	POL
1.	Traffic	MTPA	10.00	4.00
2.	Average Parcel size	T	65,000	40,000
3.	No. of Ship Calls per Annum	No.	154	100
4.	Handling Rate	TPD	60,000	25,000
5.	Time Required at Port Per Ship			
a.	Handling Time	Days	1.08	1.60
b.	Berthing / Deberthing & Miscellaneous Time	Days	0.25	0.25
	Total Time per Ship	**Days**	**1.33**	**1.85**
6.	Total Berth Days Required	Days	205	185
7.	Berth Days Available per Berth	Days	350	350
8.	Berth Occupancy	%		
	Number of Berths			
	1		59%	53%
	2		29%	26%
9.	**Capacity of Berths at 65% Occupancy**		**11.09**	**4.92**

The above calculations are only indicative and the outcome would vary significantly on the size of ship used and also the composition of the POL products, which in many cases are handled in smaller parcels. As at Paradip, the existing berth handles crude oil as well as products, the average berth capacity considered is about 7.5 MTPA. The newly constructed berth has been planned to handle only crude and therefore its capacity could be considered as 10.0 MTPA.

5.0 DETAILS OF ONGOING PROJECTS

5.1 General

Paradip Port Trust has taken many developmental projects which are in various stages of implementation. The details and locations of these projects are shown below in **Figure 5.1** and **Figure 5.2**.

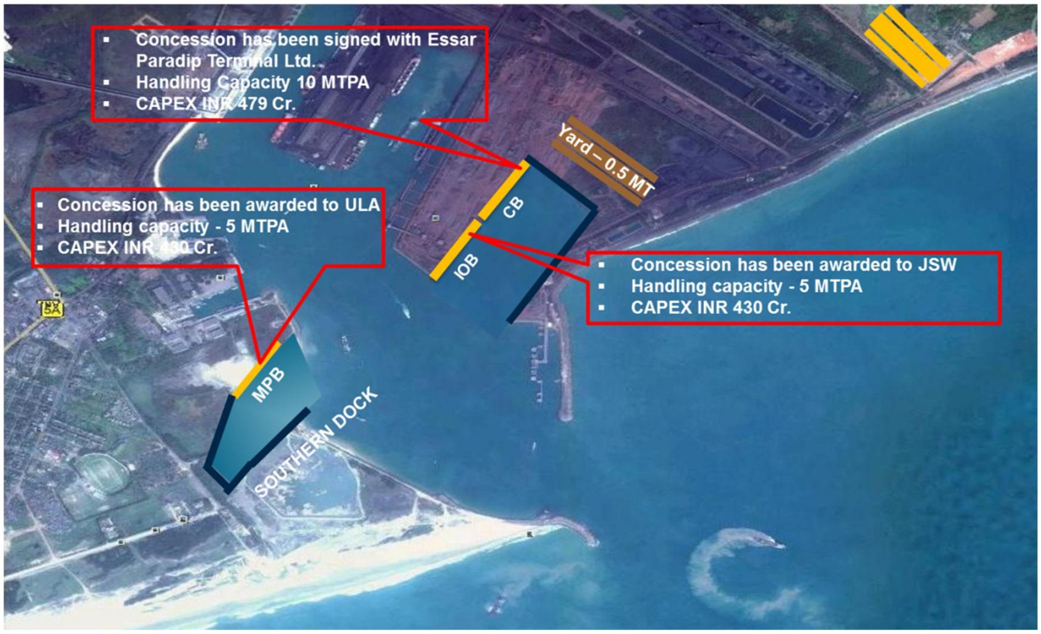


Figure 5.1 Ongoing Developments 1

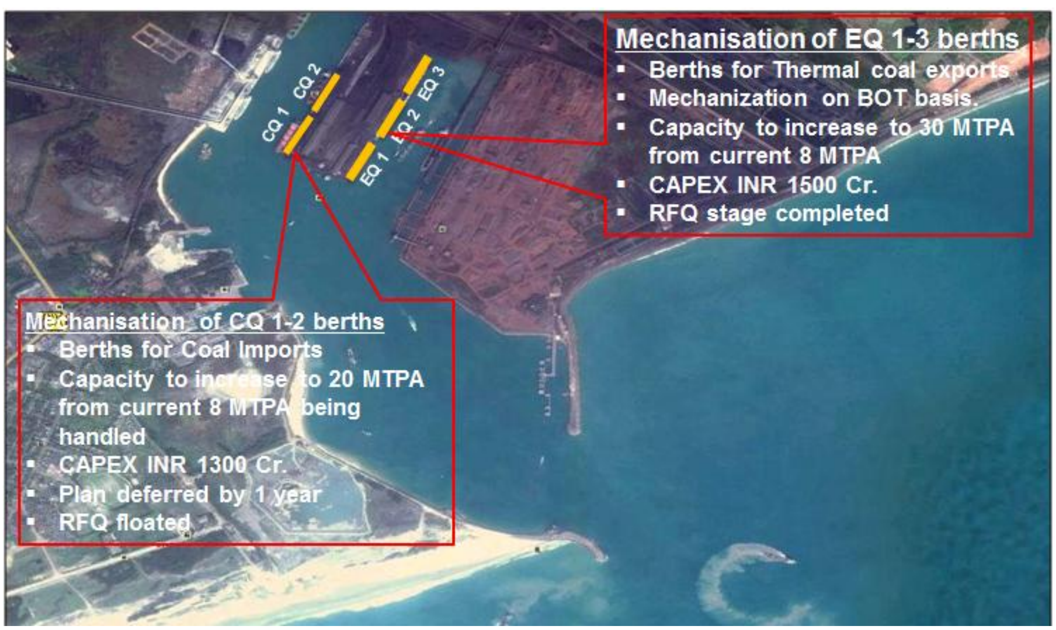


Figure 5.2 Ongoing Developments 2

5.2 Development of Deep Draft Coal Import Berth

This project is planned to provide a deep draft coal import berth for handling cape size ships within the inner harbour and the Concession Agreement has been signed with the SPV "Essar Paradip Terminal Ltd." on 10/11/2009 with revenue share of 31.00%. The terminal capacity envisaged is 10 MTPA. The location plan of berth and stackyard is shown in **Figure 5.3.**

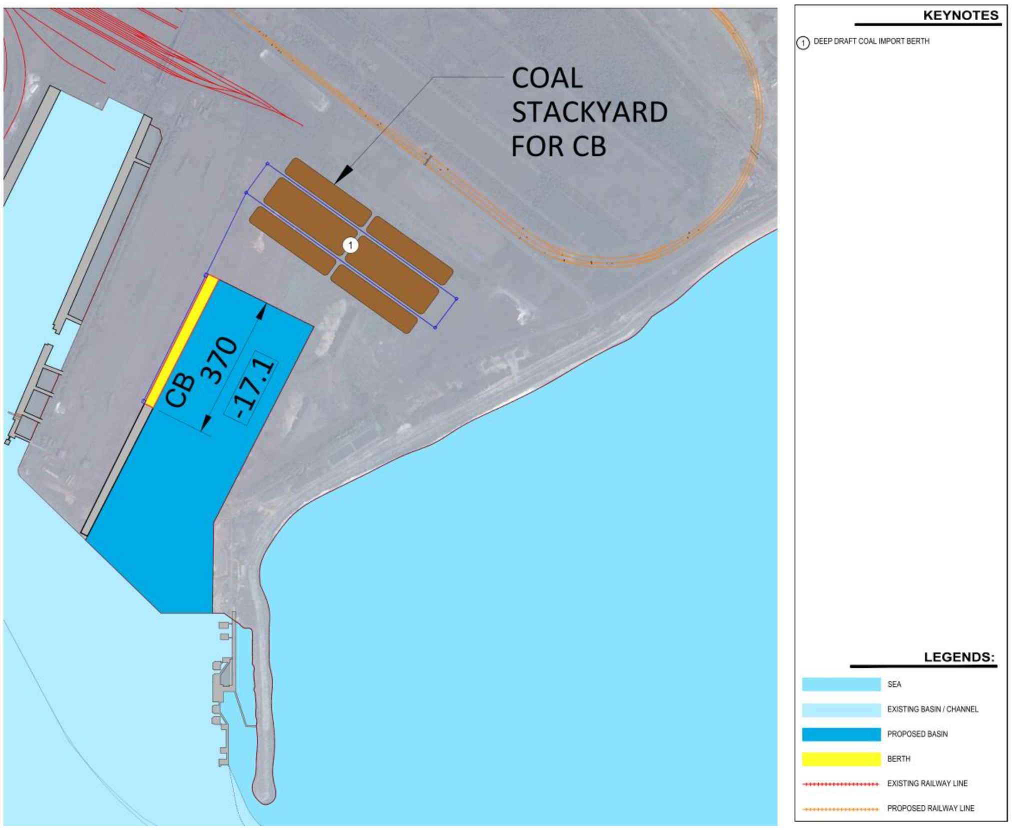


Figure 5.3 Location of Deep Draft Coal Import Berth

As per the details provided in the project report the coal berth would be 370 m long and 24 m wide. Two gantry type unloaders having rated capacity of 2,000 TPH each are connected with a separate conveyor system of same capacity. The area of stackyard allocated for the terminal is about 14.7 ha. and Stacker and Reclaimer of matching capacities have been provided at the stackyard. In motion wagon loading system has been proposed for wagon loading.

Based on the area of stackyard, it is assessed that only about 0.55 MT of coking coal could be stacked. A typical 30 days dwell time for bulk import cargo will limit the terminal capacity to only 5.0 MTPA. To achieve the required terminal capacity of 10 MTPA either the dwell time of cargo will need to be reduced to 15 days by the concessionaire.

5.3 Development of Multi-Purpose Berth to Handle Clean Cargo

A multipurpose berth of total 450 m length is proposed for handling of clean cargo such as steel products, iron and containers. The Concession Agreement has been signed with the SPV "Paradip International Cargo Terminal (Pvt) Ltd." with revenue share of 11.044%. The terminal capacity envisaged is 5.0 MTPA. The location plan of berth is shown in **Figure 5.4.** The construction is yet to start.

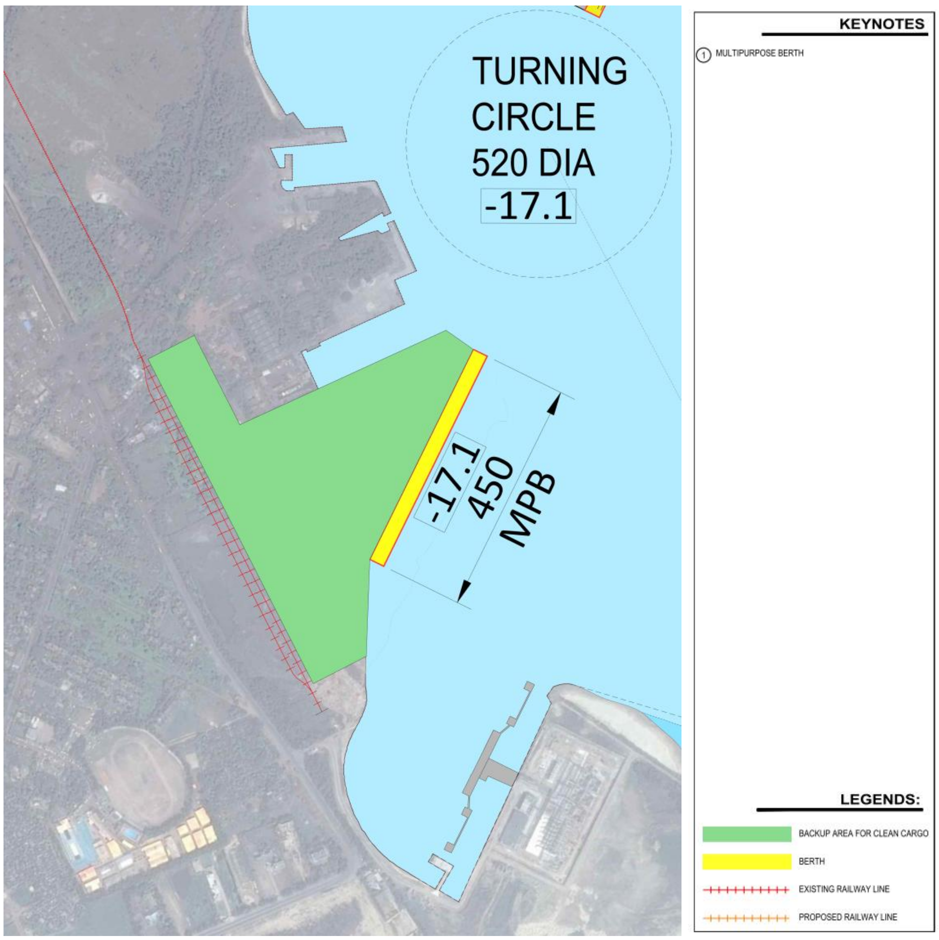


Figure 5.4 Location of Multipurpose Berth

The detailed project report for the project envisages handling of steel products and containers at this berth. In view of the requirement to handle different cargos, two mobile harbour cranes are suggested at the berth. Considering that the containers are brought in small vessels having average parcel size limited to only 500 TEUs, maximum of only two cranes can be deployed at the vessel. There is unlikely that the parcel size would increase over a period of time. Therefore it is assessed that the proposed clean cargo berth of 450 m length can handle two vessels simultaneously and thus has a capacity of about 350,000 TEUs per annum i.e., about 5.0 MTPA, if used exclusively for containers only. Similarly if the berth is used for handling steel products the annual throughput may be limited to about 4.0 MTPA.

5.4 Development of New Iron Ore Berth for Handling of Iron Ore Exports

A new iron ore berth is proposed for handling of iron ore exports, the Concession Agreement has been signed with the SPV "JSW Paradip Terminal Pvt. Ltd." on 29.06.2015 with revenue share of 21.00%. The terminal capacity envisaged is 10.0 MTPA. The location plan of berth and stackyard is shown in **Figure 5.5**.

The stackyard allocated to for the terminal has an area of **8.21 ha**. and it is envisaged that maximum 0.7 MT of iron ore could be stacked, which provides adequate area to meet the terminal throughput of 10.0 MTPA.

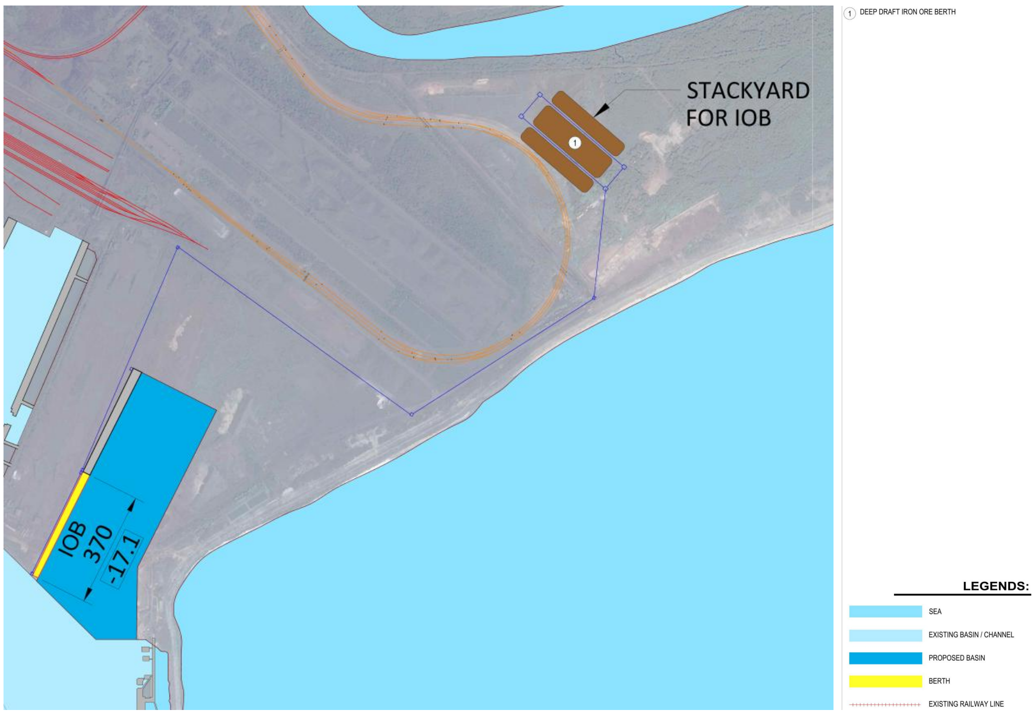


Figure 5.5 Location Plan of New Iron Ore Berth and Stackyard

5.5 Mechanization of EQ1 to EQ3 Berths

In order to enhance the existing capacity of EQ1, EQ2 and EQ3 berths (proposed to be used for thermal coal exports) from 9.69 MTPA to 30 MTPA, PPT plans to mechanize these berths. Mechanization of these berths will involve the following provision will be made:

- All three existing berths shall be strengthened and converted to two berths of adequate length to receive two panamax size ships simultaneously.
- Coal Stackyard within the existing bulb of the rail tracks.
- Addition of two more loops along with track hopper for unloading of BOBRN wagons
- The coal unloaded from track hoppers shall be received at the yard by two stream of conveyors with Stacker cum Reclaimer arrangement

- From yard the coal shall be conveyed to berths using two streams of conveyors and loaded to ships using one ship loader on each berth

The location plan of berths and stackyard is shown in **Figure 5.6**.

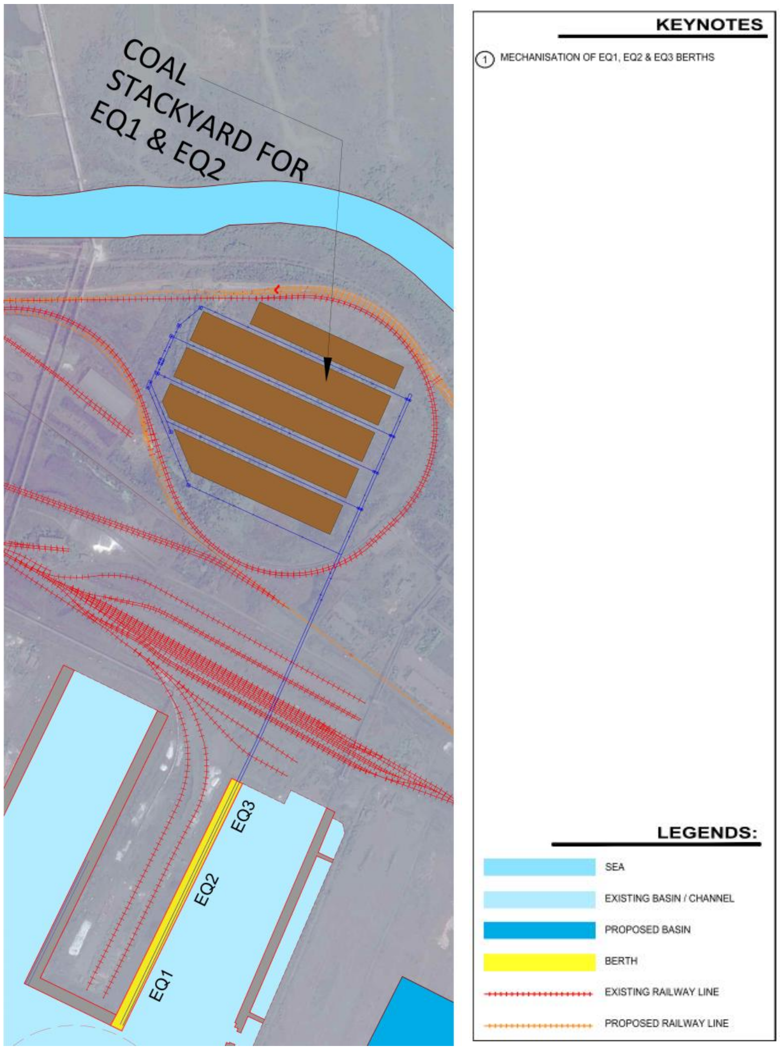


Figure 5.6 Location Plan of EQ 1 to EQ 3 Berths and Stackyard

The storage capacity of the stackyard is only about 1.0 MT and corresponding to the dwell time of 10 days it can support the terminal throughput of 30 MTPA.

5.6 LPG Terminal in South Oil Jetty

The South Oil jetty is the captive IOCL jetty is planning to expand storage and handling of LPG by setting up LPG Import Facility. LPG will be imported in VLGCs at South Oil Jetty constructed by IOCL Paradip Refinery where space for putting up Butane / Propane unloading facility is available. Imported Butane / Propane would be transferred to LPG Import Facility through 2 no. underground pipelines. Imported Butane and Propane will be stored in aboveground mounded storage vessels and sent to market as LPG after blending of Butane & Propane.

The terminal is being planned for the capacity of 2 MTPA which would be developed at a cost of INR. 690 cr.

6.0 TRAFFIC PROJECTIONS

6.1 General

In terms of volumes, Paradip is one of the largest major ports in the country handling more than 70 MTPA of cargo. Paradip is strategically in the mineral rich state of Odisha.

Currently the major commodities handled in the port are coal and POL. Roughly 23 MTPA of coal is exported from the port and is coastally shipped to the South and the Western hinterlands of the country. Additionally, the port imports around 16 MTPA of POL primarily to serve the IOCL refineries at Paradip and Haldia.

6.2 Major Commodities and their Projections

6.2.1 Coal

Coal deposits are mainly confined to eastern and south central parts of the country. The states of Jharkhand, Odisha, Chhattisgarh, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra account for nearly all of the total coal reserves in the country. The State of Jharkhand is the largest producer of coal in the country as of March 2014 followed by Odisha and Chhattisgarh. Since one of the key objectives of Sagarmala is optimizing logistics efficiency for mega-commodities, the main focus area is thermal coal.

Presently, the power plants located in Maharashtra consume the highest quantity of coal- about 77 MTPA, followed by power plants in Chhattisgarh and Uttar Pradesh, at 62 MTPA and 60 MTPA respectively. Overall, ten states account for more than 80% of current thermal coal requirement for power generation in India as shown in **Figure 6.1**.

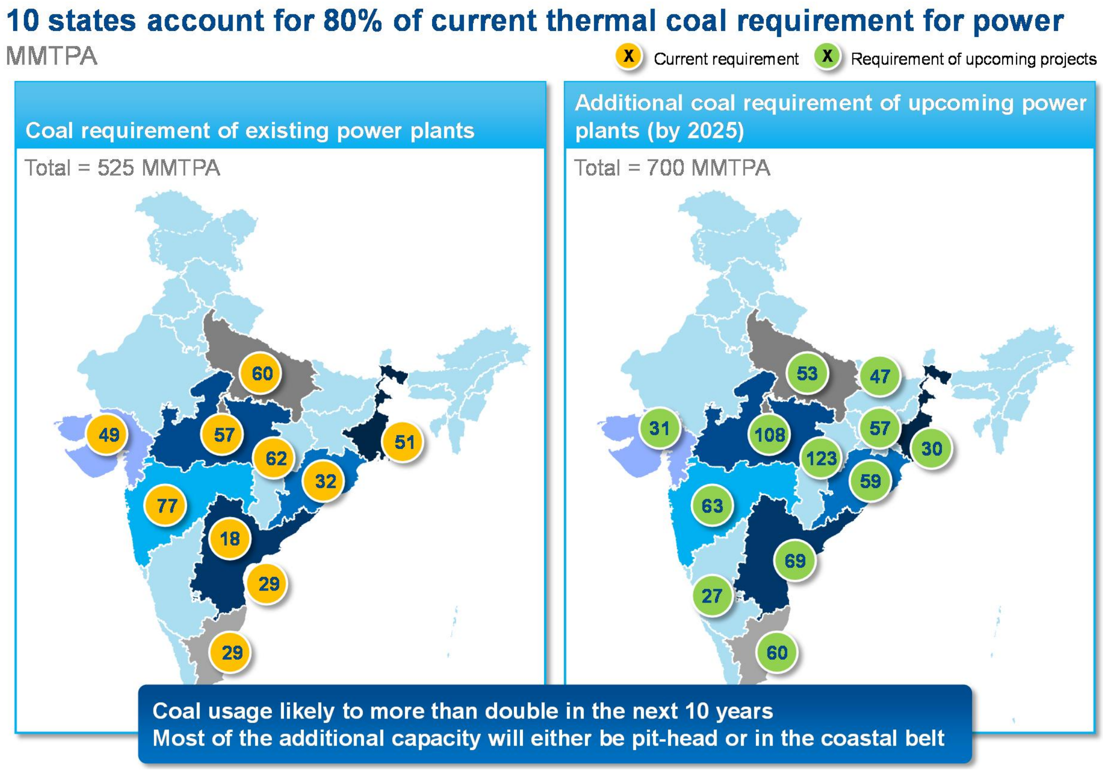


Figure 6.1 **Thermal Coal Requirement of Existing and Upcoming Power Plants**

Therefore, while coal production is concentrated mostly in Eastern and Central parts of India, it is transported for power generation to nearly all corners of the country as shown in **Figure 6.2**. For example, 26 MTPA is sent from Odisha to Tamil Nadu. Similarly, volumes of coal also move from Chhattisgarh to Maharashtra (19 MTPA) and Gujarat (14 MTPA). Coal imported from Indonesia and South Africa arrives at various ports and then moves inland.

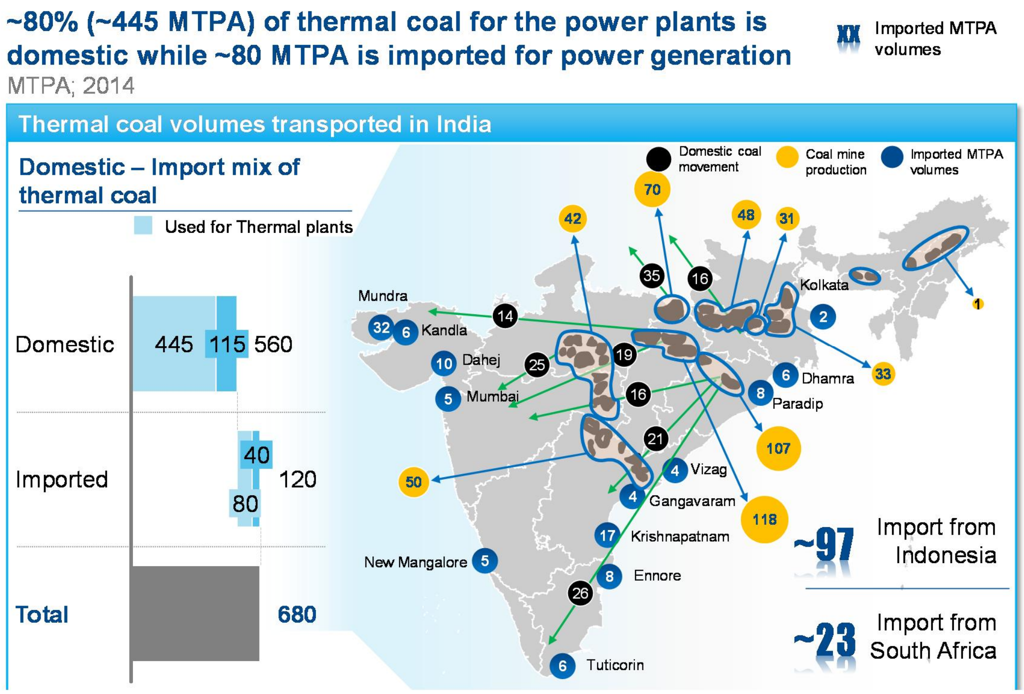


Figure 6.2 Current Coal Movement

Rail is currently the preferred mode with 61% share in overall domestic volume movement, while coastal shipping has a negligible share. Rail freight is INR 1.2-1.5 per tonne-km for coal movement; the same for coastal shipping is nearly one-sixth as shown in **Figure 6.3** .

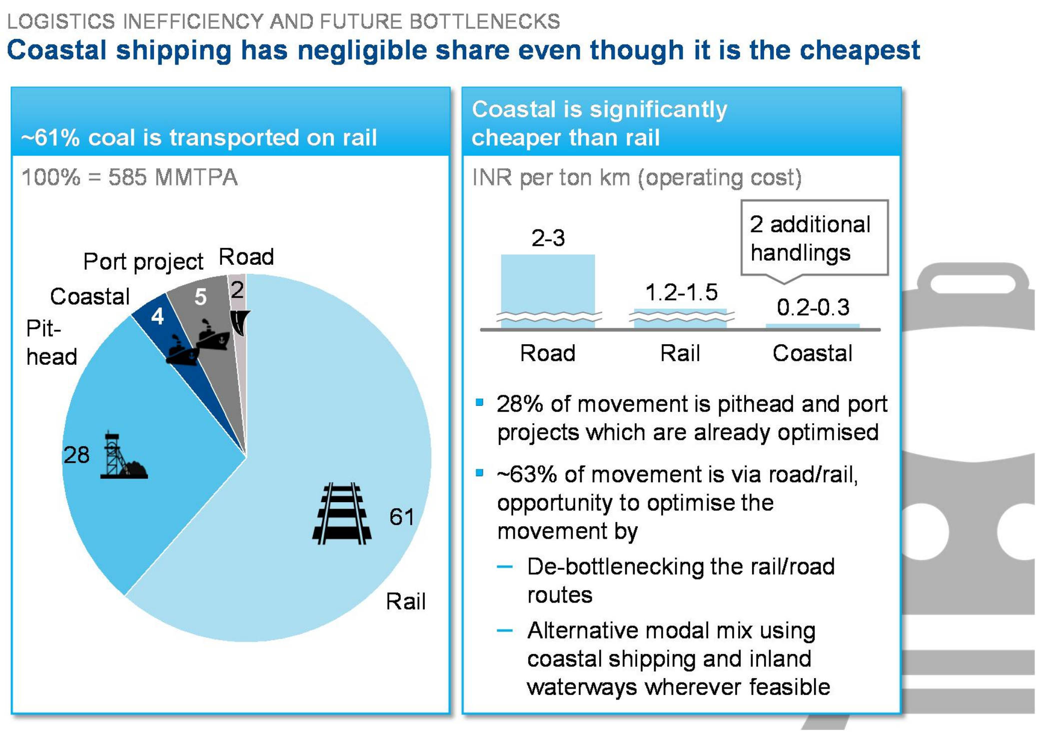


Figure 6.3 Coal Movement by Road Rail and Coastal Shipping

Further, the current rail network is already congested and industry experts believe that it cannot suffice for the future freight load projected due to growth in power generation facilities and industrial corridors. Congested rail lines cause high dwell time, resulting in an average freight speed of only 25 kmph. More than 90 per cent of rail routes relevant for coal movement have more than 100% utilisation as shown in **Figure 6.4**.

Ports are facing severe shortage of rolling stock, which causes overstocking of coal the ports and using of sub-optimal methods of conventional handling and road transportation. The expansion of rail network is slow to keep up with coal capacity needed. In the past few years rail network has only grown at 0.7 per cent year on year.

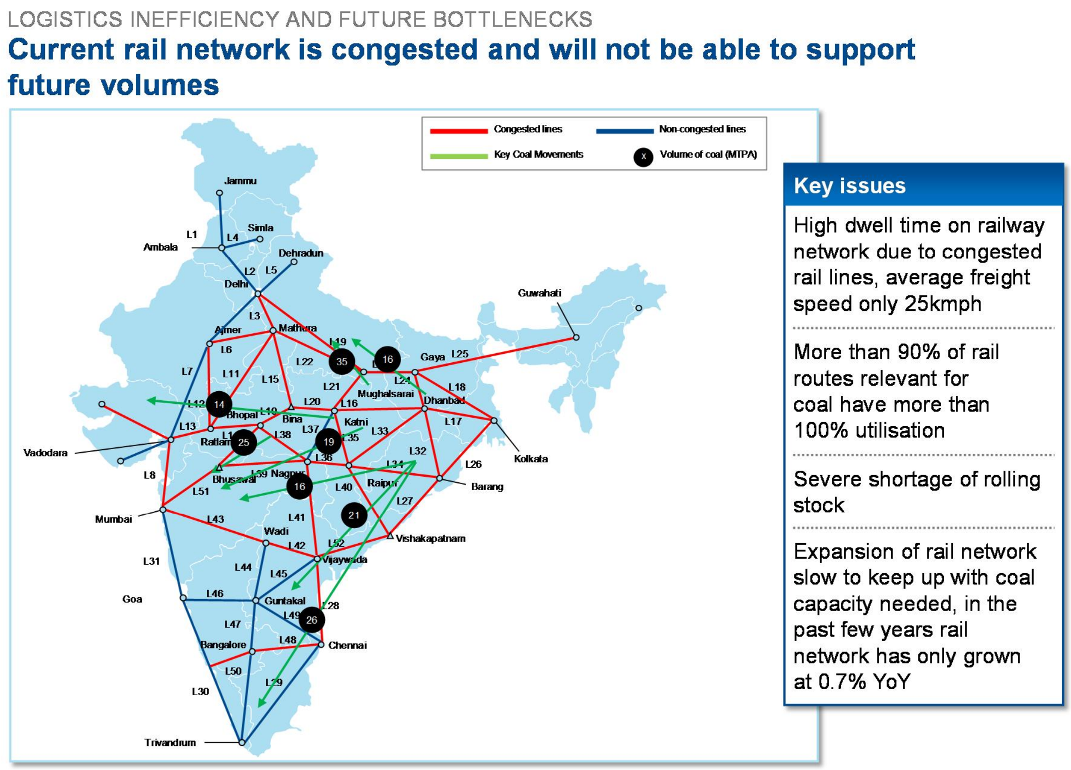
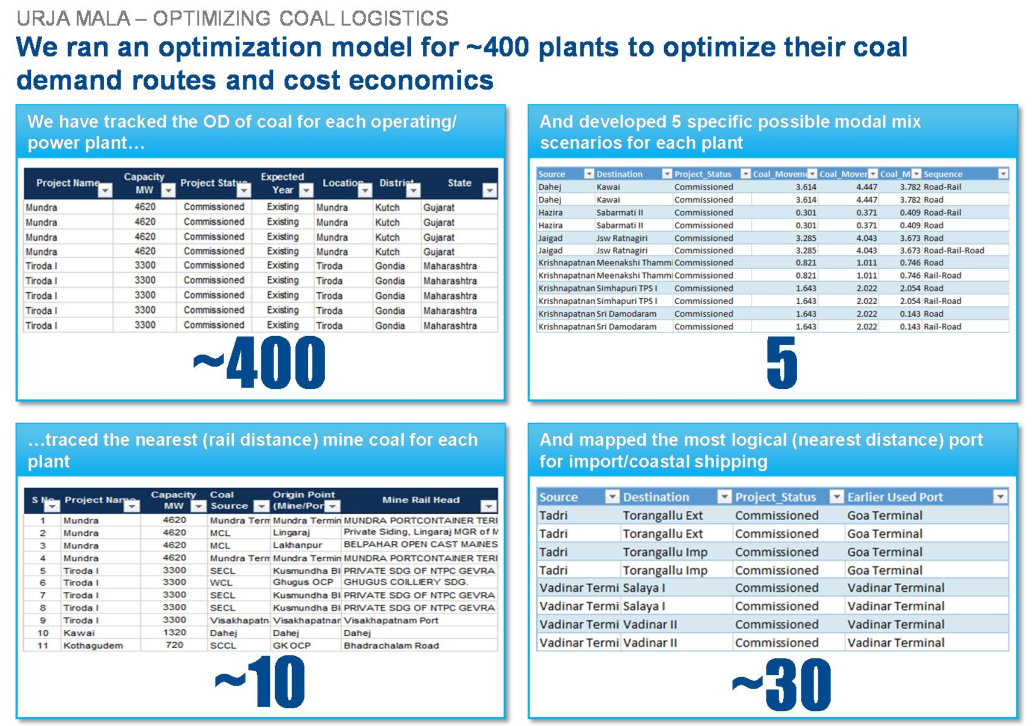


Figure 6.4 **Current Rail Network**

While rail is the primary mode of transport used for long distance coal movement currently, analysis based on research data and industry expert opinions indicate that there is a significant cost reduction potential in causing a modal mix shift towards coastal shipping. Therefore, focus on coastal shipment of thermal coal has been identified as a key component of the overall Sagarmala vision.

An in-depth study was conducted across 400 operational thermal power plants in the country to examine the origination, destination and mode of coal movement used presently as shown in **Figure 6.5**. At the same time, a cost comparison of all possible combinations of modal mix under different scenarios of vessel capacity was also done as shown in **Figure 6.6**. For example, for movement between Talcher in Orissa to a power plant at Mundra port in Gujarat, the cost for movement via rail is INR 2,980 per ton while the same via rail supported coastal shipping could be much lower at INR 1,320 per ton (i.e. a potential cost saving of as high as 56 per cent).



Project Name	Capacity MW	Project Status	Expected Year	Location	District	State
Mundra	4620	Commissioned	Existing	Mundra	Kutch	Gujarat
Mundra	4620	Commissioned	Existing	Mundra	Kutch	Gujarat
Mundra	4620	Commissioned	Existing	Mundra	Kutch	Gujarat
Mundra	4620	Commissioned	Existing	Mundra	Kutch	Gujarat
Tiroda I	3300	Commissioned	Existing	Tiroda	Gondia	Maharashtra
Tiroda I	3300	Commissioned	Existing	Tiroda	Gondia	Maharashtra
Tiroda I	3300	Commissioned	Existing	Tiroda	Gondia	Maharashtra
Tiroda I	3300	Commissioned	Existing	Tiroda	Gondia	Maharashtra
Tiroda I	3300	Commissioned	Existing	Tiroda	Gondia	Maharashtra

Source	Destination	Project_Status	Coal_Moveme	Coal_Mover	Coal_M	Sequence
Dahej	Kawai	Commissioned	3.614	4.447	3.782	Road-Rail
Dahej	Kawai	Commissioned	3.614	4.447	3.782	Road
Hazira	Sabarmati II	Commissioned	0.301	0.371	0.409	Road-Rail
Hazira	Sabarmati II	Commissioned	0.301	0.371	0.409	Road
Jaigad	Jsw Ratnagiri	Commissioned	3.285	4.043	3.673	Road
Jaigad	Jsw Ratnagiri	Commissioned	3.285	4.043	3.673	Road-Rail-Road
Krishnapatnan	Meenakshi Thammi	Commissioned	0.821	1.011	0.746	Road
Krishnapatnan	Meenakshi Thammi	Commissioned	0.821	1.011	0.746	Rail-Road
Krishnapatnan	Simhapuri TPS I	Commissioned	1.643	2.022	2.054	Road
Krishnapatnan	Simhapuri TPS I	Commissioned	1.643	2.022	2.054	Rail-Road
Krishnapatnan	Sri Damodaram	Commissioned	1.643	2.022	0.143	Road
Krishnapatnan	Sri Damodaram	Commissioned	1.643	2.022	0.143	Rail-Road

S No.	Project Name	Capacity MW	Coal Source	Origin Point (Mine/Por	Mine Rail Head
1	Mundra	4620	Mundra Term	Mundra Termin	MUNDRA PORTCONTAINER TERI
2	Mundra	4620	MCL	Lingaraj	Private Siding, Lingaraj MGR of M
3	Mundra	4620	MCL	Lakhanpur	BELPAHAR OPEN CAST MAINES
4	Mundra	4620	Mundra Term	Mundra Termin	MUNDRA PORTCONTAINER TERI
5	Tiroda I	3300	SECL	Kusmundha Bl	PRIVATE SDG OF NTPC GEVRA
6	Tiroda I	3300	WCL	Ghugus OCP	GHUGUS COILLIERY SDG.
7	Tiroda I	3300	SECL	Kusmundha Bl	PRIVATE SDG OF NTPC GEVRA
8	Tiroda I	3300	SECL	Kusmundha Bl	PRIVATE SDG OF NTPC GEVRA
9	Tiroda I	3300	Visakhapatn	Visakhapatnar	Visakhapatnam Port
10	Kawai	1320	Dahej	Dahej	Dahej
11	Kothagudem	720	SCCL	GK OCP	Bhadrachalam Road

Source	Destination	Project_Status	Earlier Used Port
Tadri	Torangallu Ext	Commissioned	Goa Terminal
Tadri	Torangallu Ext	Commissioned	Goa Terminal
Tadri	Torangallu Imp	Commissioned	Goa Terminal
Tadri	Torangallu Imp	Commissioned	Goa Terminal
Vadinar Termi	Salaya I	Commissioned	Vadinar Terminal
Vadinar Termi	Salaya I	Commissioned	Vadinar Terminal
Vadinar Termi	Vadinar II	Commissioned	Vadinar Terminal
Vadinar Termi	Vadinar II	Commissioned	Vadinar Terminal

Figure 6.5 Optimization Model for Coal Logistics

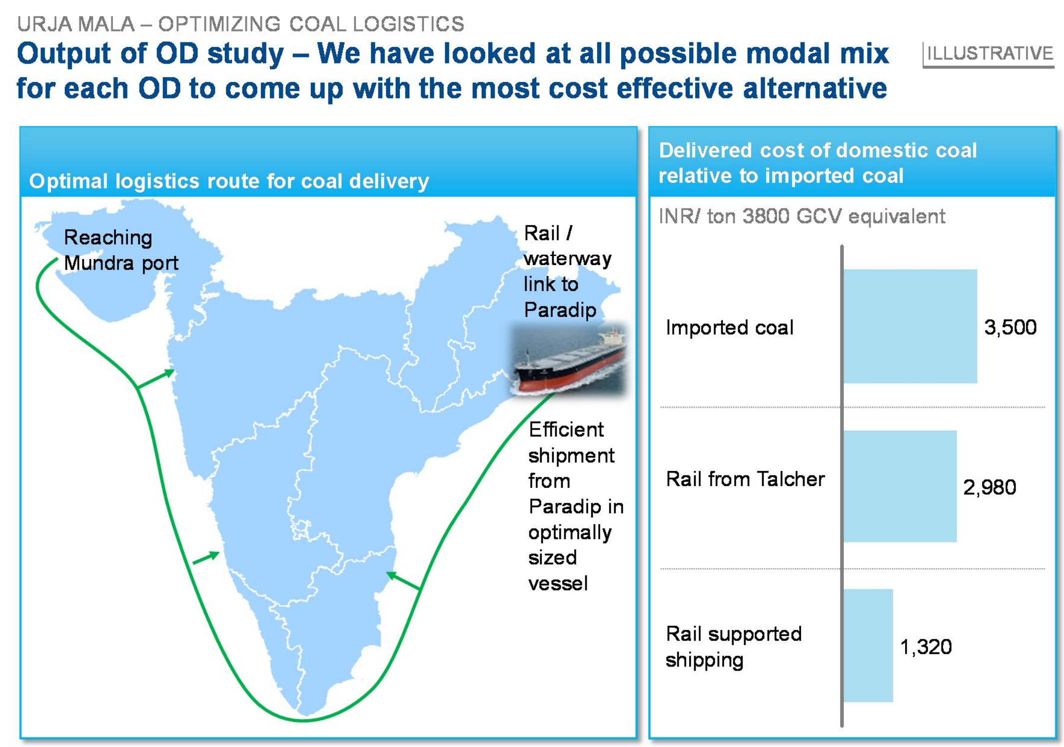


Figure 6.6 Output of O-D Study

Eventually, coastal shipping potential has been identified for ~130 MTPA of thermal coal. In some cases, the cost economics give a very marginal advantage to coastal shipment, but overall railway congestion implies that there still may be a case for coastal shipment to be undertaken in such plants. Even in a conservative scenario, ~80 MTPA of thermal coal can be coastally shipped. **Table 6.1** provides the list of power plants identified as having the potential to move to coastal shipping.

Table 6.1 List of Power Plants with Coastal Shipping

List of Power Plants with Potential for Coastal Shipping: ~ 130 MTPA

Source	Power Plant	State	Coal Movement at 80% PLF (MTPA)	Capacity (MW)	Status
MCL – Lingaraj	Andhra Pradesh Power Generation Corporation Limited, Dr. N. Tata Rao - Krishna	Andhra Pradesh	8.1	1760	Existing
MCL - Lingaraj	Andhra Pradesh Power Generation Corporation Limited, Rayalseema - Cuddapah	Andhra Pradesh	2.9	1050	Existing
MCL - Lingaraj	Andhra Pradesh Power Generation Corporation Limited, Sri Damodaram - Nellore	Andhra Pradesh	4.6	1600	Existing
MCL - Lakhanpur	Gayatri Projects Limited/Sembcorp Utilities, Thermal Powertech I - Krishnapatnam	Andhra Pradesh	3.0	660	Existing
MCL - Lakhanpur	Gayatri Projects Limited/Sembcorp Utilities, Thermal Powertech I (Partly Commissioned) - Krishnapatnam	Andhra Pradesh	3.0	660	Under construction
MCL - Lingaraj	Meenakshi Energy Private Limited, Meenakshi Thamminapatnam II - Nellore	Andhra Pradesh	3.2	700	Under construction
MCL - Lingaraj	Nagarjuna Construction Company/Gayatri Projects Limited, Muthukur Mandal I - Nellore	Andhra Pradesh	3.0	1320	Under construction
MCL - Lakhanpur	Adani Power Limited, Mundra - Kutch	Gujarat	4.6	990	Existing
MCL - Lingaraj	Adani Power Limited, Mundra - Kutch	Gujarat	4.6	990	Existing
MCL - Samaleswari	Ind Barath Power Infra Limited, Ind Barath Madras I - Tuticorin	Tamil Nadu	3.0	660	Under construction
MCL - Lingaraj	KVK Energy and Infrastructure Private Limited, Nagai - Nagapattinam	Tamil Nadu	1.4	300	Under construction
MCL - Hingula-II	National Thermal Power Corporation Limited/Tamilnadu Electricity Board, Vallur I - Thiruvallur	Tamil Nadu	6.9	1500	Existing
MCL - Hingula-II	Neyveli Lignite Corporation Limited/Tamilnadu Electricity Board, Tuticorin NLC - Tuticorin	Tamil Nadu	2.3	500	Existing
MCL - Samaleswari	Neyveli Lignite Corporation Limited/Tamilnadu Electricity Board, Tuticorin NLC (Partly Commissioned) - Tuticorin	Tamil Nadu	2.3	500	Under construction
MCL - Lakhanpur	OPG Power Gen Limited, Chennai I - Thiruvallur	Tamil Nadu	0.4	77	Existing
MCL - Lakhanpur	OPG Power Gen Limited, Chennai II - Thiruvallur	Tamil Nadu	0.4	77	Existing
MCL - Lakhanpur	OPG Power Gen Limited, Chennai III - Thiruvallur	Tamil Nadu	0.4	80	Existing
MCL - Jagannath/Jagannath Extn.	Tamilnadu Electricity Board, Ennore - Thiruvallur	Tamil Nadu	2.1	450	Existing
Mandakini B - Mandakini B	Tamilnadu Electricity Board, Ennore II - Thiruvallur	Tamil Nadu	3.0	660	Under construction
MCL - Jagannath/Jagannath Extn.	Tamilnadu Electricity Board, Mettur - Salem	Tamil Nadu	6.6	1440	Existing
MCL - Jagannath/Jagannath Extn.	Tamilnadu Electricity Board, North Chennai - Thiruvallur	Tamil Nadu	8.4	1830	Existing
MCL - Jagannath/Jagannath Extn.	Tamilnadu Electricity Board, Tuticorin - Tuticorin	Tamil Nadu	4.8	1050	Existing
	Total		**79.0**		
MCL - Lakhanpur	Andhra Pradesh Power Generation Corporation Limited, Rayalseema IV - Kadapa	Andhra Pradesh	2.8	600	Under construction
MCL - Samaleswari	Hinduja National Power Corporation Limited, Vishakhapatnam - Vishakhapatnam	Andhra Pradesh	4.8	1040	Under construction
MCL - Hingula-II	National Thermal Power Corporation Limited, Simhadri - Krishna	Andhra Pradesh	7.8	1700	Existing
ECL - Khottadih OC	National Thermal Power Corporation Limited, Simhadri - Krishna	Andhra Pradesh	1.4	300	Existing
SECL - Dipka	Gujarat State Electricity Corporation Limited, Gandhi Nagar - Gandhinagar	Gujarat	4.0	870	Existing
SECL - MANIKPUR OC	Gujarat State Electricity Corporation Limited, Sikka Rep. - Jamnagar	Gujarat	2.3	490	Existing
SECL - MANIKPUR OC	OPG Power Gen Limited, Mundra OPG - Kutch	Gujarat	1.4	300	Under construction
MCL - Bharatpur	Karnataka Power Corporation Limited, Bellary Tps - Bellary	Karnataka	2.3	1000	Existing
MCL - Ananta	Karnataka Power Corporation Limited, Raichur - Raichur	Karnataka	2.8	600	Existing
MCL - Bharatpur	Karnataka Power Corporation Limited, Raichur - Raichur	Karnataka	1.2	250	Existing
Pakri Barwadih - Pakri Barwadih	National Thermal Power Corporation Limited, Kudgi I - Bijapur	Karnataka	11.1	2400	Under construction
MCL - Lakhanpur	Indiabulls Power Limited, Nasik I - Nasik	Maharashtra	1.2	270	Existing
SECL - Dipka	Reliance Power, Dhanu - Thane	Maharashtra	2.3	500	Existing
MCL - Lingaraj	Telangana State Power Generation Corporation Limited, Kothagudem II - Khammam	Telangana	2.3	1000	Existing
	Total		**47.7**		

Note: Cases where cost advantage from coastal shipping may be marginal are marked in RED

Based on these projections it was concluded that given Paradip is the nearest port to the cluster of coal mines which are suitable for coastal shipping of coal, Paradip will have a step jump in terms of coastally shipped coal. From the current traffic of 23 MTPA, we can expect traffic of nearly 95 MTPA by 2020, 135-140 MTPA by 2025 and 200 MTPA by 2035. In order to realize this potential many connectivity projects need to be undertaken in order to feed the requisite amount of coal to the port, these projects are discussed in later portions of this report.

6.2.2 Coking Coal

Another major commodity imported in Paradip is coking coal. To service the demand of blast furnace-based steel production, around 60 to 65 MTPA of coking coal is transported in the country, and around 54 MTPA is consumed for the production of steel. Around 80 percent of the coking coal consumed is imported due to insufficient coking coal reserves in India.

Eastern India (West Bengal, Jharkhand, Odisha and Chhattisgarh) is the biggest cluster of steel production in the country with 45 MTPA (around 40 percent) of total installed steel capacity.

While the current coking coal evacuation is facing challenges due to limited availability of rakes at unloading ports and rail line capacity at key train routes around 21 MTPA of new steel capacity at key steel plants (1 MTPA and above blast furnace based) is under construction (**Figure 6.7**) and would need around 18-20 MTPA of coking coal to be evacuated on the same rail routes which are currently running at above 100 percent utilization.

According to estimates, the coking coal demand for steel would reach around 130-140 MTPA in 2035 based on increased steel demand in the country for programs like Make in India and construction impetus. Also, historically the steel growth has been growing faster than GDP with the multiplier being GDP: 1.14. However, it is also important to note that steel being a cyclical industry is subject to ups and downs of the economy.

The evacuation capability at the relevant unloading ports and the railway routes will need to be improved for optimal evacuation of coking coal.

Based on these projections we expect the traffic at Paradip to increase to 16 MTPA in the next 5 years, ~20 MTPA by 2025 and ~30 MTPA by 2035. The growth till 2020 will primarily be driven by the new Tata Kalinganagar plant and the expansion of the Bhushan Steel plant in Meramandali.

Coking coal volumes projected at Paradip port for key steel plants

Steel plants	**Coking coal volume 2020** (MMTPA)
TISCO	0.9
SAIL, Rourkela	2.8
Bhushan steel, Sambalpur	1.4
JSPL, Raigad	0.4
Neelachal Ispat Nigam, Odisha	0.6
Tata, Kalinganagar	3.5
JSPL, Patratu	2.5
Bhushan steel, Meramandali	1.7

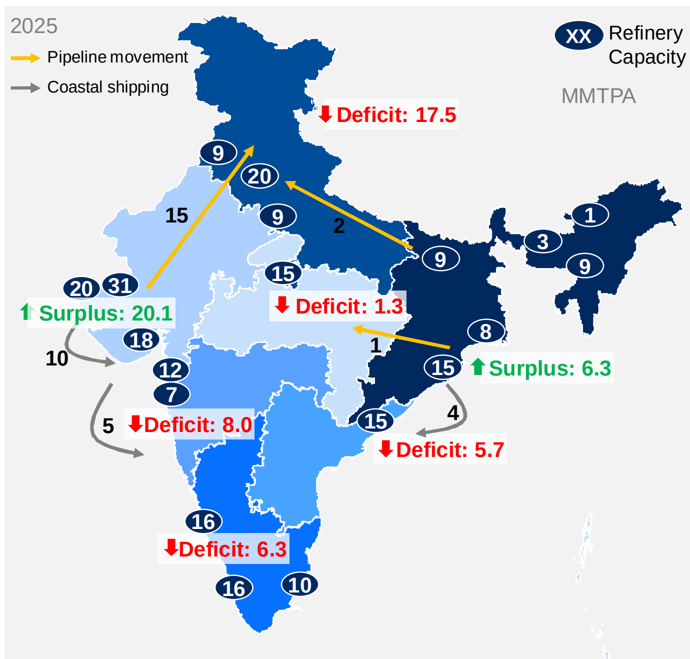
SOURCE: Origin destination analysis

Figure 6.7 Steel Plants relevant for Coking Coal

6.2.3 POL

In addition to coal and coking coal, POL is another key commodity for Paradip port. The port currently handles ~18 MTPA of POL which includes ~16 MTPA of crude import at IOCL refineries and ~2 MTPA of coastal movement of POL products from Paradip. By 2025, crude oil import is expected to rise to ~34 MTPA considering Paradip refinery getting operational. LPG imports are expected to rise considering government's focus on distribution of LPG connections to rural households. Additional 4-5 MTPA of MS/HSD is expected to be coastally shipped from Paradip to cater to the demand of Andhra Pradesh and Telangana as shown in **Figure 6.8**.

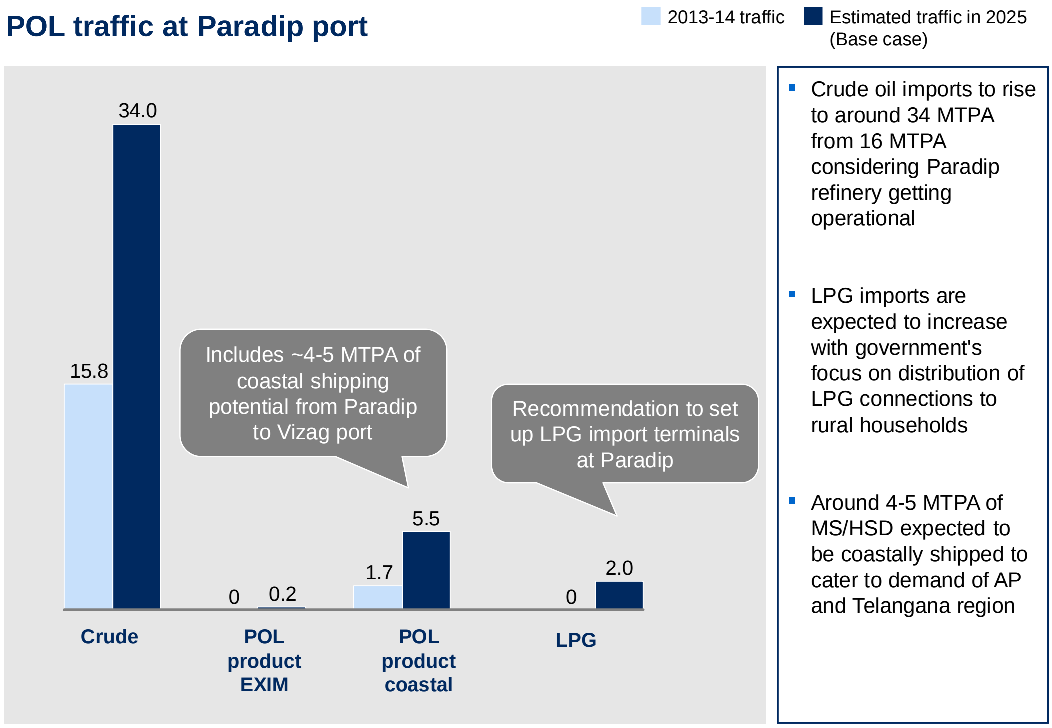
There is a potential for coastal shipping of ~5 MMTPA of MS/HSD from Paradip to Vizag port by 2025



1. Assumes RIL Jamnagar and Essar Oil export nothing while Reliance SEZ exports 100% product

Figure 6.8 Coastal Shipping Possibilities

The split of the current traffic of POL and the projected traffic for 2025 is as shown in **Figure 6.9**.



SOURCE: Indian Petroleum and Natural Gas Statistics 2013-14; Basic Port Statistics of India 2013-14

Figure 6.9 POL Traffic – Paradip Port

6.2.4 Other Commodities

Other key commodities handled at Paradip port include iron ore, limestone, fertilizers, gypsum, etc. In the base case scenario we expect the exports of Iron Ore from the port to be depressed due to the crashing of the global prices and the non-competitiveness of the Indian ore in the export markets.

Fertilizer traffic is also projected to grow to roughly 7 MTPA by 2025 due to the presence of IFFCO and good connectivity to agricultural areas in Bihar and UP. **Table 6.2** summaries the traffic potential for key commodities for Paradip port.

Table 6.2 Paradip Port – Traffic Projections

Paradip Port - Traffic Projections

Units: MMTPA (except Containers)

xx Base Scenario | xx Optimistic Scenario

Commodity	2014-15	2020	2025 (Base)	2025 (Optimistic)	2035 (Base)	2035 (Optimistic)	Remarks
Liquid Cargo							
POL	17.9	35.2	41.8	45.4	47.5	51.2	▪ Mainly Crude oil imports by IOCL Paradip, IOCL Haldia and coastal shipping
Dry and Break Bulk Cargo							
Thermal Coal (Loading)	23	95	135	142	200	201	▪ Driven by coastal shipping from MCL mines
Thermal Coal (Unloading)	7.0	6.0	7.5	8.5	9.0	11.0	▪ Imported Coal for power likely to be reduced as CIL production increases
Coking Coal	7.9	16.3	19.0	21.0	28.0	32.0	▪ TATA Kalinganagar and Bhushan Steel Meramandli expansion
Iron Ore	2.2	6.5	7.5	15.9	10.0	30.1	▪ Mostly exports; likely to remain low. JSW captive berth cargo considered. Optimistic case is related to the volumes handled before ban. Pellets are part of others
Limestone	2.2	3.1	4.3	4.5	7.6	8.8	
Dolomite	0.7	1.0	1.35	1.44	2.4	2.8	
Gypsum	0.8	1.1	1.5	1.6	2.7	3.1	
Fertilizers	4.4	5.6	7.0	7.3	10.5	11.7	
Containers and other Cargo							
Containers (MnTEU)	0.004	0.02	0.10	0.13	0.15	0.18	
Others	4.6	6.1	8.2	8.6	13.6	15.4	▪ Highly fragmented
Total (MMTPA)	**71.0**	**176.2**	**234.8**	**258.4**	**333.8**	**370.1**	

Conversion Factor Used for Containers Projections: 1 TEU = 16.75 Tons

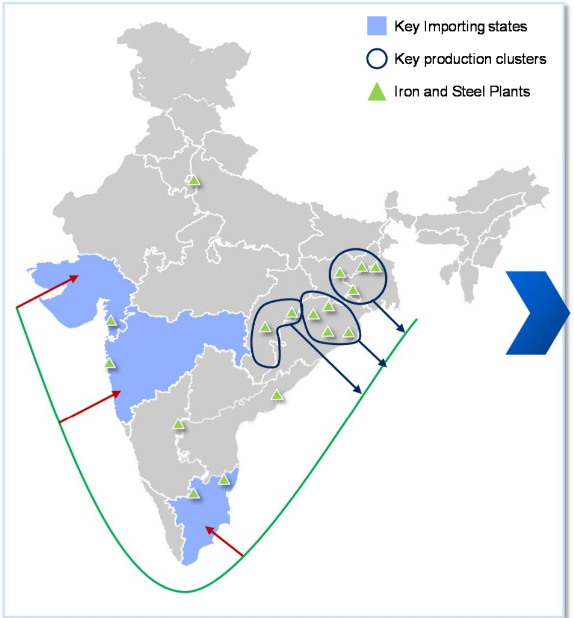
6.2.5 Coastal Shipping Potential

Paradip is strategically positioned to serve large areas in the hinterland of the country through coastal shipping. Steel can be major commodities from Paradip in case coastal shipping revolution takes place in the country.

- **Steel:** 5-6 MTPA of steel can be coastally shipped to demand states of Maharashtra, Tamil Nadu, Andhra Pradesh and Gujarat by 2025. The key plants which will lead to the advent of coastal shipping of steel from Paradip are SAIL Rourkela, BPSL Sambhalpur, BSL Meramandli, JSPL Angul, etc. as shown in **Figure 6.10**.

COASTAL SHIPPING | IRON AND STEEL

~5-6 MTPA of steel can be coastally shipped from Odisha to demand states of Maharashtra, Gujarat, AP and TN by 2025



Key plants with coastal shipping potential from Paradip Port

Plant	Location	Volume Potential to shift to coastal (in MTPA)
SAIL	Rourkela	1.3-1.4
BPSL	Sambalpur	0.4-0.5
BSL	Meramandali	0.9-1.0
JSPL	Angul	0.8-0.9
Tata Steel	Kalinganagar	0.4-0.5
NINL	Duburi	0.4-0.5

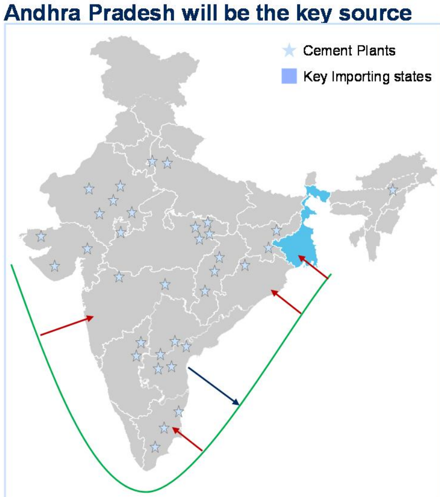
SOURCE: DGCIS data 2013-14; Team analysis

Figure 6.10 Coastal Shipping - Steel

- **Cement:** 1-2 MTPA of cement can be coastally shipped to Paradip port from Andhra Pradesh by 2025 as shown in **Figure 6.11** and **Figure 6.12.** Additional ~2.5 MTPA can be coastally shipped from the proposed cement cluster in AP by 2025 if the central AP port comes up.

COASTAL SHIPPING | CEMENT

~ 1-2 MTPA of cement can be coastally shipped to Paradip Port by 2025; Andhra Pradesh will be the key source



Key ODs with coastal shipping potential to Paradip Port

Route	Volume, '000 TPA
Andhra Pradesh to Odisha	1,690

SOURCE: DGCIS data 2013-14

Figure 6.11 Coastal Shipping – Cement

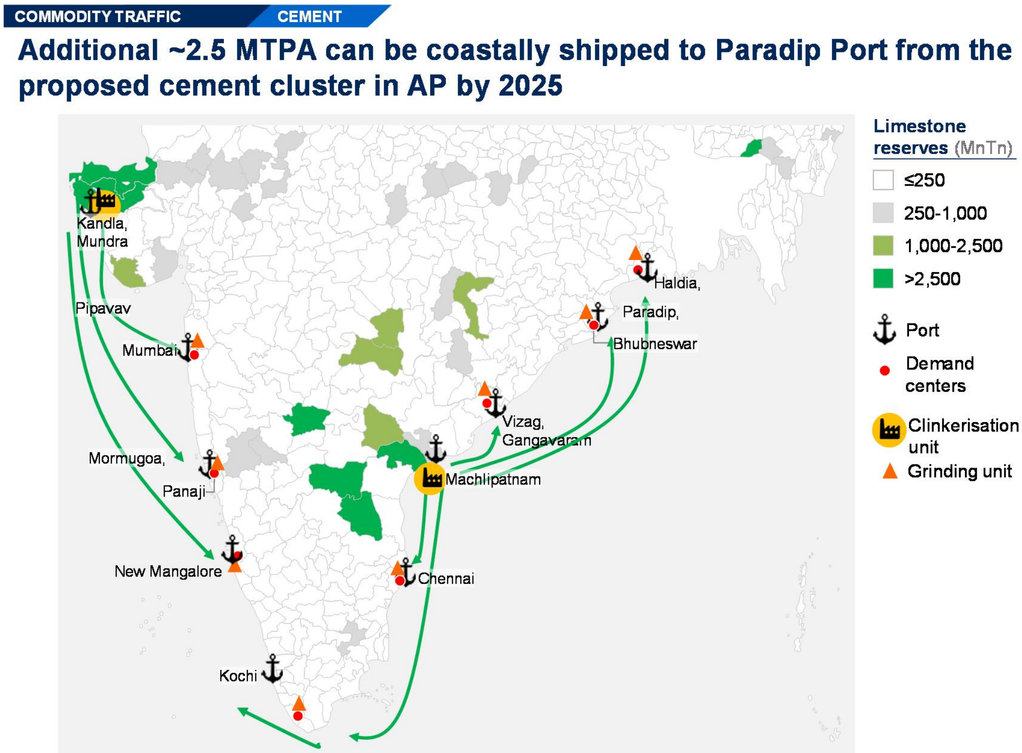


Figure 6.12 Coastal Shipping – Cement Cluster

- **Fertilizers:** ~1 MTPA of fertilizers can be coastally shipped from Paradip port by 2025 to Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra as shown in **Figure 6.13**.

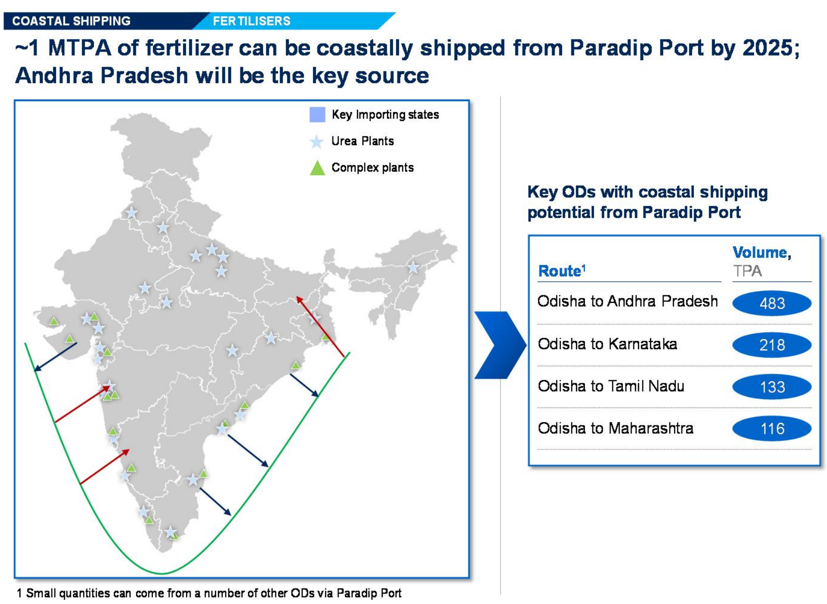


Figure 6.13 Coastal Shipping – Fertiliser

Table 6.3 summarizes the potential of coastal movement for key commodities.

Table 6.3 Paradip Port – Coastal Shipping Opputunity

Paradip Port – New Opportunities Possible via Coastal Shipping

Units: MMTPA (except Containers)

Commodity	2020	2025	2035
Steel (Loading)	3.91	5.23	9.37
Steel (Unloading)	0.50	0.67	1.19
Cement (Loading)	0.01	0.01	0.02
Cement (Unloading)	1.27	4.2	5.5
Fertilizer (Loading)	0.87	1.06	1.57
Fertilizer (Unloading)	0.39	0.47	0.70
Food Grains (Loading)	0.40	0.49	0.72
Food Grains (Unloading)	-	-	-

- 2.5 MMTPA can be shipped from Central AP cement cluster (If Central AP port comes up)

7.0 CAPACITY AUGMENTATION REQUIRMENTS

7.1 Port Capacity after On-Going Developments

The capacity of the existing berths and that of proposed berths have been worked out and the same is presented in **Table 7.1**.

Table 7.1 Existing and Proposed Capacity of Berths (MTPA)

Area of Expansion	Cargo Handled	I/E	Current Capacity	Additional Capacity after Debottlenecking	Addition with Upcoming New Facility / Mechanisation	Total Capacity
MCHP	Coal - Export	E	23.50	-	-	23.5
EQ1,2,3	Coal - Export	E	9.69	-	20.31	30.0
CQ1,2	Coal – Import	I	12.10	-	7.90	20.0
IOB	Iron Ore	E	6.39	-	-	6.39
Southern Quay	Breakbulk	I/E	4.76	-	-	4.76
FB1,2	Fertiliser	I	7.50	-	-	7.50
North Oil Jetty	Crude/ HSD	I	7.50	-	-	7.50
CQ 3	Dry bulk	E	6.55	-	-	6.55
MPB		I/E	3.45	-	-	3.45
Essar Coal Berth	Coal	I	-	-	10.00	10.00
JSW Iron Ore berth	Iron ore	E	-	-	10.00	10.00
South Oil Jetty (IOCL New Oil Jetty)	Crude	I	10	-	-	10.00
New MPB	Clean Cargo	I/E	-	-	5	5.00
3 SBM (IOCL)	POL	I/E	37.0			37.00
Total Capacity (MTPA)			**128.44**	**0**	**53.21**	**181.65**

It may be noted that the capacity of the berths has been worked out based on the allowable level of berth occupancy so as to limit the waiting time of ships and also allow sufficient time for the repair and maintenance of handling equipment.

7.2 Requirement for Capacity Expansion

While comparing the existing and planned capacities for the Paradip port with the traffic projections as shown in **Table 7.2** it could be seen that by 2020 there would be a shortfall of capacity for the thermal coal export.

It is therefore necessary that action be initiated immediately for the capacity augmentation of handling bulk export cargo and other cargo so that the projected could be completed by year 2020.

In addition to that there is likely to be significant demand for berths for Breakbulk and other cargo.

Table 7.2 Additional Need in Capacity by 2020, 2025 and 2035

Cargo Handled	I/E	Current Capacity (MTPA)	2020		2025		2035	
			Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)
Coal - Export	E	33.21	95.00	61.79	135.00	101.79	200.00	166.79
Coal – Import	I	12.10	22.30	10.20	26.50	14.40	37.00	24.90
Breakbulk	I/E	14.76	11.64	0.00	17.03	2.27	28.81	14.05
Iron Ore	E	6.39	6.50	0.11	7.50	1.11	10.00	3.61
Fertiliser	I	7.50	5.60	0.00	7.00	0.00	10.50	3.00
Crude/ POL	I	54.50	35.20	0.00	41.80	0.00	47.50	0.00
Total		**128.46**	**176.24**	**72.10**	**234.83**	**119.57**	**333.81**	**212.35**

8.0 PORT CONNECTIVITY AND INFRASTRUCTURE

8.1 Constraints in Rail and Road Connectivity to the Port

8.1.1 General

The current cargo receipt/evacuation modal split is shown in **Figure 8.1**.

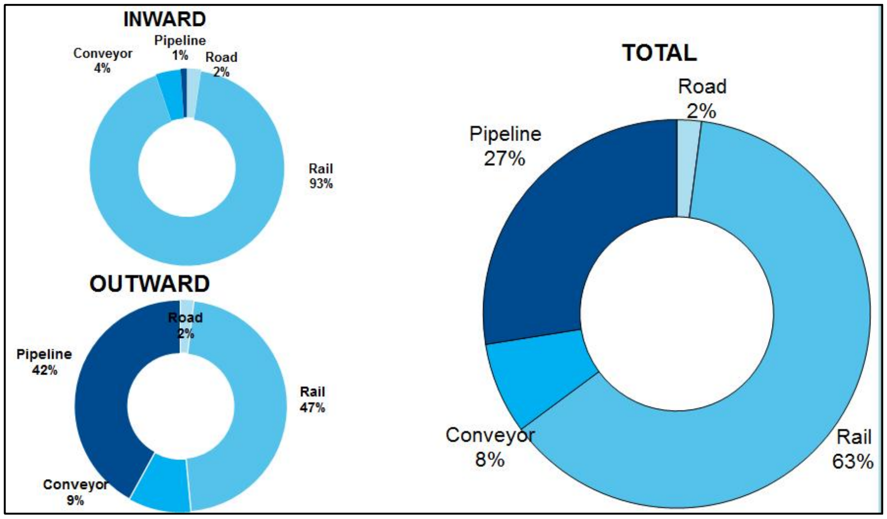


Figure 8.1 Evacuation Modal Spilit

It could be seen that railway is the key for receipt /evacuation of cargo to/from port of the current cargo. Considering that the future traffic projections are also mainly for the bulk commodities, railway shall continue to play the key role for the port infrastructure.

8.1.2 Road Connectivity

Paradip Port is connected by NH-5A (4 lane) and SH-12 (2 lane) to Chandikhole and Cuttack respectively. During the iron ore boom period NH-5A witnessed frequent congestion; however the same seems to be eased out for the time being. With the growth in traffic of breakbulk and containers over a period of time, congestion on NH-5A would increase requiring additional lane to be provided. The existing 4 lane road can be upgraded to 6 lane road by NHAI with equity contribution from PPT and other stakeholders.

Further the junction points near approach to the port need to be widened for smooth traffic flow. Also adequate space for the parking of trucks entering the port needs to be provided.

8.1.3 Rail Connectivity

Thermal coal is the key cargo being brought to Paradip from Talcher. The route details are given below:

- Distance from Talcher to Cuttack is 112 km and that from Cuttack to Paradip is 84 km.
- Presently 20-24 rakes each side totalling to 40 rakes per day are handled.
- The number of outgoing rakes from Talcher currently is of the order of 40 rakes per day (average). Out of these, 20 rakes per day (max.) reach Paradip and balance 20 rakes go to other destinations.

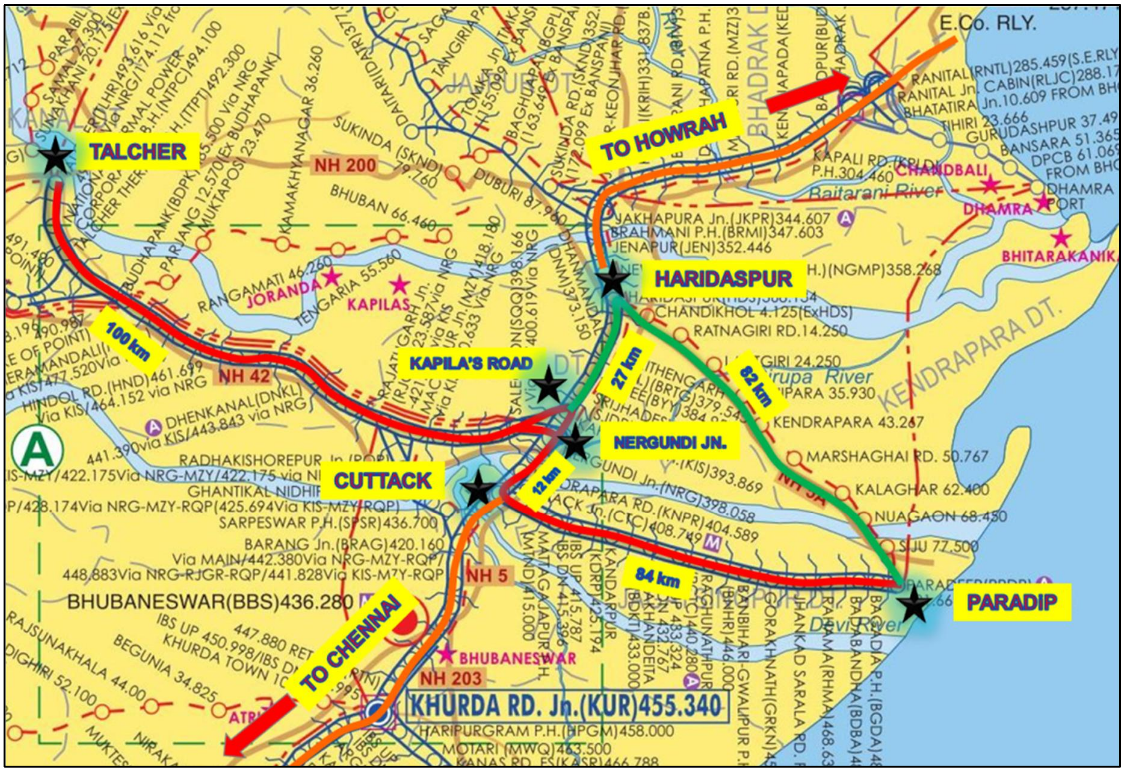


Figure 8.2 **Rail Connectivity**

There are several issues on the effective movement of rakes to the Paradip Port. As could be seen from **Figure 8.2**, the rake movement from Talcher to Paradip involves an overlap with Howrah-Chennai mainline for a stretch of about 41 km between **Talcher – Kapilas Road – Cuttack**. Passenger trains between Howrah- Chennai stretch is given priority over coal rakes and therefore an exclusive **single line between Kapilas Road – Cuttack** is needed.

There are many other lines between Talcher and Cuttack, as shown in **Figure 8.3** which are over utilised and the work for their upgradation is in progress.

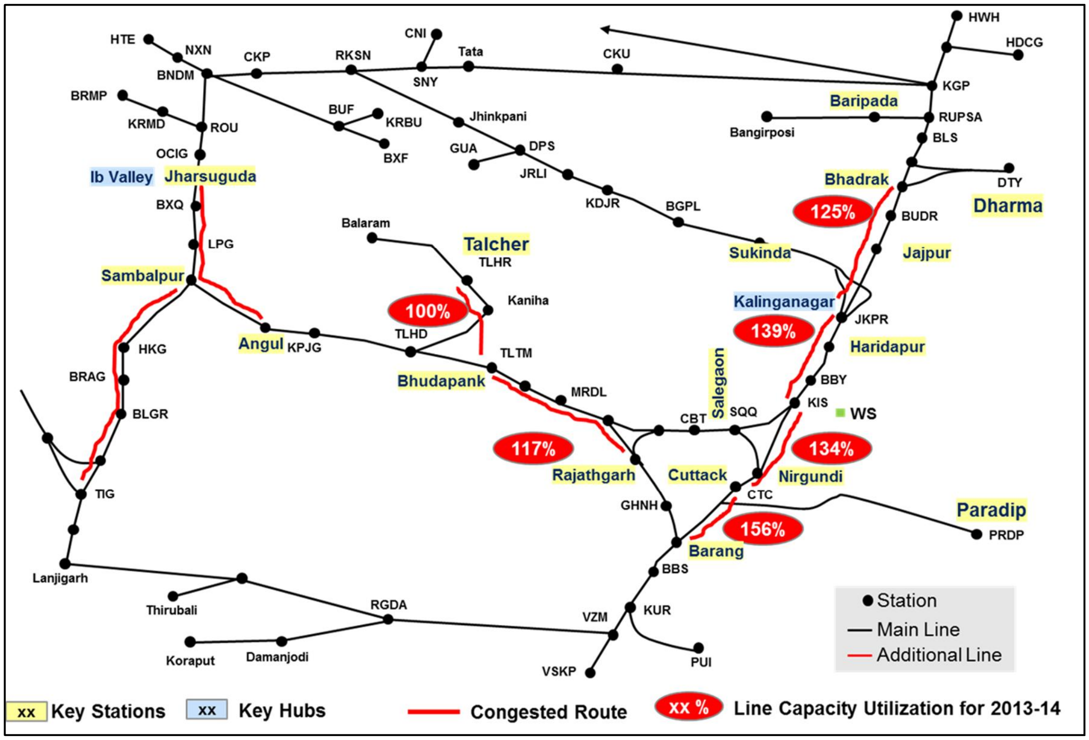


Figure 8.3 Key Rail Routes Between Talcher/Ib Valley and Paradip/Dharma

Some interventions required for effective transfer of coal mined from Talcher and Ib Valley to Paradip is presented in **Figure 8.4**.

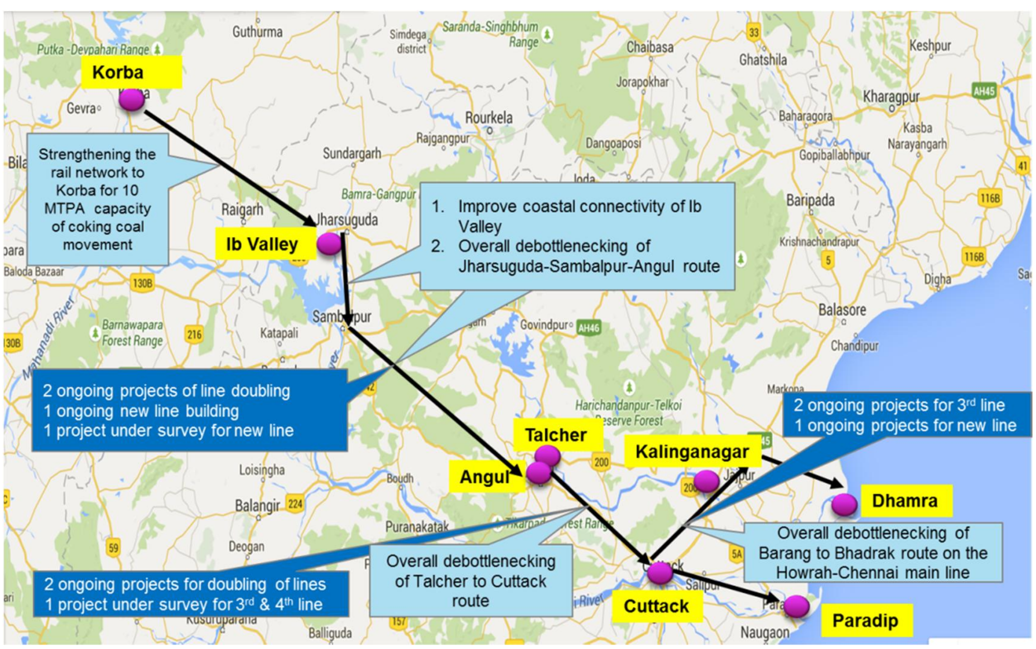


Figure 8.4 Interventions required for Effective Transfer of Coal Mined from Talcher and Ib Valley to Paradip

Many of the rail upgradation projects are already in progress with the current status as shown in **Table 8.1**.

Table 8.1 Status of Rail Evacuation Projects Critical to Coastal Coal Movement

S. No.	Project Name	Project Status
1.	IB Signalling in Talcher-Cuttack-Paradip route for 192 km	Completed
2.	New Line from Haridaspur - Paradip (82 km)	Completion by 2017
3.	New Line from Angul - Sukhinda road (99 km)	Completion by 2016
4.	Doubling of line from Titlagarh - Sambalpur	Completion by 2017
5.	Doubling of line from Sambalpur - Talcher	Completion by 2018
6.	Doubling of line from Rajathgarh - Barang	Completion by 2016
7.	Doubling of line from Barang - Cuttack	Completed
8.	Budhapank - Salegaon via Rajathgarh (3rd and 4th Lane)	To be started post financial closure. Critical Project
9.	Third lane from Bhadrak - Nergundi	Status to be confirmed
10.	Third lane from Jakhapura - Haridaspur	Status to be confirmed
11.	Increase track weight handling capacity from 22.5 to 25 T axle load	Completion in 4-5 years
12.	Build long haul loop for 192 km on Paradip- Talcher route	Completion in 4-5 years
13.	Bypass railway line from Salegaon to Kandarapur	DPR in progress

With the completion of above projects the total rake movement could go up to about 80 rakes per day each way. To further increase the capacity of coal movement through rail, there would be a need to ply a dedicated heavy haul rail line between the mines and port, the feasibility of which has been taken by government in a separate assignment.

At the port end there would be many initiatives required to increase the rake handling capacity and these are discussed in subsequent sections.

8.2 Intersections in Rail & Traffic Conflict

8.2.1 Locations of Intersections

The rail networks inside the Port boundary are grouped into 6 sub-divisions as shown in the **Figure 8.5**. This results in incoming & outgoing traffic crossing each other. Each such conflict slows down the traffic. With the total volume of rail traffic projected in next sections, it is clearly required to remove such traffic conflict as much as possible.

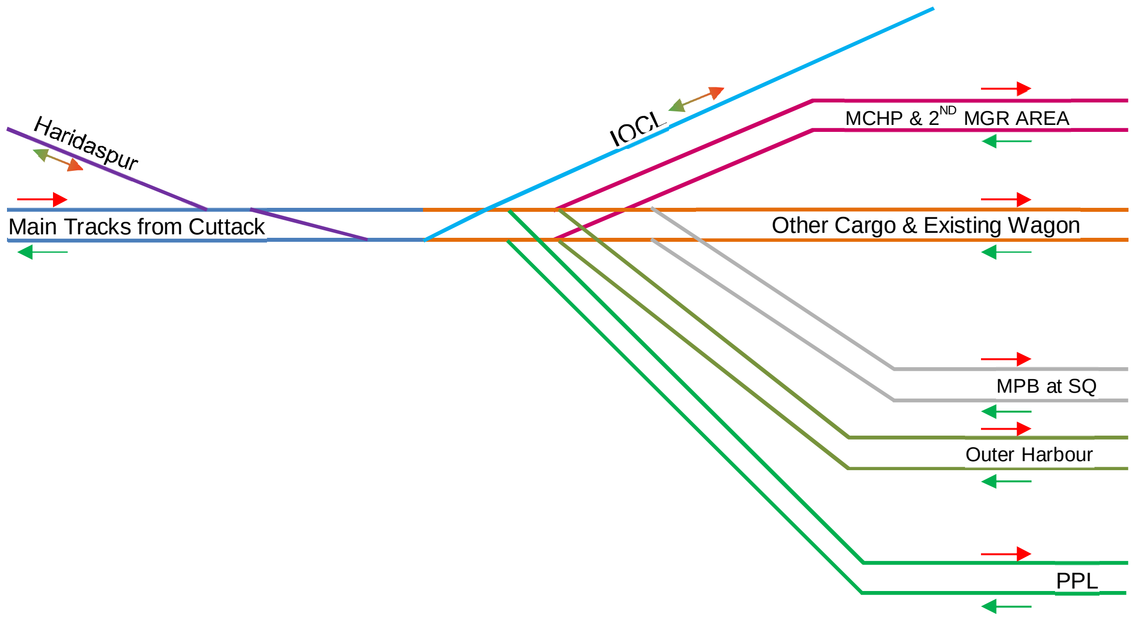


Figure 8.5 Rail Traffic Intersection in Present Scenario

8.2.2 Main Tracks from Cuttack

As per the traffic estimated, the main tracks from Cuttack need to be expanded to 4 (2 up + 2 down) for traffic projections for the year 2025.

Two options for developments are proposed as under:

<u>Option 1</u>: The main line tracks west of Paradip station shall be upgraded to 2 up + 2 down tracks with 2 up tracks on one side & 2 down tracks on the other. Near the PPL Level crossing, one up track has to the raised to pass over the crossing down track (via flyover) and shall come down at the existing exchange yard. Up Traffic for Outer Harbour and MPB at SQ shall be routed through this. Schematic of this option is shown in **Figure 8.6**.

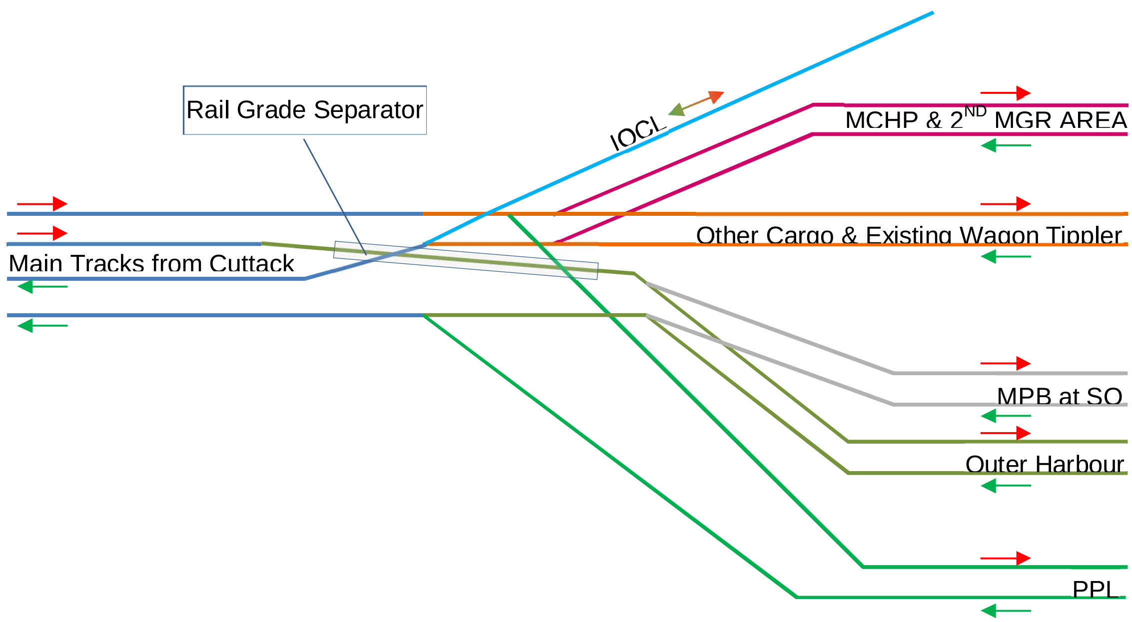


Figure 8.6 Option 1 for Development of Rail Tracks

<u>Option 2</u>: In this option, the new set of up & down tracks shall be laid on one side of the existing tracks. New up track shall be passed over the existing down track at place near Barabandha station and a location & conceptual layout for the same is suggested in **Figure 8.8**.

This option effectively segregates the existing harbour network from outer harbour. The traffic of PPL & MPB at SQ is proposed to be handled by this new network. A schematic of the proposed layout is shown in **Figure 8.7**.

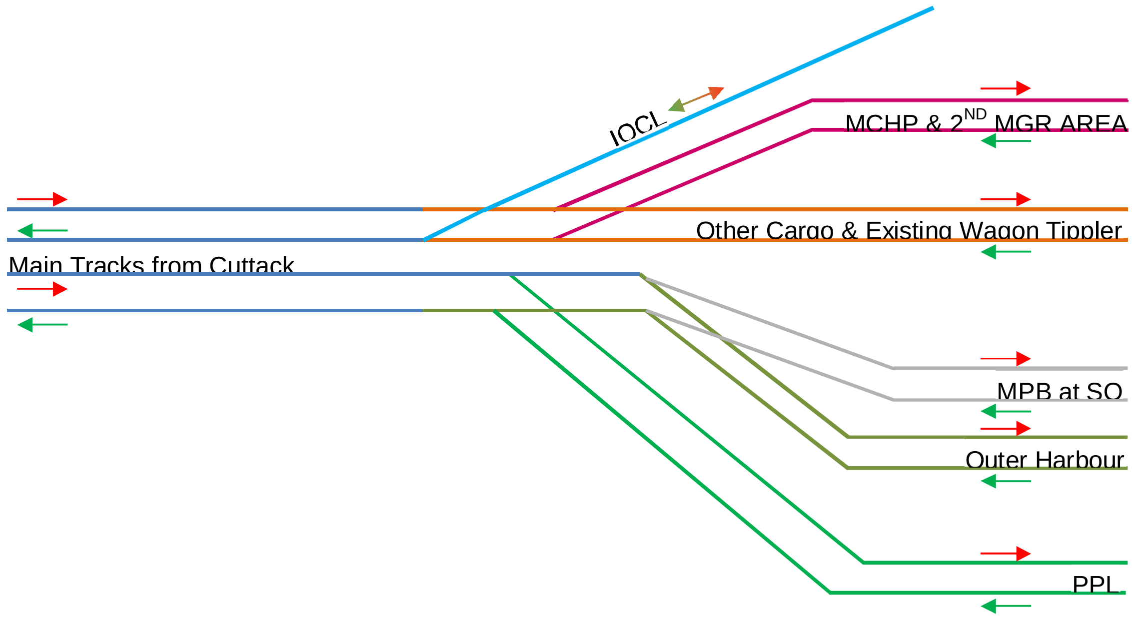


Figure 8.7 Option 2 for Development of Rail Tracks

Figure 8.8 Location and Conceptual Layout of Rail Grade Separator Near Barabandha Station

Table 8.2 Comparison of Two Options

Description	Option 1	Option 2
Traffic Separation of 2 networks	Up/Incoming traffic shall be segregated. However, Down/ Outgoing traffic shall have some intersection remaining (e.g. up PPL traffic shall intersect down traffic from existing harbour).	Up & Down traffic shall be completely segregated.
Location of proposed developments	Other than laying of additional tracks, most of the development works are nearby the Paradip station & Paradip Exchange Yard	Rail Flyover shall be nearby Barabandha Station. Track adjustments at Paradip exchange yard.
Effects to Existing Paradip station	Up ramp for the proposed flyover shall become a visual obstruction in front of the Paradip station.	No effect
Land acquisition	Very minor around Paradip station for the Up ramp. Down ramp will be within Port Land.	Some land may have to be acquired. However, being in the open field and in river plains in uninhibited area, it may not be difficult
Track reconfiguration	Existing main down track shall become main up track. New down tracks shall be laid. All points and exchange tracks have to be suitably relocated/ modified.	Existing up & down tracks shall remain as they are and shall function in the same way too. Only points and exchanges for up traffic leading to PPL is to be shifted to new up track.

8.2.3 Tracks to Haridaspur

Also, the new track from Haridaspur (single track) is planned to connect at the existing dead end near the IOCL Flyover. Then this track shall become connected to the existing main up track. For traffic going to Haridaspur area (imported coal mainly) has to cross-over to the existing up track first before being moved out to the new track. This shall create a major traffic conflict point and needs to be solved.

Figure 8.9 Existing DE for Haridaspur Connectivity

For down traffic to Haridaspur, a separate grade separator flyover is proposed near by the existing DE where the track shall be leading into. Conceptual layout of the same is proposed in **Figure 8.10**. There shall be some land to be acquired for this development. The land marked is seen to be presently unoccupied.

Figure 8.10 Conceptual Layout of Flyover for Down Track to Haridaspur

Figure 8.11 Land on the Other Side of DE for Haridaspur Track

8.3 Internal Rail Connectivity

Material handling in most area of the Port is either already by mechanized means or in the process of mechanization. Proposed new facilities within the existing harbour & new outer harbour are proposed to be fully mechanized. Rated rake handling capacities of various facilities are mentioned in the **Table 8.3** below:

Table 8.3 Rated Rake Handling Capacities of Material Handling Facilities

Facility	Capacity	
	Rakes / day	MTPA
Existing Track Hoppers in MCHP Area – 2 No.	24	30
Existing Wagon Tipplers (T-149 & T-150) – 2 No.	10	12
Proposed Track Hoppers for CQ Mechanization – 2 No.	24	30
Proposed Iron Ore Wagon Tippler for JSW – 1 No.	8	10
Proposed Wagon Loaders for Essar – 1 No.	10	10
Proposed Wagon Loaders for CQ Mechanization – 2 No.	20	20

Proposed facilities for Outer Harbour shall be planned to suit with the traffic demands.

8.3.1 Evaluation of Rail Networks

Overall traffic in the rail network has been calculated and presented in attached, **Table 8.4** & **Table 8.5** for the year 2020 & 2025 respectively.

Table 8.4 Rail Traffic Projections for Year 2020

Commodity	Berth	Projected Traffic (MTPA)	Proportion		Projected Rail Traffic (MTPA)	Type of Rake	Ratio of BOBRN/ BOXN to total	Rakes/day		Probability of backloading	Possible for backloading	Empty Out	Empty In	Effective rakes/day	
			Rail	Road/Conv.				Incoming	Outgoing					Incoming	Outgoing
Existing Harbour															
Coal - Export	CB1, CB2, EQ	65.0	100%	0%	65.0	BOBRN	0.77	40.0		33%	13.3	26.7		40.0	26.7
						BOXN	0.23	12.0		100%	12.0	8.3		12.0	8.3
Coal - Import	ESSAR, CQ	21.3	100%	0%	21.3	BOBRN			13.3					0.0	13.3
						BOXN			3.7					0.0	3.7
Breakbulk	MPB(JMB), CQ3, MPB	11.3	25%	75%	2.8	BCNA		3.4	2.3	60%	2.0	0.9	0.2	3.6	3.2
Iron Ore	JSW	2.8	100%	0%	2.8	BOXN		2.2		100%	2.2	2.2		2.2	2.2
Fertiliser	FB1, FB2	5.6	10%	90%	0.6	BCNA			0.4	100%				0.0	0.4
Outer Harbour															
Coal - Export		30	100%	0%	30.0	BOBRN		24.0		0%	0.0	24.0		24.0	24.0
Coal - Import		0	100%	0%	0.0	BOXN			0.0	0%	0.0		0.0	0.0	0.0
													Total	**81.8**	**81.8**

With Auto-Signalling

Capacity of a track for handling incoming & outgoing rakes 50 /day

No. of tracks required at the entrance to the port 2

Table 8.5 Rail Traffic Projections for Year 2025

Commodity	Berth	Projected Traffic (MTPA)	Proportion		Projected Rail Traffic (MTPA)	Type of Rake	Ratio of BOBRN/ BOXN to total	Rakes/day		Probability of backloading	Possible for backloading	Empty Out	Empty Transfer from/to OH	Empty In	Effective rakes/day	
			Rail	Road/Conv.				Incoming	Outgoing						Incoming	Outgoing
Existing Harbour																
Coal - Export	CB1, CB2, EQ	75.0	100%	0%	75.0	BOBRN	0.77	46.2		33%	15.4	32.2			46.2	32.2
						BOXN	0.23	13.8		100%	13.8		13.8		13.8	0.0
Coal - Import	ESSAR, CQ	17.4	100%	0%	17.4	BOBRN			13.9						0.0	13.9
						BOXN			0.0						0.0	0.0
Breakbulk	MPB(JMB), CQ3, MPB	15.4	25%	75%	3.8	BCNA		3.1	3.1	60%	1.8	0.6		1.2	4.3	3.6
Iron Ore	JSW	2.8	100%	0%	2.8	BOXN		2.2		100%	2.2		2.2		2.2	0.0
Fertiliser	FB1, FB2	8.2	10%	90%	0.8	BCNA			0.7						0.0	0.7
Outer Harbour																
Coal - Export		60	100%	0%	60.0	BOBRN		48.0		0%	0.0	48.0			48.0	48.0
Coal - Import		10	100%	0%	10.0	BOXN			8.0	0%	0.0	8.1	16.1	0.0	0.0	16.1
														Total	114.5	114.5

With Auto-Signalling

Capacity of a track for handling incoming & outgoing rakes 50 /day

No. of tracks required at the entrance to the port 2.0

Overall schematic layout of the future port rail network is presented in **Figure 8.12**. For detailed evaluation of various operational areas of the port rail networks, the entire area is marked up in separate zones; namely:

Zone 1. Exchange Yard for Existing Harbour at Paradip Station (**Figure 8.19**)

Zone 2. Existing MCHP Area & MGR line (**Figure 8.13**)

Zone 3. Proposed BOT Lines and 2nd MGR (Merry-go-round) (**Figure 8.14**)

Zone 4. General Cargo Loading Area (**Figure 8.15** & **Figure 8.16**)

Zone 5. Existing Wagon Tippler & Yard (**Figure 8.17**)

Zone 6. Loading Area for Multi-purpose berth at Southern Dock (**Figure 8.18**)

Zone 7. Outer Harbour MGR (**Figure 8.20**)

Zone 8. Outer Harbour Exchange Yard (**Figure 8.21**)

Rail Traffic for zones 2 till 6 are calculated for all traffic projection years separately.

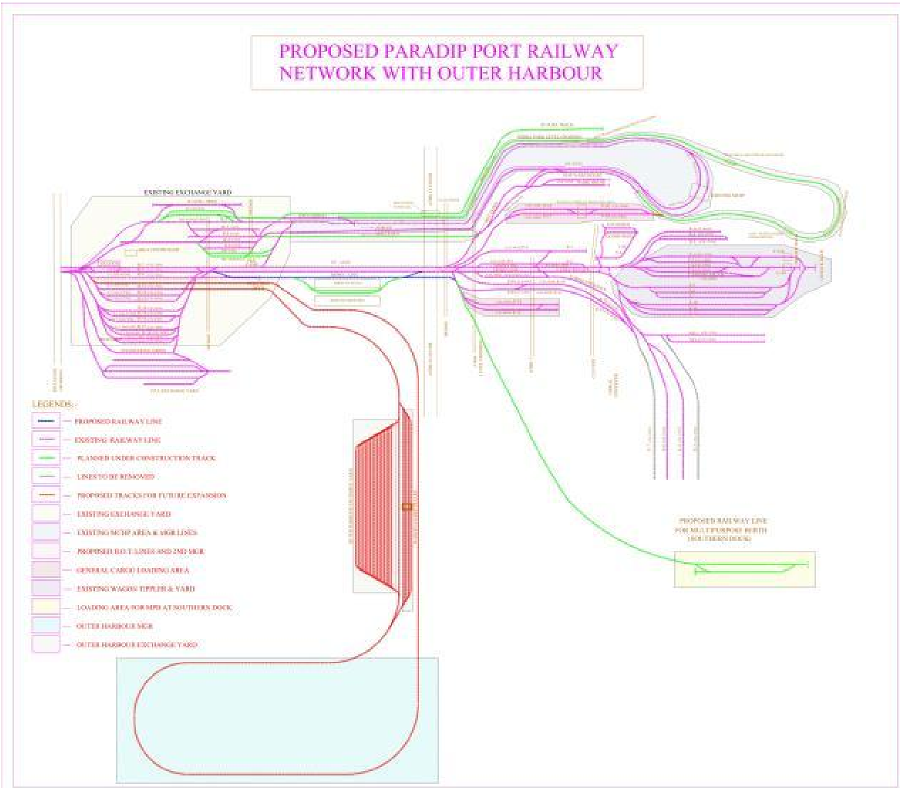


Figure 8.12 Overall Schematic Port Rail Network

8.3.2 Observations from the Calculations

8.3.2.1 Existing MCHP & MGR Lines

Presently the complete circuit from the exchange yard till MCHP area is operated with auto-signalling. The total turnaround time estimated is about 3 hr/rake. Total number of locomotive required is 3 as shown in **Table 8.6**. However, with additional locomotive, more number of rakes can be handled in peak hours.

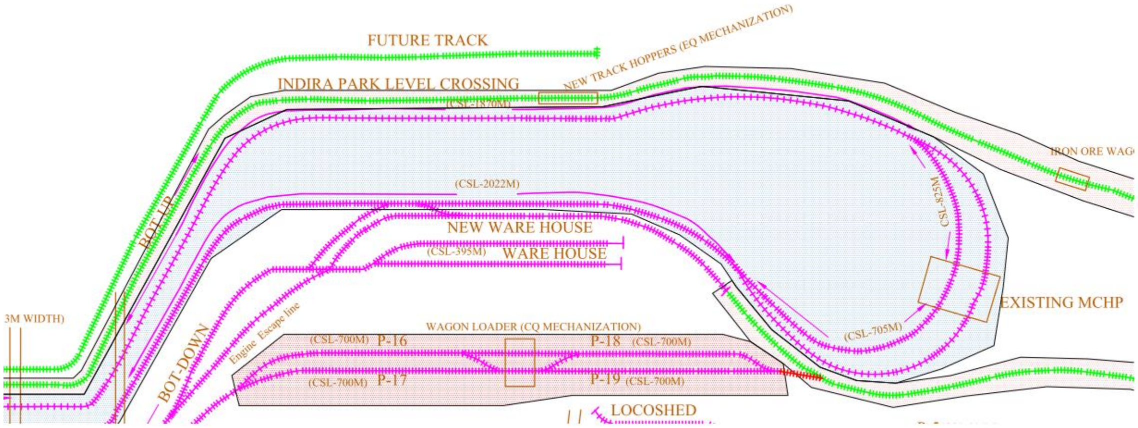


Figure 8.13 Existing MCHP Area & MGR Lines

Table 8.6 Traffic Estimate for Existing MCHP Area

Distance from Receiving yard till Track Hoppers	5.5 km	
Average Driving speed of train in this area	20 km/h	
Engine Exchange time at receiving yard	0.5 hr.	
Time required for traversing receiving yard to hopper	0.28 hr.	
Unloading time at Track Hopper	1.5 hr.	
Time required for traversing hopper to receiving yard	0.28 hr.	
Engine Exchange time at receiving yard	0.5 hr.	
Total turnaround time	3.05 hr/rake	
Number of Locos required	3	
Nr. Sidings required for bunching/peaking	3.13	
Total sidings required at Receiving Yard	3.13 i.e.	4 No.

Presently non-mechanized loading of coal is done on track numbers RRS-3 & RRS-4 (Line No. C18 & C13). Once the BOT Track construction is done, these would become a part of the new MGR tracks. Hence, the non-mechanized loading, if still be required, could be shifted to sidings P-6 & P-7.

8.3.2.2 Proposed BOT Tracks & 2nd MGR Area

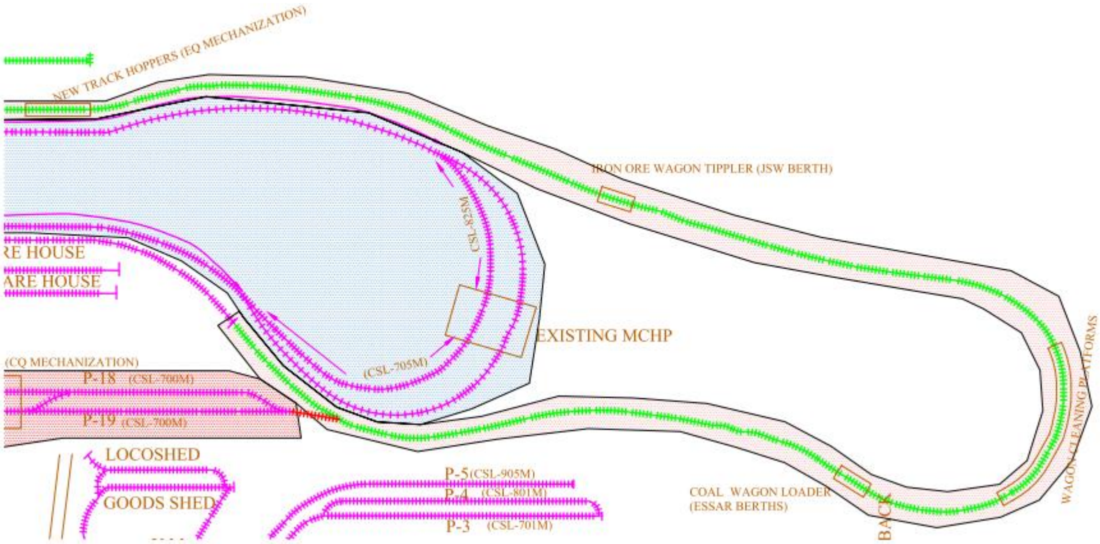


Figure 8.14 Proposed BOT Lines and 2nd MGR

Proposed new tracks are being constructed along with the facilities for new Track Hoppers, Wagon Tipplers, Cleaning Platforms & In-motion Wagon Loaders. All of these facilities shall have one by-pass track.

Upon detailed check it is found that the time required for inspection & cleaning of rake shall be a constraint here. As per the present proposal, 2 platforms shall be built. However, for traffic expected in 2020 an additional platform may be required. Of course, this can be offset by reducing the time required for inspection & cleaning, for which more human resources may have to be deployed.

As per the DPR for this development, BOT operators may not use any captive locomotives for rake movement and shall use the IR Locos for the purpose. However, for emergency locos may be required from PPT. Hence only 2 numbers of locos has been added in the total requirements.

From the detailed calculations presented in **Table 8.7**, it may be seen that the coal unloading facilities are expected to reach their working limits by the year 2025. This would mean more traffic shall be diverted to outer harbour.

Table 8.7 Traffic Estimate for BOT Tracks along with CQ Mechanization

Capacity of the new Track Hoppers	=	24 rakes/day			
	~	20.9 rakes/day (avg.)	Demand	19.1 rakes/day (avg.)	Ok
Capacity of Wagon Tipplers	=	8 rakes/day			
	~	7.0 rakes/day (avg.)	Demand	2.2 rakes/day (avg.)	Ok
Capacity of Wagon Loader	=	8 rakes/day			
	~	7.0 rakes/day (avg.)	Demand	17.0 rakes/day (avg.)	Ok
Capacity of Proposed Wagon Loader for CQ	=	16 rakes/day			
	~	13.9 rakes/day (avg.)			
Capacity of proposed cleaning area	=	22.2 rakes/day			
3 tracks	~	19.3 rakes/day (avg.)	Demand	17.0 rakes/day (avg.)	Ok

	Scenario 1 (Coal unloading, no back loading)	Scenario 2 (Coal unloading, cleaning, coal back loading)	Scenario 3 (Iron Ore unloading, cleaning, coal back loading)	Scenario 4 (Iron Ore unloading, no back loading)
Engine Exchange time at receiving yard	0 hr	0 hr	0 hr	0 hr
Distance from Receiving yard till Track Hoppers/Tippler	4 km	4 km	9 km	9 km
Average Driving speed of train in this area	20 km/h	20 km/h	20 km/h	20 km/h
Time required for traversing receiving yard to hopper/Tippler	0.2 hr	0.2 hr	0.45 hr	0.45 hr
Placing Time for Rake	hr	hr	0.5 hr	0.5 hr
Unloading time at Track Hopper/Tippler	1.5 hr	1.5 hr	2 hr	2 hr
Distance from Track Hopper/Tippler to Cleaning Area		2.5 km	1.5 km	km
Time required for traversing hopper/tippler to Cleaning		0.125 hr	0.075 hr	hr
Cleaning Time for Rake (effective)		0.67 hr	0.67 hr	hr
Distance from Cleaning to Backloading Area		0.5 km	0.5 km	km
Time required for traversing Cleaning to Backloading Area		0.03 hr	0.03 hr	hr
Loading Time for Rake		1.5 hr	1.5 hr	hr
Distance from Last stop to receiving yard	9 km	9.5 km	9.5 km	11.5 km
Time required for traversing last stop to receiving yard	0.45 hr	0.475 hr	0.475 hr	0.575 hr
Engine Exchange time at receiving yard	0 hr	0 hr	0 hr	0 hr
Total turnaround time =	2.15 hr/rake	4.5 hr/rake	5.7 hr/rake	3.5 hr/rake
Average ratio of rakes for Scenario1/2 and 3/4	0.77	0.23	0.0	1.0
Average Turnaround Time =	2.69		3.53	
Number of Locos required =	3		2	
Total Number of Locos required =	5			

Total number of rakes handled (up & down) in an hour (average) =	3.20
Add peaking factor of 30% =	1.0
Total amount of rakes to be handled in 0.25 day peak =	5.76
Hence, sidings required at exchange yard =	6

8.3.2.3 Location & Tracks for Wagon Loader for CQ Mechanization in Future

The project for CQ Mechanization is on hold at this moment. However, it will be executed in near future to provide additional capacity of Coal Imports.

The present BOT Lines are not planned with this facility. Within the area of the existing and planned MGR Tracks, there is not much space where the Coal Loading facility can be added. It is identified that the present sidings P-16 to P-19 are suitable for providing coal wagon loader with adequate track length. However, these tracks are dead-ended presently. To convert them to a wagon loader facility tracks, they need to be connected to a loop line. So, it is proposed to have connectivity from the 2nd MGR Tracks to these sidings.

The sidings P-16 to P-19 are being used for GCB cargo loading at present. This operation may be shifted to P-14, P-15.

Alternatively, additional 2 tracks parallel to P-16 to P-19 may be built with wagon loader facility.

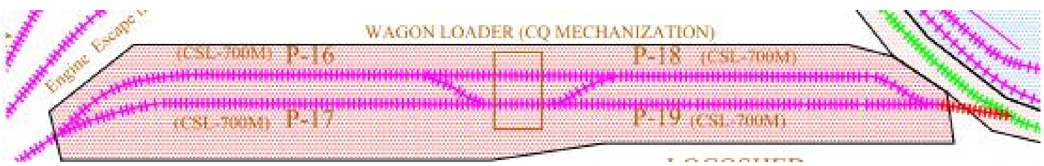


Figure 8.15 General Cargo Loading Area (Existing)

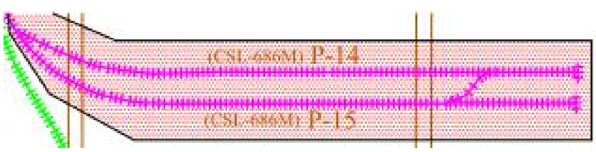


Figure 8.16 General Cargo Loading Area (Proposed)

Table 8.8 Traffic Estimate for GCB Loading Area

GCB Loading-unloading area

Traffic for JMB-MPB at Southern Dock =	5.00 MTPA	
Traffic for GCB =	6.30 MTPA	
Rail Share =	25%	
Rail Traffic Expected =	1.26 rakes/day	
Distance from Receiving yard till GCB Loading/Unloading Area	5.00 km	
Average Driving speed of train in this area	20.00 km/h	
Engine Exchange time at receiving yard	0.50 hr	
Time required for traversing receiving yard to hopper	0.25 hr	
Unloading & Loading time at Yard (non-mechanised)	8.00 hr	
Placing Time for Rake	0.50 hr	
Time required for traversing GCB till receiving yard	0.25 hr	
Engine Exchange time at receiving yard	0.50 hr	
Total turnaround time =	10.00 hr/rake	
Nr. of rakes possible to be handled =	2.00 /day	
Nr. of Sidings Required =	0.63	
Number of Tracks in the GCB Yard =	2.00	Ok
Presently the GCB cargo is handled on track P-16 to P-19. However, after CQ Mechanization, the same shall become the tracks for Wagon Loader for CQ. The GCB Cargo Loading is proposed to be shifted to P-14, P-15.		
Number of Locos required =	1	
Siding Tracks needed in the exchange yard =	1	
Nr. Sidings required for bunching/peaking =	0.189	
Total sidings required at Receiving Yard =	1.189 i.e.	2 Nrs.

8.3.2.4 Existing Wagon Tippler Facility & Yard for it

Existing wagon tippler facility (T-149 & T-150) along with Yard Siding Tracks (T-1 to 7 & T-10 to 12) was originally constructed for Iron Ore unloading. Presently these are being used for Coal Unloading. These tracks are so located that they cannot be connected to the proposed MGR Tracks. Moreover, the dead end of the facility is constructed with “Kick-back” system for pushing back the empty wagons to collection yard. Hence, this facility shall remain “stand-alone”.

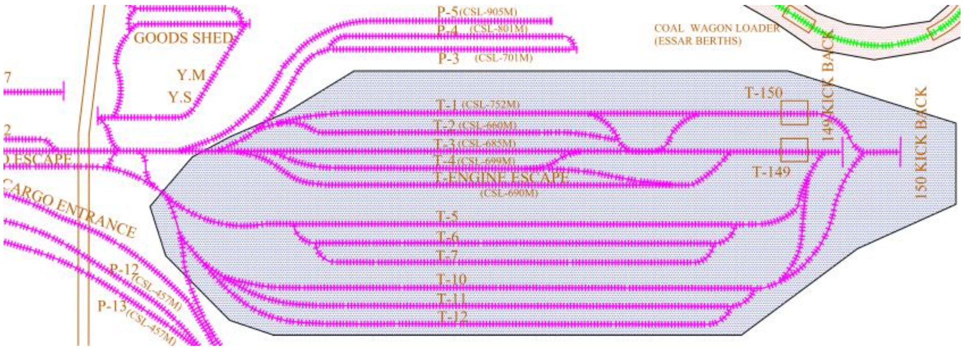


Figure 8.17 Existing Wagon Tippler & Yard

Table 8.9 Traffic Estimate for Existing Wagon Tippler

Capacity of the wagon Tippler (2 No.)		5-6 rakes/day (rated)
Average Rakes that can be handled		8.7 rakes/day (avg.)
Demand	12.0 rakes/day (avg.)	Larger than Capacity

The above shows that the present facility of unloading BOXN Coal Wagons are not enough. However, the ratio of BOXN to BOBRN wagons received are based on present day ratio which is expected to change with introduction of more track hoppers. Hence the traffic expected with BOXN shall be lesser and may be limited to the capacity of the present facility only.

Distance from Receiving yard till Tippler Yard	5 km	
Average Driving speed of train in this area	20 km/h	
Engine Exchange time at receiving yard	0.5 hr	
Time required for traversing receiving yard to hopper	0.25 hr	
Unloading time at Yard	2.5 hr	
Placing Time for Rake	0.5 hr	
Collecting Time for rake	0.5 hr	
Time required for traversing Tippler till receiving yard	0.25 hr	
Engine Exchange time at receiving yard	0.5 hr	
Total turnaround time =	5 hr/rake	
No. of Tippler	2	
No. of rakes can be handled =	9.6 rakes/day	
Nr. of tracks needed =	1.25	
Nr. of existing tracks at the Tippler Yard =	4	
Nr. Sidings required for bunching/peaking =	1.44	
Total sidings required at Receiving Yard =	1 i.e.	1 No.
Number of Locos required =	0	

8.3.3 Tracks between EQ & CQ Area

Between the Quay face of existing EQ & CQ there are 4 tracks at present. After both EQ & CQ Mechanization, 2 tracks shall have to be removed. Also the remaining yard here shall be serving only SQ, with non-mechanized loading.

8.3.4 Tracks to Multi-purpose Berths in Southern Dock

BOT Operator (JMB) is in the process of construction of the Multi-purpose berths in Southern Dock along with the yard and rail tracks. The proposed track connecting the main up & down tracks to the Yard of MPB, runs parallel to the existing road (NH-5A) just inside the port boundary. This track shall cross the access road to existing harbour in front of Gate 3 & 4 where level crossings are planned.

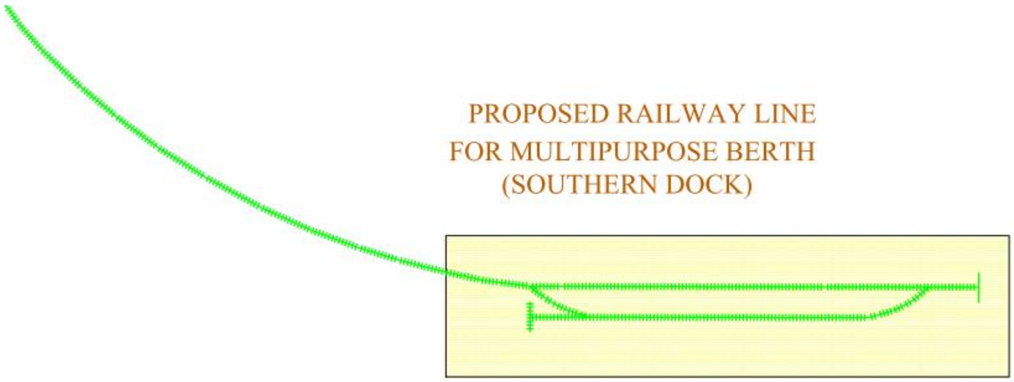


Figure 8.18 Loading Area for MPB

Table 8.10 Traffic Estimate for MPB in Southern Dock

	Containers	Other Cargo
Traffic Projected (as per Tender Documents/DPR)	0.43 MTEU	2.18 MTPA
Rail share	30 %	50 %
Rail Traffic	0.129 MTEU	1.09 MTPA
Daily rail traffic (average)	4.1 rakes/day	0.9 rakes/day
Total number of rakes =	5.0 rakes/day	
Turnaround time for rakes (as per IR Rules)	6 hrs	
Number of Loading Tracks required	2	

Number of loading tracks planned within MPB Yard	3	
Distance from exchange yard till MPB Area	6 km	
Rakes can be accomodated enroute to MPB	2	
Nr. Sidings required for bunching/peaking =	0.75	
Total sidings required at Receiving Yard =	1 i.e.	1 No.
Number of Locos required =	2	

8.3.4.1 Existing Exchange Yard along with All Planned Projects

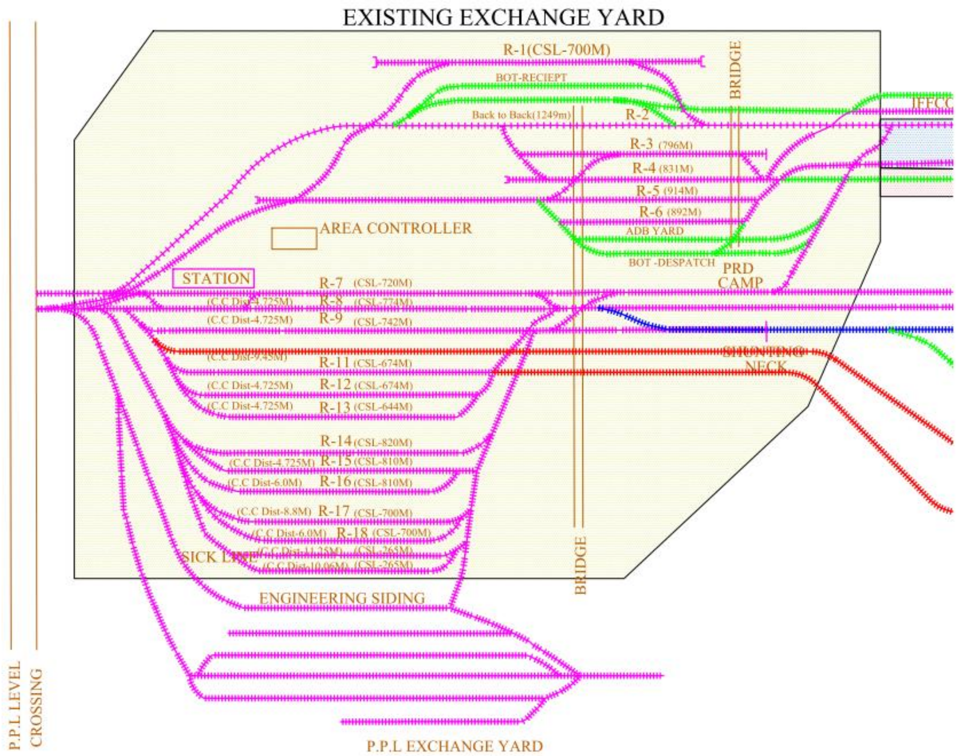


Figure 8.19 Exchange Yard for Existing Harbour

From all the traffic estimates for separate facilities, it is seen that the total number of sidings in the exchange yard required are less than already available space. Of course, this also depends on the efficiency of the external rail network on incoming and outgoing traffic.

8.3.5 New Tracks and Rail Network for Outer Harbour

The rail network for the proposed outer harbour is planned to be able to work independently of the existing rail network. Since this is a complete new development, all facilities can be planned as per the traffic demands within the limits of the harbour.

In the Master Plan, for unloading of the coal rakes track hoppers are proposed and for loading of imported coal, In-motion wagon loader is proposed. Capacities of these facilities shall match the projected demand.

The main rail network to outer harbour shall consist of a Loop line on which the track hoppers and cleaning platforms shall be located. The wagon loader shall load near the import coal stacking location planned in the Western Dock area.

It is proposed to have a dedicated parallel set of up & down tracks from existing Paradip station exchange yard till the new exchange yard for the outer harbour located at the existing golf club area.

The proposed tracks shall take a turn just before the flyover at Atharbanki and then continue parallel to NH5A to the outer harbour area.

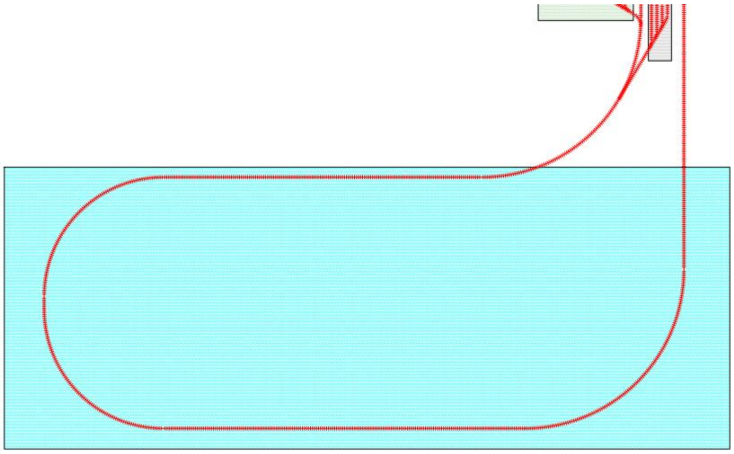


Figure 8.20 Outer Harbour MGR

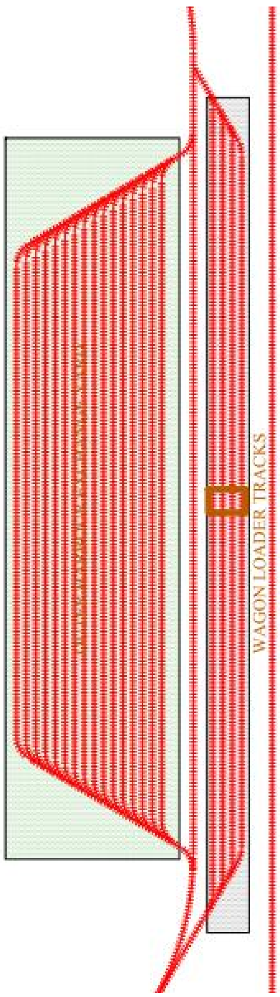


Figure 8.21 Exchange Yard for Outer Harbour

Table 8.11 Traffic Estimate for Outer Harbour Area for 2020

Capacity of Track Hoppers	24 rakes/day (rated)			
~	20.9 rakes/day (avg.)	Demand	20.0 rakes/day (avg.)	Ok
Capacity of Proposed Wagon Loader for OH	10 rakes/day (rated)			
~	8.7 rakes/day (avg.)	Demand	0.0 rakes/day (avg.)	Ok
Capacity of proposed cleaning area	7.4 rakes/day			
1 tracks ~	6.4 rakes/day (avg.)	Demand	0.0 rakes/day (avg.)	Ok

	Scenario 1 (Coal unloading, no back loading)	Scenario 2 (Coal unloading, cleaning, coal back loading)
Engine Exchange time at receiving yard	0 hr	0 hr
Distance from Receiving yard till Track Hoppers/Tippler	4 km	4 km
Average Driving speed of train in this area	20 km/h	20 km/h
Time required for traversing receiving yard to hopper/Tippler	0.2 hr	0.2 hr
Placing Time for Rake	hr	hr
Unloading time at Track Hopper/Tippler	1.5 hr	1.5 hr
Distance from Track Hopper/Tippler to Cleaning Area		1.5 km
Time required for traversing hopper/tippler to Cleaning		0.075 hr
Cleaning Time for Rake		2 hr
Distance from Cleaning to Backloading Area		2.5 km
Time required for traversing Cleaning to Backloading Area		0.125 hr
Loading Time for Rake		1.5 hr
Distance from Last stop to receiving yeard	4 km	0 km
Time required for traversing last stop to receiving yard	0.2 hr	0 hr
Engine Exchange time at receiving yard	0 hr	0 hr
Total turnaround time =	1.9 hr/rake	5.4 hr/rake
Average ratio of rakes for Scenario1/2	1	0
Average Turnaround Time =	1.9	
Number of Locos required =	2	

Total number of rakes handled (up & down) in an hour (average) =	1.67
Add peaking factor of 30%=	0.5
Total amount of rakes to be handled in 0.25 day peak =	3.00
Hence, sidings required at exchange yard =	3

Since the Wagon Loader is co-located with the exchange yard, additional 2 tracks would be required for the same.

Hence total tracks required at the exchange yard 5 No.

Based on similar calculations total 15 tracks are required for traffic projected for year 2035 in the exchange yard.

8.3.6 No. of Mainlines Entry / Exit to Port

Indian Rail Network reaching to Paradip Port is being converted to auto-signalling to increase the network capacity. Taking the track capacity as 50 rakes/day average on conservative side, the requirement of the number of tracks estimated for traffic till 2025 are presented in **Table 8.4** & **Table 8.5** above. As can be seen total 2 up & 2 down tracks should be sufficient to cater to the projected traffic in the port till year 2025. This would mean additional up & down tracks to be laid in the main line to cater to increased traffic demands.

It has been observed that basis the similar calculations for year 2035 would result in 4 up and 4 down lines which may not be practically provided. However it is expected that by that time better technology like heavy haul rail might be in place, which using the same line space could handle much higher throughput.

8.4 Recommendations for Improvement in Road Access

The following recommendations are made with reference to improvement in road access to and from the existing harbour:

1. After completion of EQ & CQ mechanisation along with other planned projects as mentioned earlier, the vehicular traffic exchange is expected to significantly reduce. Hence, the requirements of vehicle access gates shall reduce too. In light of this and the development of BOT Tracks, the gate 2 is proposed to be closed. Minor road traffic shall use gates 1 & 3 for accessing the harbour.

2. Existing NH-5A from Athrabanki Flyover till outer harbour shall be bound by rail tracks on either side of it; on eastern side tracks to southern dock and on western side the tracks to outer harbour. With all access from port township cut-off this portion of the NH shall become a dedicated corridor for Port traffic only.

3. For accessing the harbour from the Township, two flyovers for personal & light commercial vehicles are proposed as mentioned below:

    a. **Flyover near Gate 3**: In the Smart-city planning being developed under separate contract, a flyover is proposed parallel to existing Athrabanki Flyover for access to township from Main NH-5A. It is proposed to have a ramp out of the same to cross over the NH-5A & Rail Tracks parallel to it and land directly in the harbour area nearby Gate 3. Proposed flyover is shown in **Figure 8.22**.

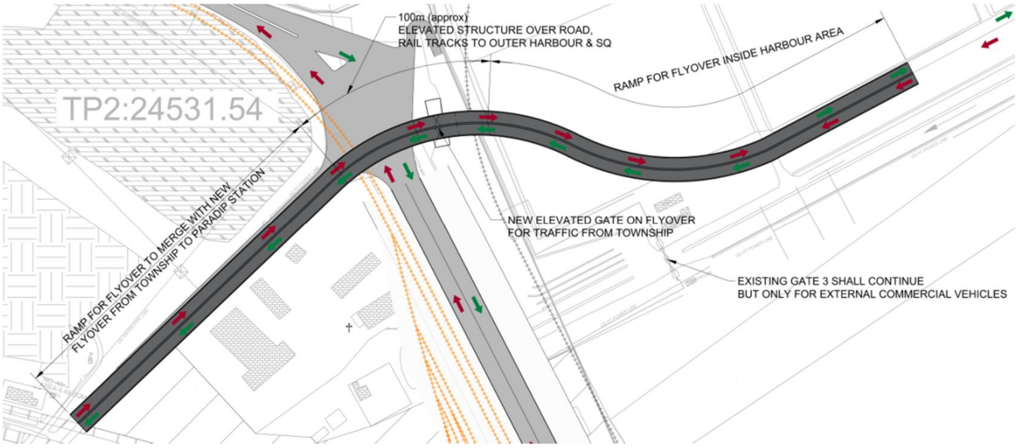


Figure 8.22 Proposed Flyover at Gate 3

b. Similar to Gate 3, a separate flyover for Gate 4 is proposed (**Figure 8.23**). It shall start in front of Port Trust Hospital, cross over the rail tracks & NH5A below and would end inside the harbour on other side. This flyover is proposed to have stairs and footpaths on either sides of the main deck for ease of pedestrian movement.

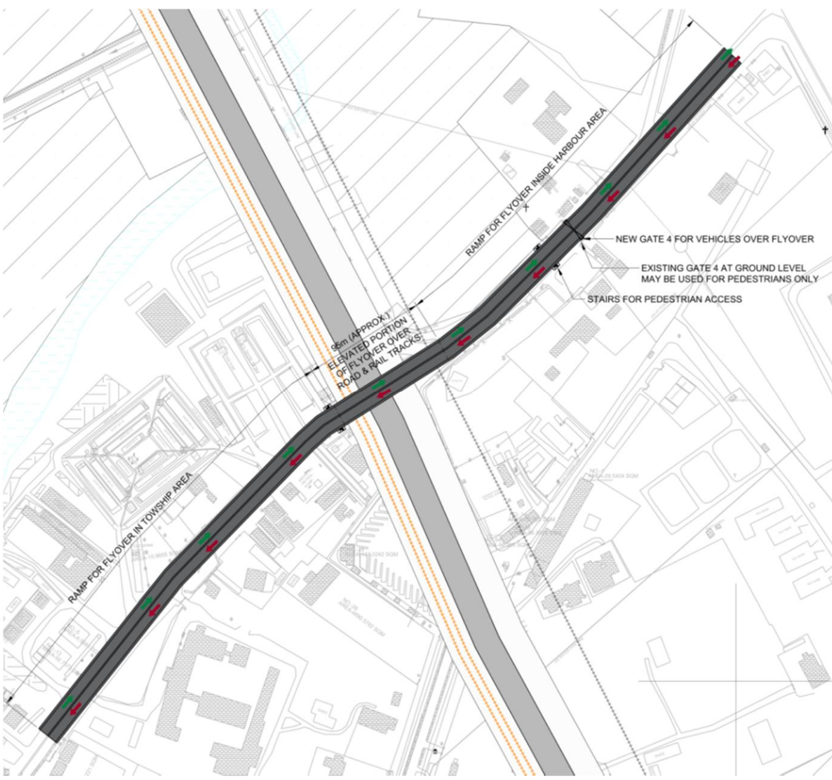


Figure 8.23 Proposed Flyover at Gate 4

It may however be noted that the above proposals may be refined keeping in view of the recommendations of the report on Smart City, which is in progress currently.

9.0 SCOPE FOR FUTURE CAPACITY EXPANSION

9.1 Development Possible within the Existing Harbour

9.1.1 Mechanization of CQ1 to CQ2

The port also proposes to mechanize berths CQ1 and CQ2 to enable import of cargo like coking and thermal coal, limestone, gypsum etc.

Mechanization of these berths will involve the following:

- Strengthening these berths to receive 2 coal unloaders on each berth.
- Bulk Stackyard south of the incoming rail track, adjacent to the bulb having storage capacity of about 0.83 MT of coal. The port also proposes to allocate an additional stacking area just south of the proposed stackyard to add additional capacity of 0.44 MT.
- Mechanization of the stackyard with stacker cum reclaimers and connected conveyor system.
- Two rapid loading systems with 4,000 T capacity silos each.

The location plan of berths and stackyard is shown in **Figure 9.1**.

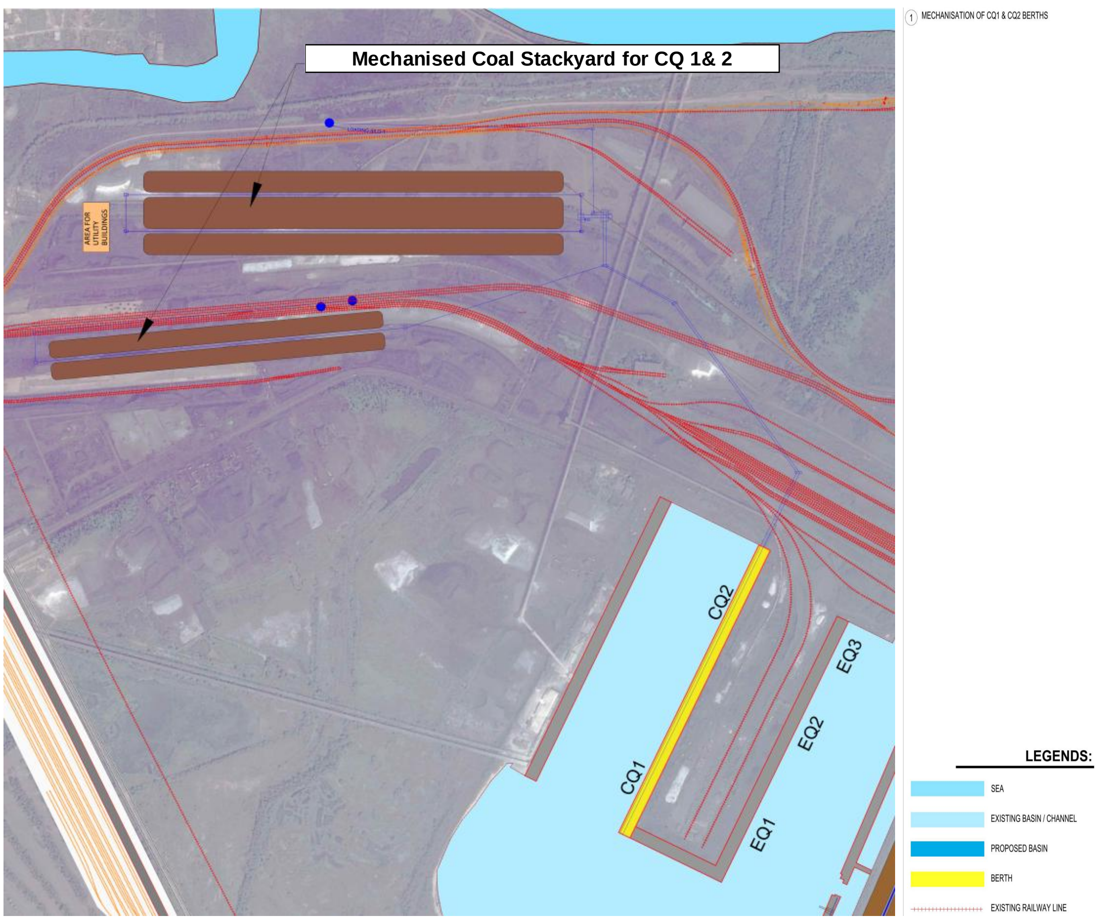


Figure 9.1 Mechanization of CQ1 & CQ2 Berths

It was assessed that even after allocation of additional stackyard the total storage capacity of coking coal (which is the main commodity to be handled at the proposed terminal) would only be limited to about 1.3 MT only. Considering the average dwell about 30 days, the proposed stackyards can only support the terminal capacity of about 11.0 MTPA only. Significant efforts would be needed to evacuate the cargo faster so that the dwell time could be reduced to match the stacking capacity.

This project could be initiated once the projects for mechanisation of EQ1-3 and deep draft coal import berth are in advanced stage of completion.

9.1.2 Capacity Augmentation of MCHP

The utilization of the equipment at MCHP is very high, which is likely to impact the maintenance schedule requirement. The port is therefore considering various options for the capacity augmentation of the MCHP whereby increasing the rated capacity of the equipment by way of replacing the motors, gears etc.

It is also suggested that the augmentation of stacking area could also be carried out in the following manner:

- Addition of one row of stockpile towards north of existing stackyard
- Add one stream of conveyor and Stacker cum Reclaimer

The proposed arrangement is shown in **Figure 9.2**.

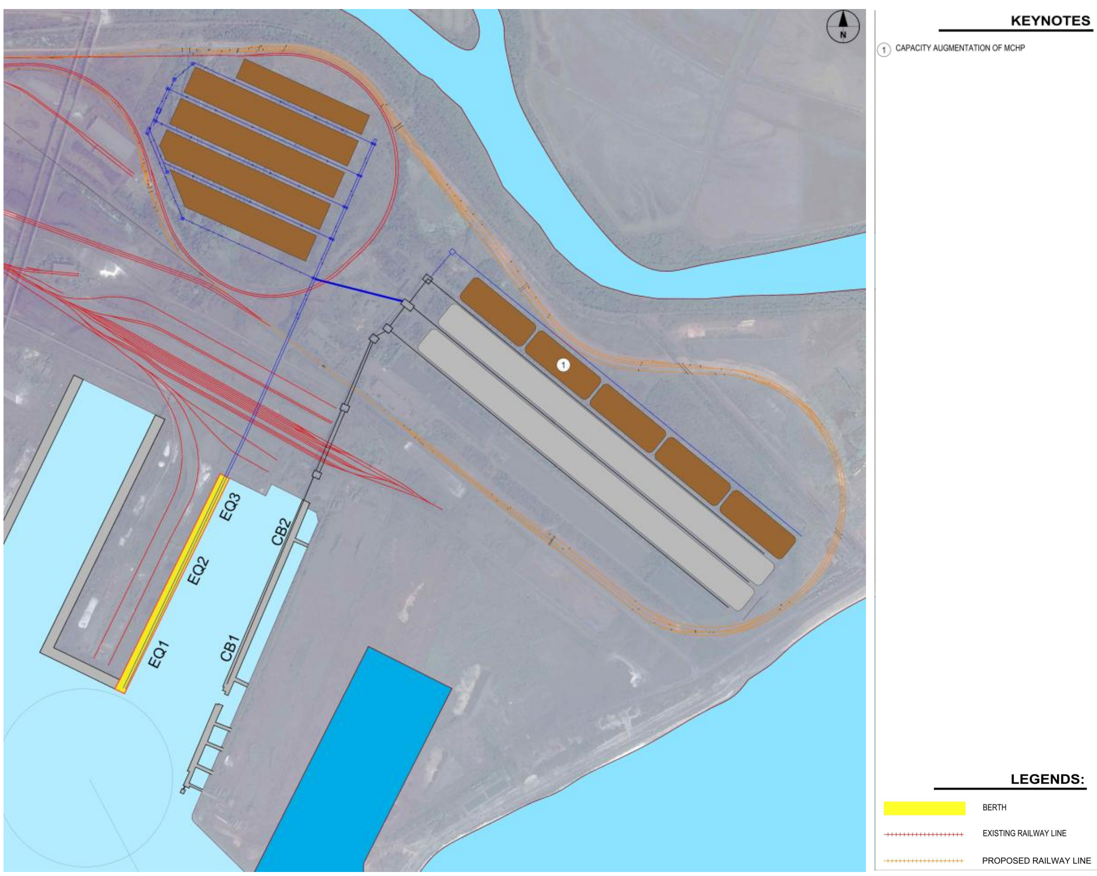


Figure 9.2 Proposed Arrangement for Capacity Augmentation of MCHP

The capacity of the stackyard would go up from existing 0.97 MT to 1.45 MT and would have the following advantages:

- The yard would be able to support additional berth capacity of MCHP.
- This would reduce the overutilization of existing stackyard equipment so that adequate time of scheduled maintenance would be available.

The additional yard can also support the upcoming EQ1, 2 and 3 berths. This could be accomplished by providing a conveyor system connecting the additional yard with the proposed stackyard of EQ1 to EQ3. The modalities of development of the additional stackyard and sharing with MCHP and EQ berths need to be worked out.

9.1.3 IWT Terminal

Another possible development within the existing inner harbour is the IWT terminal, which needs to be developed as part of NW5 development for movement of coal from Talcher mines to Paradip and Dhamra port. This has a potential to ease the congested rail lines in the region. The indicative locations for the IWT terminal are shown in **Figure 9.3**.

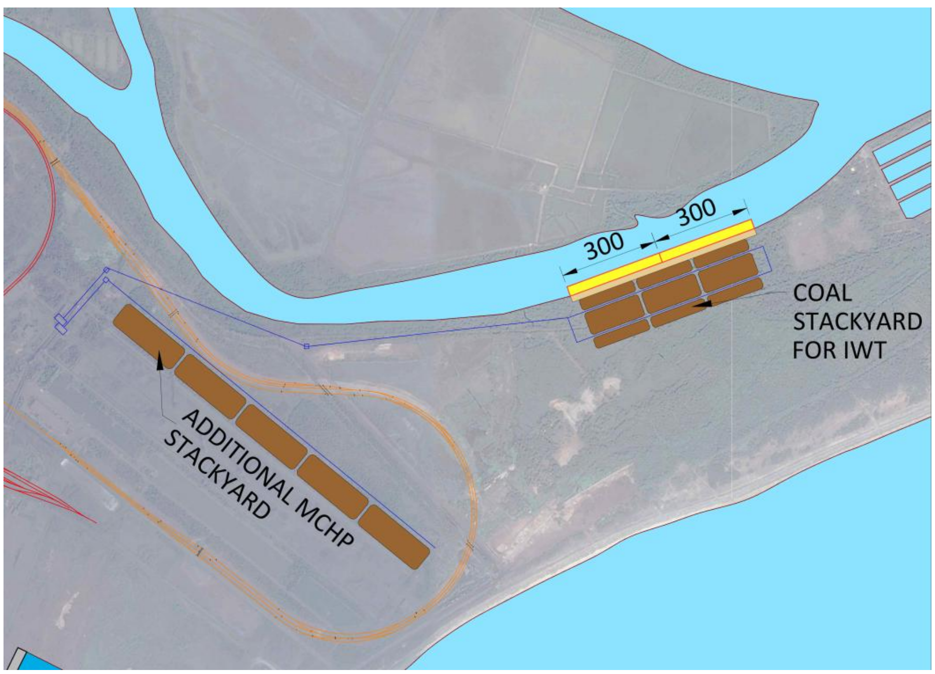


Figure 9.3 Proposed Location for the IWT Terminal

As part of the proposed development, the barge unloading jetties along with associated infrastructure like barge unloaders, connected conveyor system and transit stackyard shall be built. The coal from the transit stackyard would thereafter be transferred to the main coal yard of MCHP or EQ 1 to 3 berths for onward loading to ships.

The project should be initiated once the overall development of National Waterway NW5 is undertaken. Meanwhile the IWT traffic could be handled at NQ1 & NQ2 with deployment of suitable cranes.

9.1.4 Conversion of Iron Ore Berth to Handle Coal

In the past few years there was decline in iron ore traffic through IOHP, and therefore it was proposed to handle Thermal coal at IOB in addition to Iron ore. The proposal envisages unloading thermal coal rakes in BOXN wagons at Wagon Tippler and loading through IOHP. In fact coal loading was already carried out in the past and there is nothing new in handling coal.

The mechanised IOHP has a capacity to handle Iron ore at a designed rate of 3,000 TPH. Due to lower projection of iron ore traffic to be handled at this berth, it is proposed that this berth be used for coal exports as well apart from the little iron ore traffic that may come in future. However, considering bulk density of coal being about a third of iron ore the capacity of this berth for loading coal would be limited to about 1,000 TPD, which is quite low and does not meet the objective.

It is therefore suggested that the handling system is upgraded to enable coal loading at 2,000 TPH. It is proposed to provide additional conveyor streams parallel to conveyors IV and VI and an additional ship loader having capacity of 2,000 TPH for loading coal as shown in **Figure 9.4**.

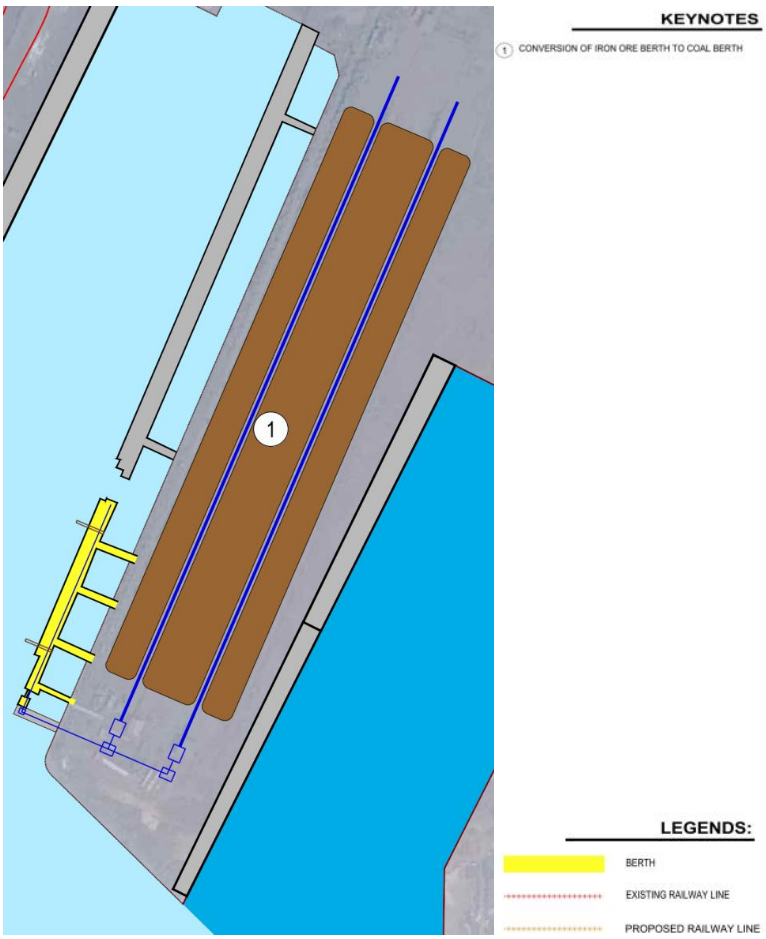


Figure 9.4 Conversion of IOHP to Handle Coal

Port has reported recent spurt in the traffic of iron ore and pallets and thus it is advisable to keep a close watch on this trend and the above conversion is not required to be initiated immediately. In future if there is again a substantial decline in iron ore traffic due to policy change etc. this project may be undertaken.

9.2 Development of Potential Outer Harbour

9.2.1 Alternative Locations

The possible alternative locations for development of outer harbour are shown in **Figure 9.5**.

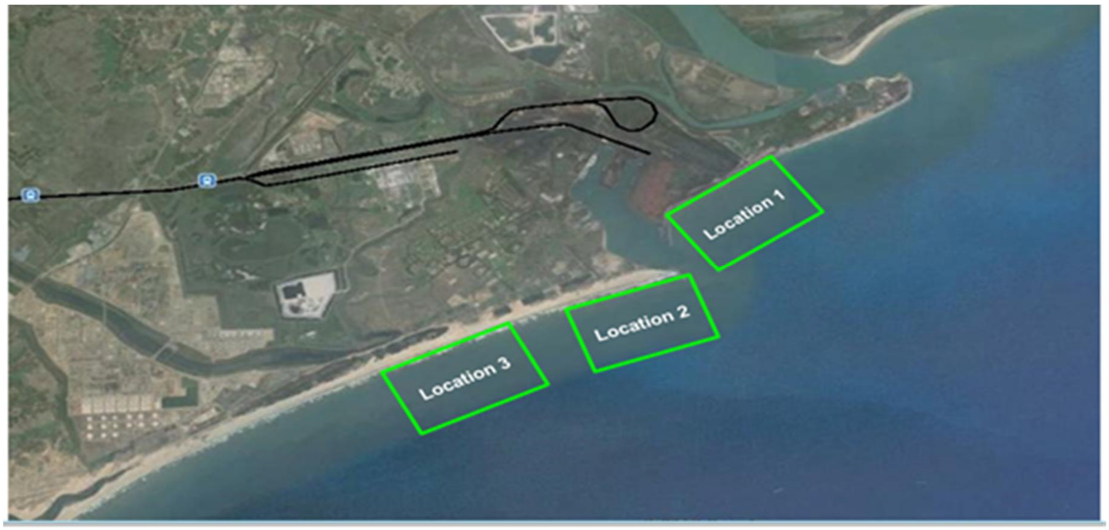


Figure 9.5 Location of Project Sites

9.2.2 Qualitative Evaluation of the Alternative Sites

Based on the site visits and discussions with the port personnel the following observations are made:

1. Technically, it is possible to locate the outer harbour in any of the three alternative sites.
2. The access to Location 1 would be through the existing port facilities and thus is likely to constraint the existing port infrastructure.
3. Location 3 is close to the fishing village. Further the rail and road access to this site would need to be through PPL establishments involving R&R issues.
4. Location 2 seems to be best suited for the development of the outer harbour with rail and road access without any R&R issues.

9.2.3 Planning of the Outer Harbour

To cater to the proposed traffic in the year 2020, it is estimated that initial two coal export berths and one coal import berth would be needed along with the associated handling system and storage at outer harbour.

For an outer harbour development following technical requirements need to be addressed:

1. Adequate Channel width to handle 200,000 DWT cape size ships
2. Adequate stopping distance for vessels entering the harbour
3. Adequate water depths in the channel and harbour for the cape size ships
4. Acceptable tranquillity in the harbour basin and berths

5. Optimisation of dredging and reclamation

Considering the above aspects various alternative layouts were prepared as part of a separate TEFR prepared for the project. The shortlisted layout of the proposed development is shown in **Figure 9.6**. The salient features of the development are given below:

1. North breakwater of length 1,140 m and south breakwater of length 4,150 m shall be provided. The breakwaters are proposed to be rubble mound type with ACCROPODES provided as artificial armour units on sea side to absorb the wave forces.
2. The dredged depths in the channel and harbour basin shall be provided to handle capesize vessels.
3. The layout has been planned such the requirement of borrowed fill for reclamation purposes could be minimised.
4. The fully mechanised system shall be provided for import and export of bulk cargo.
5. The proposed Phase 1 layout can be suitably developed out of the proposed layout based on the immediate augmentation requirement i.e. two berths for coal export and one berth for coal import.

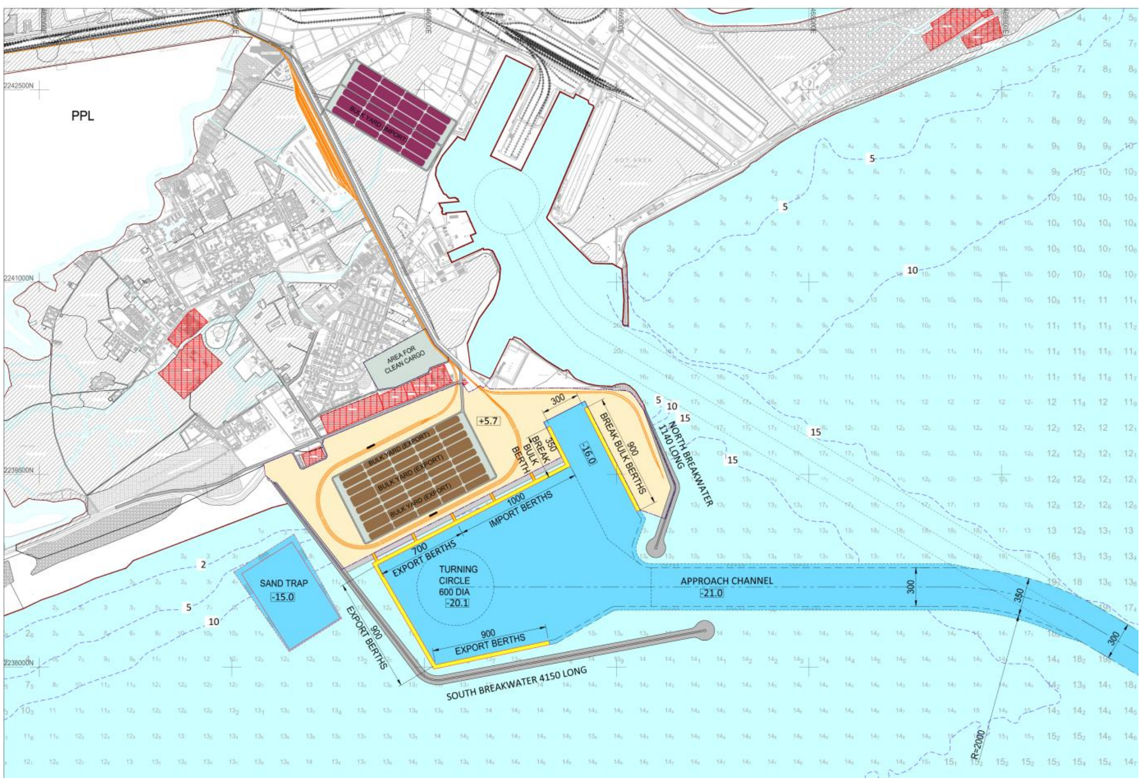


Figure 9.6 Master Plan Layout for Proposed Outer Harbour

9.3 Land Use Plan

The estate department of the port has already prepared the land use plan, which would need to be updated in view of the updated master plan of the port. In this connection our recommendations are follows:

1. Adequate area needs to be reserved for the storage and operations for the proposed outer harbour. The land area behind 1.8 km from the waterfront of outer harbour can be reserved for this purpose. The land owned by state government can be excluded.
2. Land towards the south west of proposed port land till the Atharabanki creek could be utilised for setting up Smart city.
3. Land towards northwest can be developed for the commercial purposed and leased out for hotel, offices etc.

The broad suggestions are indicated in **Figure 9.7**.

Figure 9.7 Port Land Use Plan

It may however be noted that the above proposals may be refined keeping in view of the recommendations of the report on Smart City, which is in progress currently.

10.0 SHELF OF NEW PROJECTS AND PHASING

10.1 General

As part of Paradip Port Master Plan several projects have been identified which need to be taken up in phased manner with the built up in traffic. The proposed phasing, capacity addition and the likely investments are discussed in paragraphs below.

It may be noted that apart from these projects there could be several other projects which port would be implementing as part of the routine operations and maintenance of the port facilities. Further the phasing proposed is not cast in stone but could be reviewed periodically and revised based on the economic scenario and demand for port at that particular point of time.

10.2 Ongoing Projects

The details of the projects which have already been awarded and development is ongoing are given below in **Table 10.1**.

Table 10.1 Ongoing Projects

S. No.	Project Name	Investment required (INR in Crores)	Capacity Addition (MTPA)	Mode of Implementation
1.	Deep Draft Coal Import Berth	479	10.0	PPP
2.	Deep Draft Iron Ore Export Berth	430	10.0	PPP
3.	Development of Clean Cargo Berth	430	5.0	PPP
4.	Development of Rail Connectivity for BOT berths	128	-	Port's funds
5.	Mechanisation of EQ1 -3 Berths	1,437	30.0	PPP
6.	Capital Dredging of BOT basin	173	-	Port's funds

The port layout after completion of ongoing projects shall be as shown in **Figure 10.1**.

Figure 10.1 Port Layout along with Ongoing Developments

10.3 Projects to be completed by Year 2020

The details of the projects which are envisaged to be completed by year 2020 are given below in **Table 10.2**.

Table 10.2 Projects to be Completed by Year 2020

S. No.	Project Name	Investment required (INR in Crores)	Capacity Addition (MTPA)	Mode of Implementation
1.	Development of IWT Terminal at Paradip Port	200	2.5	PPP
2.	LPG Terminal at South jetty	690	0.75	PPP
3.	Development of Outer Harbour - Phase 1	4,179	39	PPP

The port layout after completion of projects mentioned above shall be as shown in **Figure 10.2**.

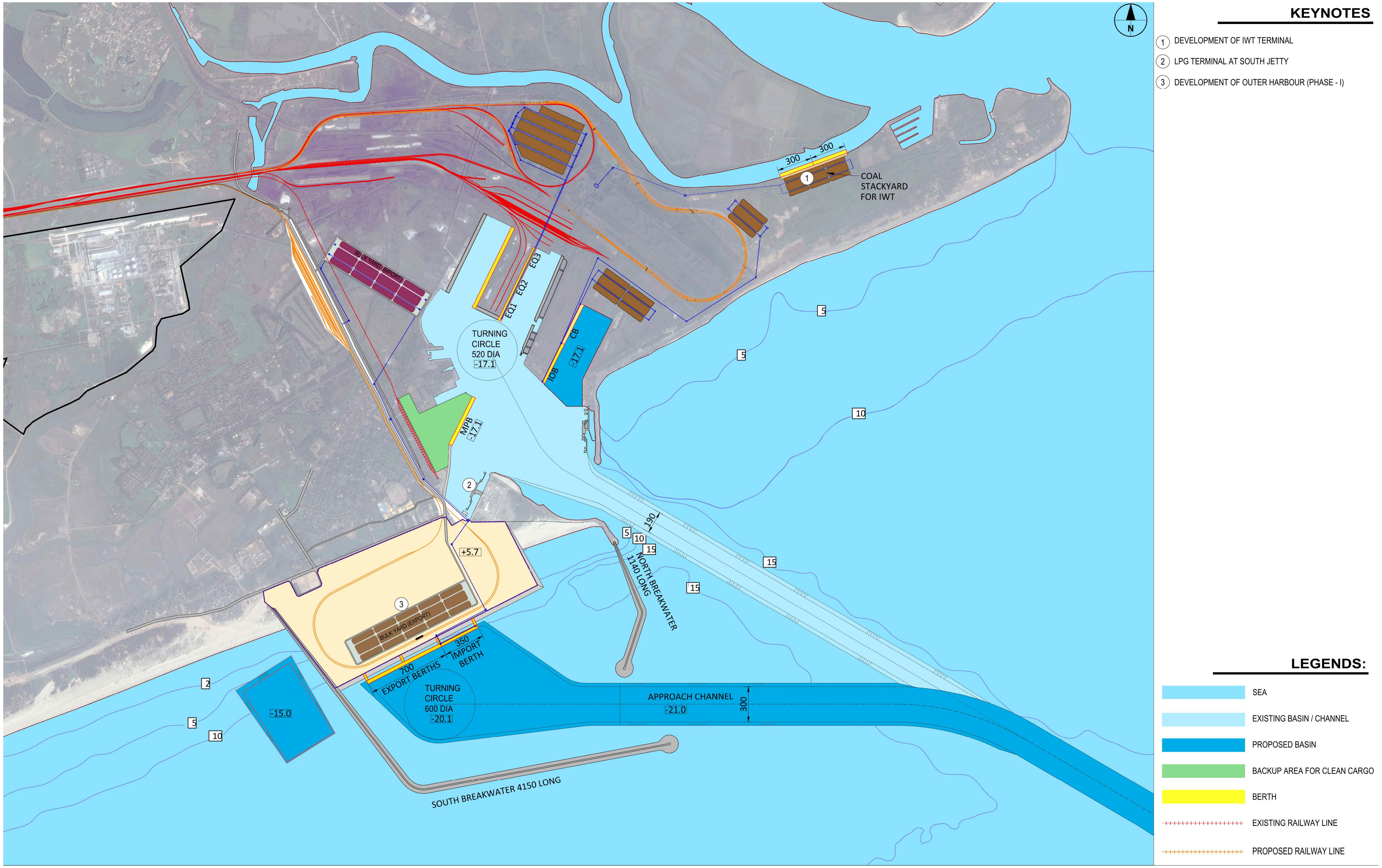


Figure 10.2 Layout Plan 2020

10.4 Projects to be completed by Year 2025

The details of the projects which are envisaged to be completed by year 2025 are given below in **Table 10.3**.

Table 10.3 Projects to be Completed by Year 2025

S. No.	Project Name	Investment required (INR in Crores)	Capacity Addition (MTPA)	Mode of Implementation
1.	Mechanisation of CQ1 -2 Berths	1,357	20	PPP
2.	Development of Outer Harbour - Phase 2	1,103	32	PPP
3.	Conversion of Iron Ore Berth to Coal Berth*	100	5.0	Port's Fund
4.	Expansion of the MCHP stackyard for additional coal storage#	150	6.0	PPP

* The project to be initiated only if berth is available due to insufficient iron ore traffic.

The project to be initiated only if additional stackyard capacity is envisaged.

The port layout after completion of projects mentioned above shall be as shown in **Figure 10.3**.

Figure 10.3 Layout Plan 2025

10.5 Projects to be completed by Year 2035

The details of the projects which are envisaged to be completed by year 2035 are given below in **Table 10.4**.

Table 10.4 Projects to be Completed by Year 2035

S. No.	Project Name	Investment required (INR in Crores)	Capacity Addition (MTPA)	Mode of Implementation
1.	Development of Outer Harbour – Ultimate Phase	3,485	75+	PPP

The port layout after completion of mentioned above shall be as shown in **Figure 10.4**.

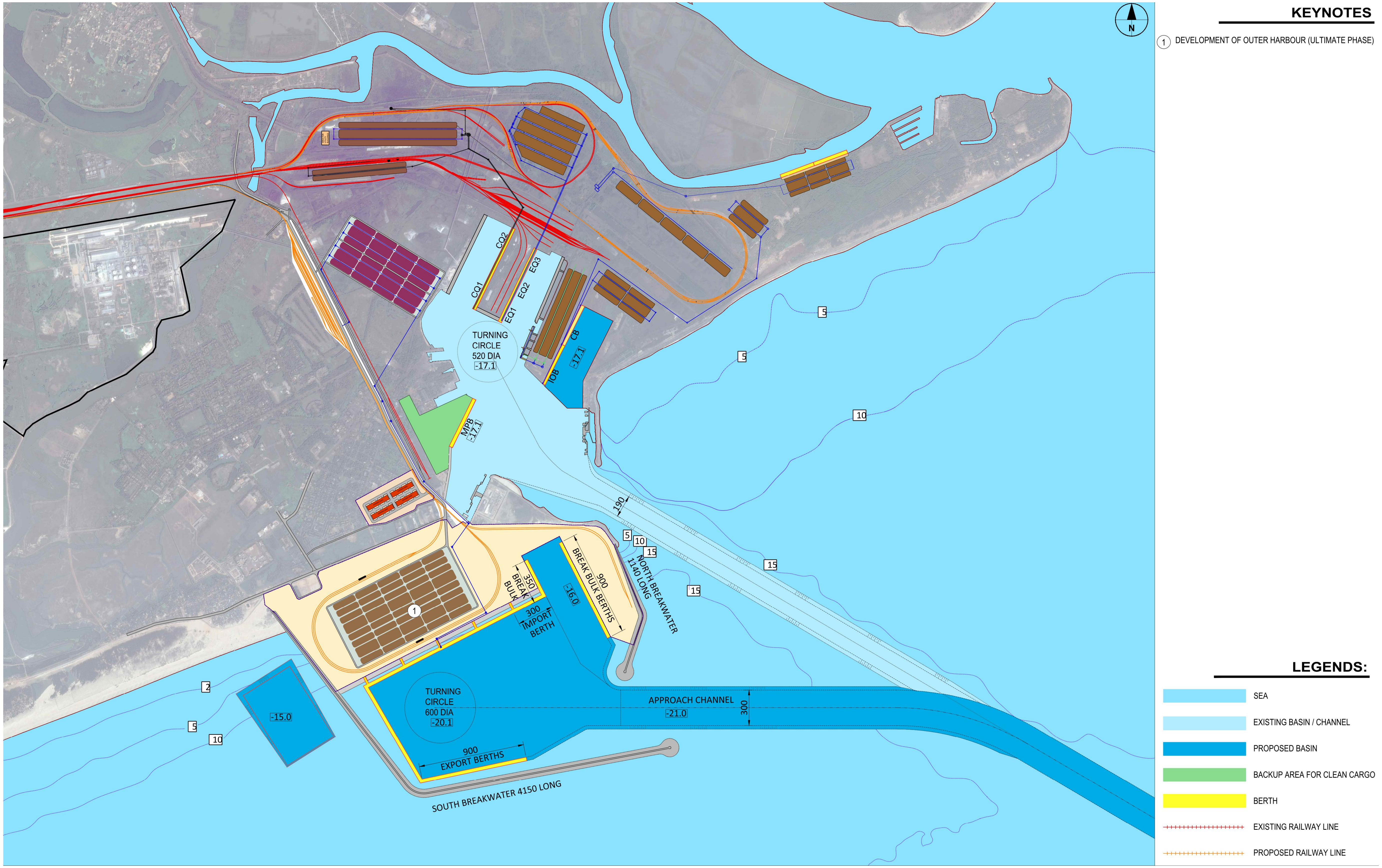


Figure 10.4 Layout Plan 2035

Appendix-1: **BCG Benchmarking Study for Paradip Port**

3 Paradip Port Deep-dive

3.1 Port overview

Paradip port is located on the eastern coast of India in Jagatsinghpur district of Odisha on the Bay of Bengal. It is situated between the ports of Kolkata and Visakhapatnam. Paradip has 15 berths and 3 SPMs. The 15 berths comprise 3 mechanized berths, 7 general cargo conventional berths, 2 oil jetty berths and 3 dedicated berths.

Figure 60: Paradip berth layout

Paradip Port Trust (PPT) has seen an increase of 6% CAGR in volume over the last 5 years. Its total revenues have increased at 8% YoY in line with its growth in operating income of 8% YoY. Total expenses at PPT have, however, gone up by 14% YoY. While operating expenses have gone up by 9% YoY, non-operating expenses have increased by 27% YoY.

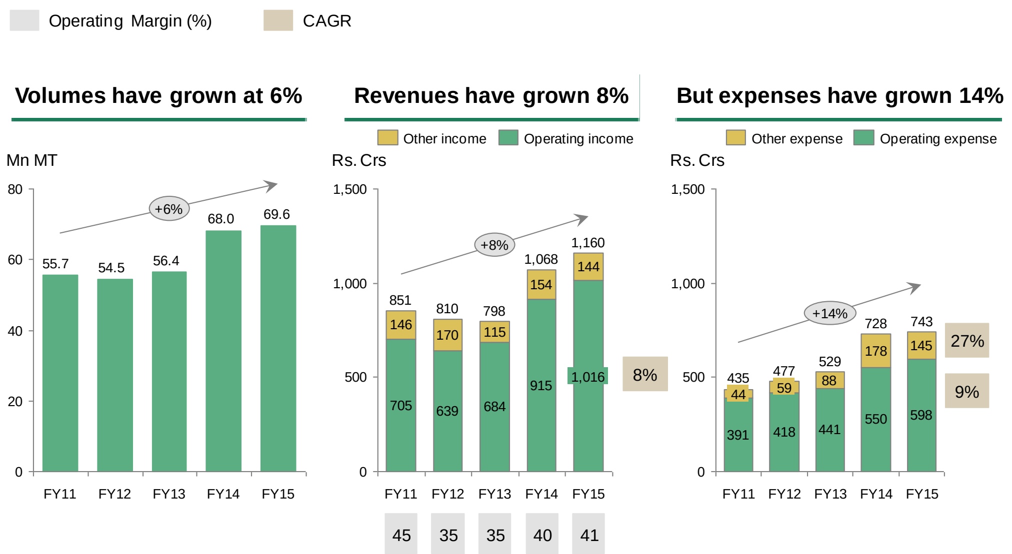


Figure 61: Volume, revenue and expense trend of Paradip port

Coal is the biggest cargo being handled at Paradip. Paradip handles large volumes of both export thermal coal and import coking and steam coal. In FY15, it handled ~22 Mn MT of export thermal coal, ~9 Mn MT of import steam coal, and ~7 Mn MT of import coking coal. Among other major cargo categories, PPT handles ~18 Mn MT of POL products, ~3 Mn MT of iron ore and iron pellets, and ~5 Mn MT of fertilizer products. Overall, PPT handles ~46 Mn MT of dry bulk cargo.

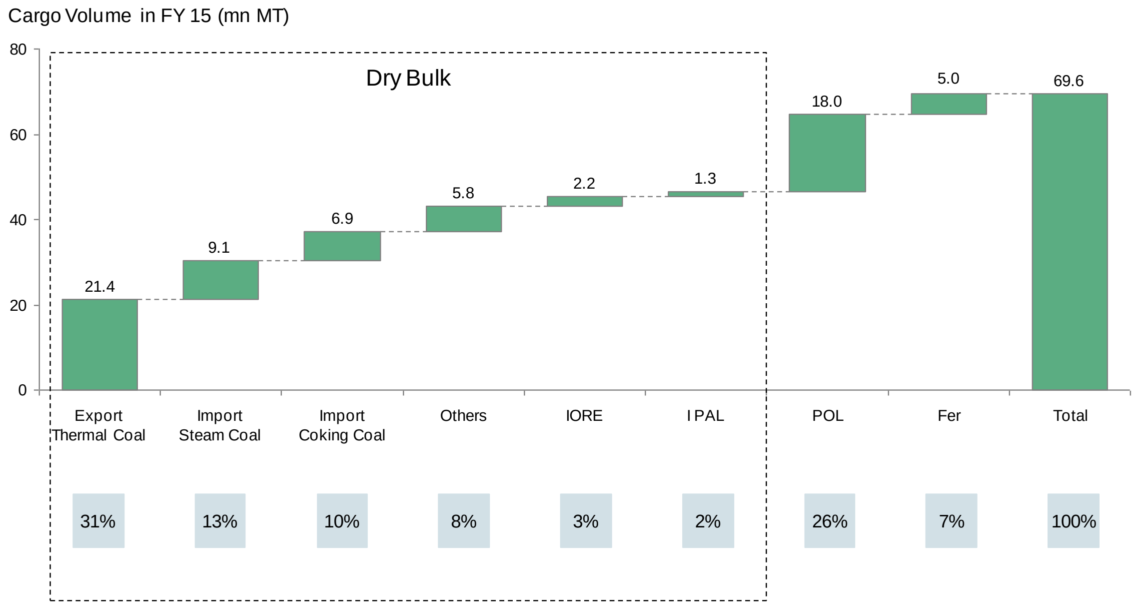


Figure 62: Volume split by cargo at Paradip port

Paradip port is characterized by high berth occupancy and low berth productivity across its Export coal berths (Mechanized Coal Handling Plant – MCHP) and General Cargo Berths. These berths handle the dry bulk volume at Paradip port.

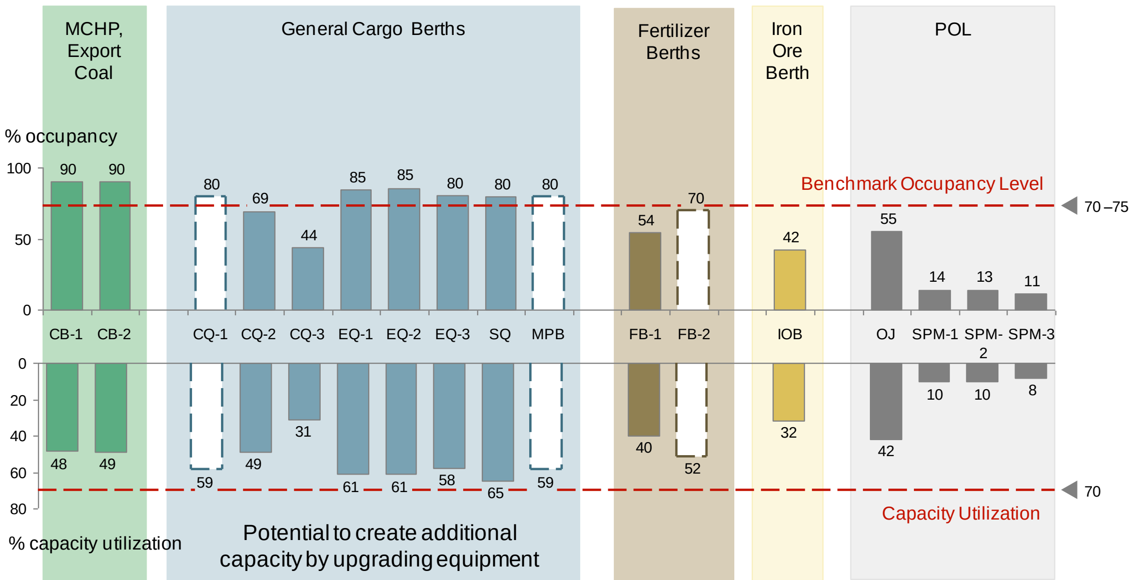


Figure 63: Occupancy and capacity utilization at Paradip port

PPT, because of its location close to Mahanadi Coal fields, can emerge as a major hub and major export center for coastal coal. Based on Origin/Destination studies for different power plants in India under the Sagarmala project, export coal handling requirement at Paradip is expected to grow >4x over the next 5 years—from the current volumes of ~22 Mn MT to~95 Mn MT.

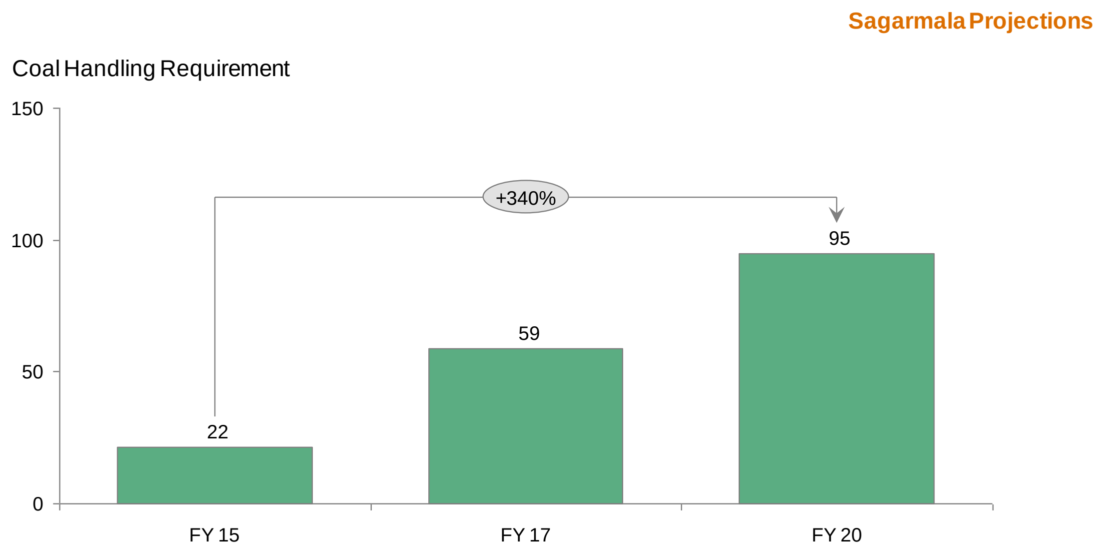


Figure 64: Future coal handling requirement at Paradip port

3.2 Key findings and initiatives from deep-dive

Paradip port has the potential to handle additional volume by increasing productivity at its existing berths. There are multiple operational levers that the port can use to drive a jump in its productivity and performance.

The following 6 broad levers exist to improve port productivity and performance:

- Increase MCHP productivity through changed berthing policies, productivity norms and reduction in non-working time
- Use Iron Ore Handling plant to handle coal to drive higher volume
- Improve land use in MCHP berths and optimize railway performance to drive higher cargo handling
- On the conventional cargo handling side, add new HMCs to lead to improved productivity of vessels. Setting of productivity norms for vessels berthing on the conventional general cargo berths will see an increase in overall productivity and, hence, cargo handling capacity of the berths
- Develop additional storage areas and add dumpers to the fleet of equipment available for cargo handling to evacuate wharf faster and drive productivity higher
- Mechanize existing conventional berths to drive higher cargo volumes

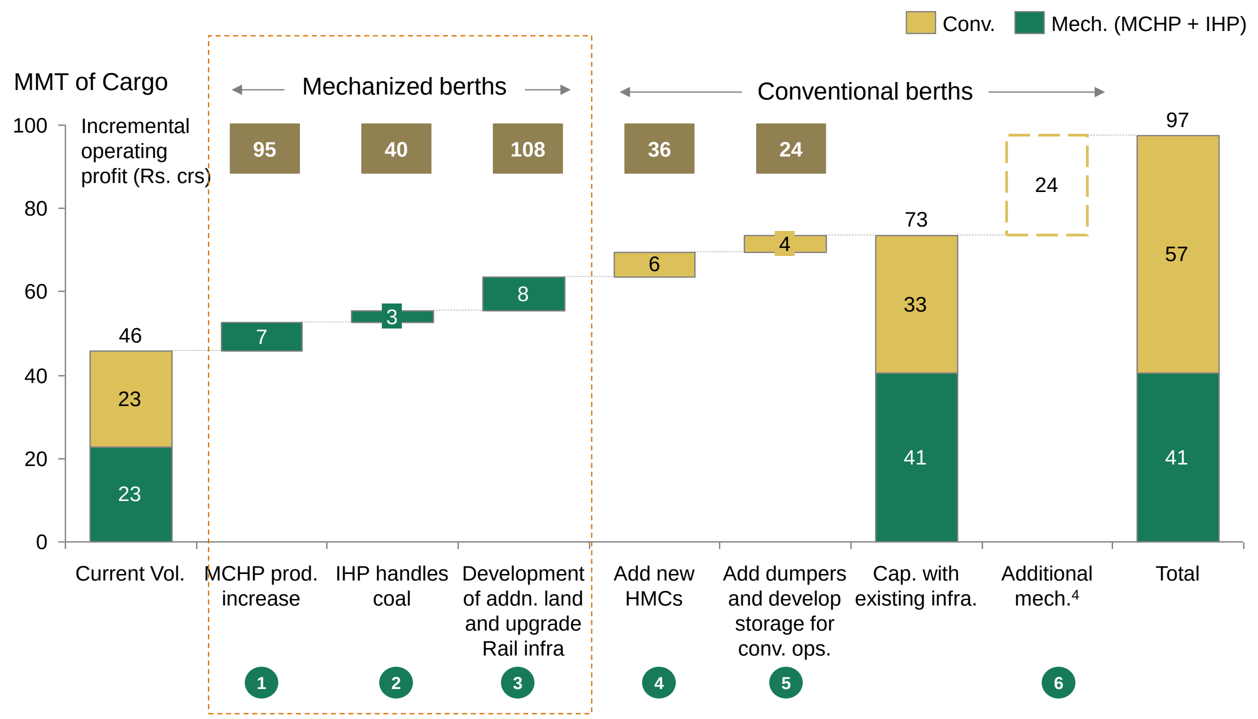


Figure 65: Identified incremental capacity through operational improvements at Paradip port

3.2.1 Mechanized coal handling plant (MCHP)

MCHP is the export coal handling plant at Paradip. MCHP handled 21 million tons of thermal coal exports in FY15.

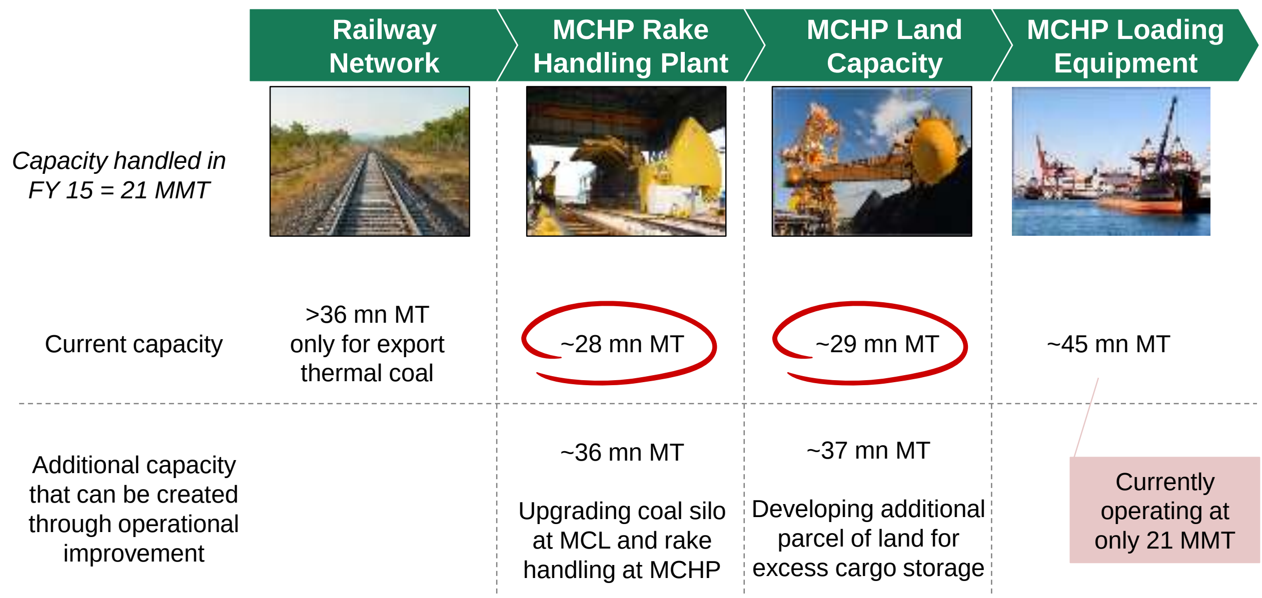


Figure 66: Value chain for MCHP handling

MCHP berth is in a position to handle a much larger volume of cargo than what it handled in FY15, provided certain operational constraints in its value chain are removed. Chief among the operational constraints include the vessel quality berthing at MCHP and the effective use of MCHP land parcel. In addition, the turnaround time for rake handling at MCHP receiving station also needs to be addressed to assist the berth to handle a larger volume of cargo. In FY15, berth productivity was much lower than the potential rated capacity of MCHP equipment. The highest gross productivity (Total Quantity Loaded / Total time spent by vessel on the berth) achieved at the berth was ~2,027 MT/hour, and the average gross productivity for the vessel was ~1,370 MT/hour.

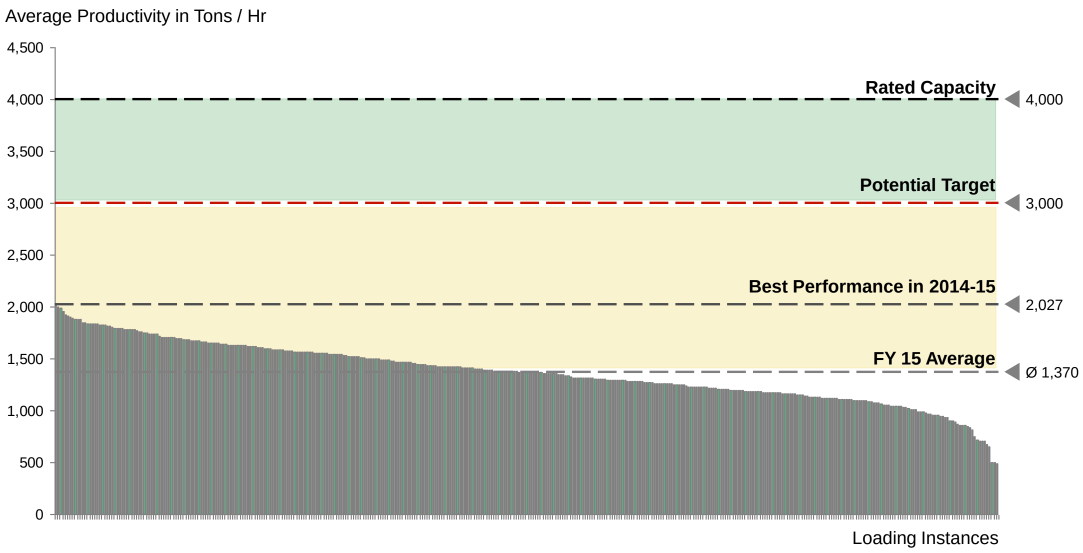


Figure 67: Productivity of every vessel at MCHP in FY15

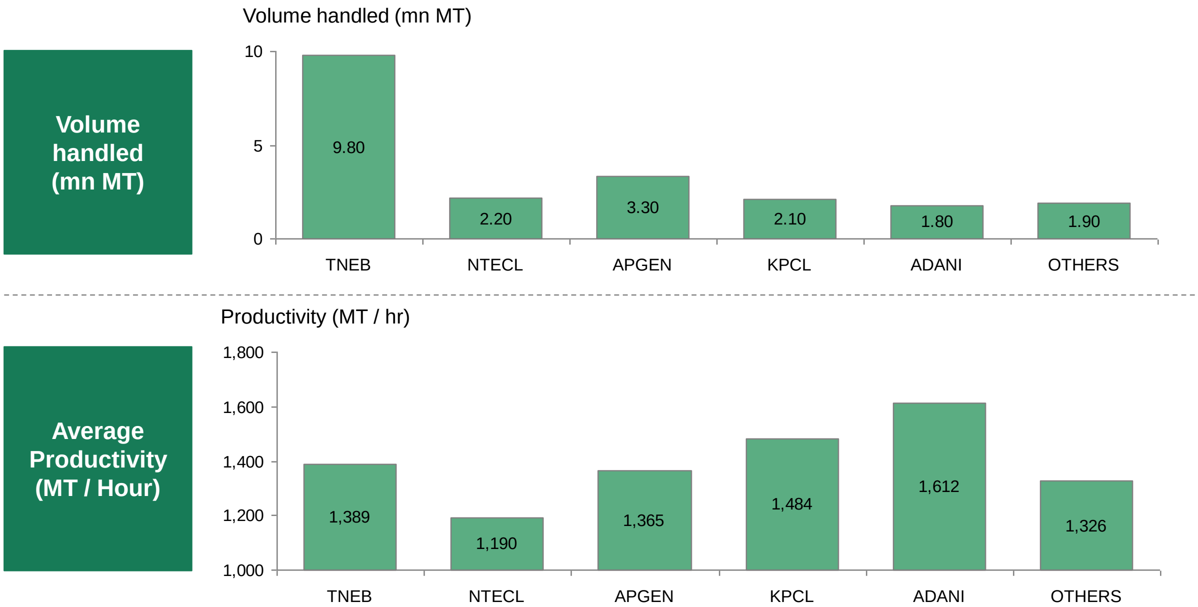


Figure 68: Volumes and productivity performance for end customers at MCHP

3.2.1.1 Initiative: PPT 1.1 Modification of existing berthing policy and set up of penal berth charges

Initiative Overview

The requested loading rate of vessels arriving at Paradip is much lower than the MCHP rated capacity. A key reason behind this low rate is the absence of defined productivity norms and penal berth charges. Thus, there is no incentive for the end customer to upgrade vessels over time. Absence of norms for number of hatch changes and draft checks results in little control over non-working time for the vessels.

In order to improve berth performance, there is a need to put in place a stringent set of productivity norms and penal charges. Also, a roadmap for how these norms will change over time needs to be provided to the end customer so that they can phase out their existing set of poor performing vessels.

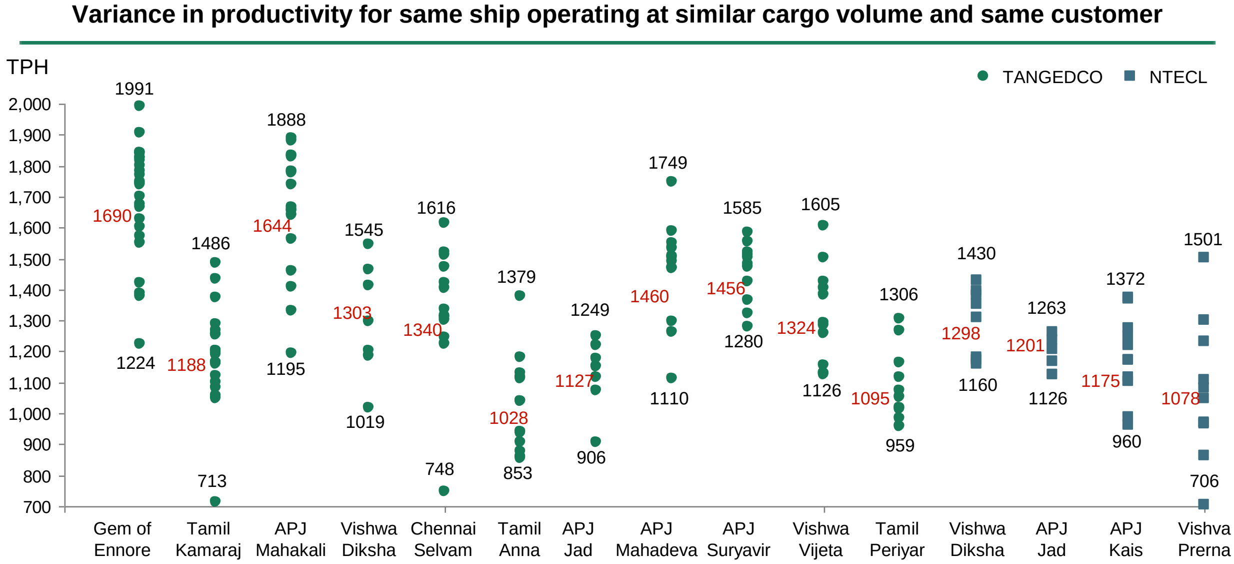


Figure 69: High variance in productivity for the same vessel handling similar parcel sizes

Key Findings

Low average productivity of vessels arriving at Paradip

Due to the use of older vessels in the coastal coal transport network, overall productivity rate requested by the vessels is low at Paradip. In FY15, more than 60% of the vessels arriving at Paradip requested loading rate below 2,000 tons per hour, while the average loading rate requested is only 2,278 tons/hr. This low request rate is impacting the overall performance of the berth.

Since PPT does not mandate vessels achieving a specific productivity during loading, there is no incentive for any of the vessels berthing currently to push towards higher productivity (unless the results are being pushed by checks that drive significant high non-working time). High variance in actual planning and execution time, conservative trimming passes, high number of hatch changes in absence of norms for each hatch change and no control on number of allowed hatch changes, absence of norms on draught checks and high number of actual draught checks are all driving high non-working time.

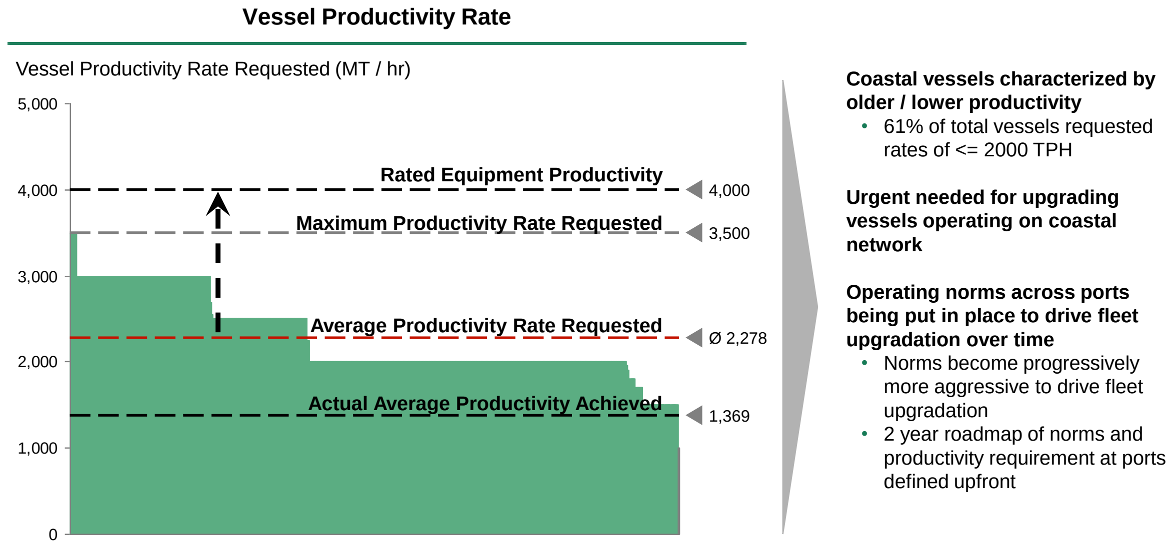


Figure 70: Average productivity rate requested by vessels at MCHP

Low parcel size of vessels arriving at Paradip

TANGEDCO / NTECL coal linkage with Eastern Coal Fields is ~1.0 Mn MT. This coal is handled mostly at Haldia port, where the vessel draught is between 7.0 – 7.5 m. Such vessels hold only up to 30,000 MT when they leave Haldia and come to Paradip to handle the remaining cargo. Such part-loaded vessels end up having a much lower productivity during operations.

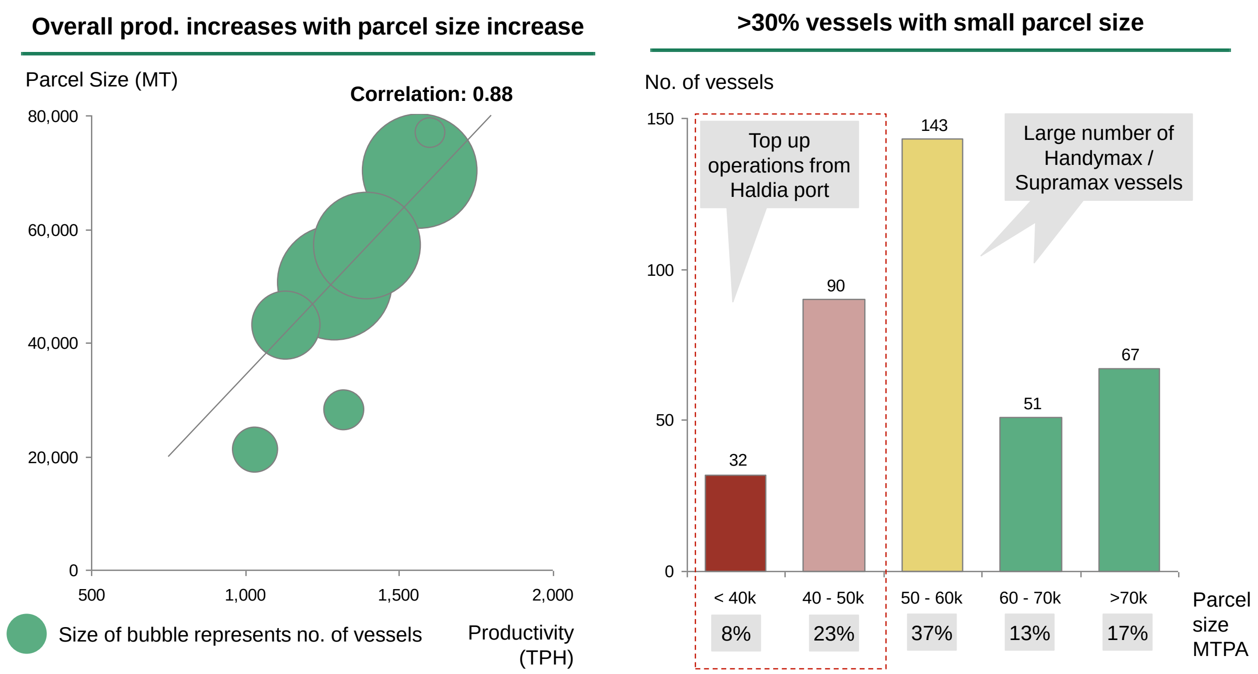


Figure 71: High correlation between vessel productivity and parcel size; ~30% of total vessels in Paradip required cargo of < 50,000 MT

Globally, ports have stringent norms and penal charges to maintain higher productivity. Private ports like Mundra in India have also adopted and implemented norms to achieve higher productivity.

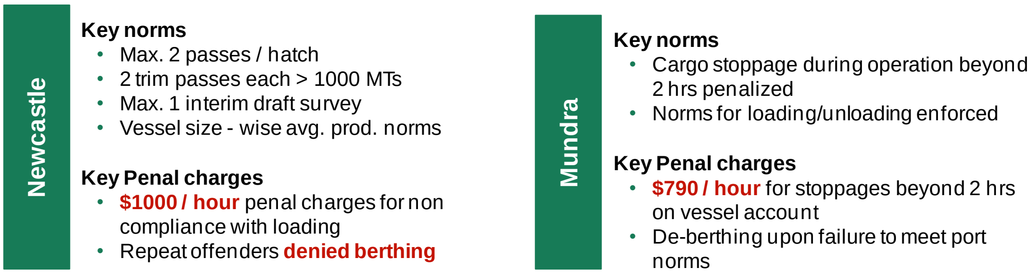


Figure 72: Key norms and penal charges at other ports

Recommendations

Of the 2 MCHP berths (CB-1 and CB-2), PPT already has a berthing policy in place wherein CB-1 berth is reserved for TANGEDCO / NTECL / APGENCO and KPCL. This prioritized berthing at CB-1 also mandates that the vessels at CB-1 achieve gross productivity of up to 2,500 MT/hour. However, this condition has not been strictly enforced by PPT. CB-2 is the MCHP berth that is being used for all vessels. There is no priority vessel berthing at CB-2.

For both CB-1 and CB-2, there should be priority of berthing vessels that needs to be followed (over and above the existing priority at CB-1). The priority should be derived on the basis of:

- Declared vessel productivity
- Vessel loading rate
- Vessel parcel size

If each of the above parameters is the same, priority should be given to the vessel on a first-come-first-serve basis.

There is also a need to set norms for number of hatch changes and number of draught checks. On the basis of vessel productivity and norms for non-working time, each vessel will be given a time within which they are expected to complete loading and deberth, failing which they will need to pay penal berth charges for every additional hour spent on the berth. If vessel stays more than double the time as mandated under the productivity norms, vessel should be compulsorily de-berthed. Also, vessels not meeting port productivity norms for 3 instances should be denied berthing in the future.

In order to derive the productivity norms, a structured approach has been devised. Any non-working time created due to inefficiencies/losses at the port side (e.g.: equipment breakdown, strike) or natural causes (bad weather, etc.) should not be incorporated in the time spent by the vessel at the berth.

		Mechanized Operations	Conventional Operations
Loading Operations	Working Time	**Optimal Working time = f(Optimal Vessel size, Optimal productivity)** • Vessel size = f(Berth draft, Length) • Optimal productivity = 80% of rated equipment capacity	**Optimal Working time = f(Optimal Vessel size, Optimal productivity)** • Vessel size = f(Berth draft, Length) • Optimal productivity = f(Crane moves, Cargo, Crane capacity)
	Non Working Time	**Non working time = 2 x # of hatches x time per hatch + 2 trim passes x time per trim pass + 3 draft checks + other elements of non working time** • does not include port related time losses, weather related time losses • draft checks can be higher for conventional operations	
Unloading Operations	Working Time	**Optimal Working time = f(Optimal Vessel size, Optimal productivity, Vessel quantity)** • Vessel size = f(Berth draft, Length) • Optimal productivity = 75% of rated eqpt. cap. when vessel quantity > 50% • Optimal productivity = 50% of rated eqpt. cap. when vessel quantity < 50%	**Optimal Working time = f(Optimal Vessel size, Optimal productivity, Vessel quantity)** • Vessel size = f(Berth draft, Length) • Optimal productivity = f(Crane moves, Cargo, Crane capacity, Vessel quantity) • HMC optimal productivity for different cargo can be standardized across ports
	Non Working Time	**Non working time = 2 x # of hatches x time per hatch + 2 trim passes x time per trim pass + # of draft checks x time per draft check + other elements of non working time** • does not include port related time losses, weather related time losses • draft checks can be higher for conventional operations	

Figure 73: Methodology to determine working time and non-working time norms

Define Berthing Norms

Optimal working time and non working time estimated for each vessel

Prioritize berthing norm basis:
- Maximum daily productivity
- In case daily productivity levels are the same, prioritize vessel which have higher cargo parcel size

Define Penal Charges

Penal charges if vessel exceeds time as defined in the norms
- Port related losses e.g. equipment breakdown, port shutdown or weather related losses not included

Penal charges pegged at 3X – 5X of berth hire charges
- Extra hour charged ~$750 for mechanized and ~$250 for conventional berths

Repeat offenders to be denied berthing

Deberthing: If vessel time crosses 2x as defined by norms

Plan phase wise rollout

Initially, the norm setting process can start with the average / median performance

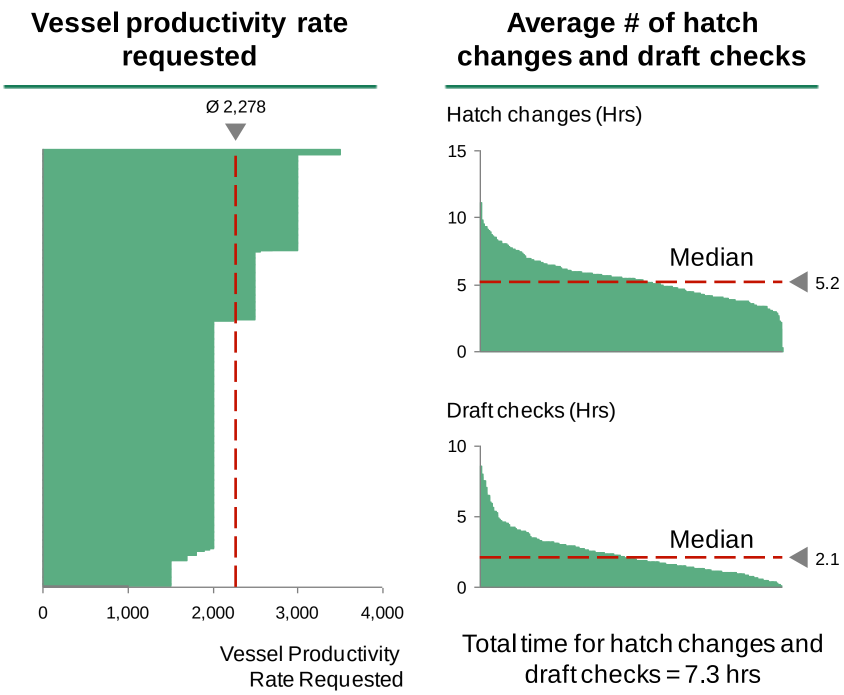
Plan for progressive strengthening of norms should be upfront defined and communicated

Ports should aim to reach optimal norm levels within 2 years

Norms and penal charges need to be updated regularly to account for latest improvements in vessel / port performance

Figure 74: Berthing norms and penal charges defined using structured approach in the previous figure

Using the above approach, we have identified MCHP norms for FY16 and FY17.



Calculated productivity norms

Min. prod. rate = 2,300 TPH

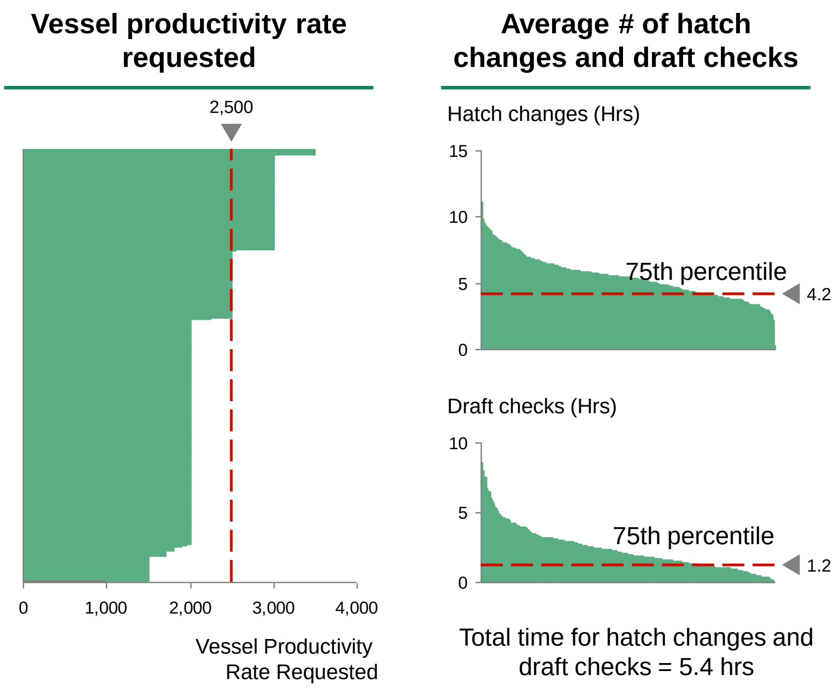
Working time for 70,000 MT = ~30 hrs

Total time for hatch changes and draft checks = 7.3 hrs

Total time = 37.3 hrs

Gross productivity = 45,040 TPD

Figure 75: Vessel productivity norms for August ’15 to July ’16



Calculated productivity norms

Min. prod. rate = 2,500 TPH

Working time for 70,000 MT = ~28 hrs

Total time for hatch changes and draft checks = 5.4 hrs

Total time = 33.4 hrs

Gross productivity = 50,300 TPD

Figure 76: Vessel productivity norms for August ’16 to July ’17

Year 1 (Aug – 15 to Jul – 16)			
Ship Class	Declared productivity	Quantity to be loaded	Loading Rate requested
Mini-Cape/ Panamax	45,000 TPD	>69,000 MTs	>3000 TPH
Panamax	43,000 TPD	>65000 MTS	>2500 TPH
		or	
Supramax	41,000 TPD	>55000 MTs	>3000 TPH
Supramax	39,000 TPD	>57000 MTs	>2500 TPH
Panamax / Supramax	37,000 TPD	>55000 MTs	>2000 TPH

Year 2 (Aug – 16 to Jul – 17)			
Ship Class	Declared productivity	Quantity to be loaded	Loading Rate requested
Mini-Cape/ Panamax	50,000 TPD	>74,000 MTs	>3500TPH
Supramax	48,000 TPD	>57000 MTs	>3000 TPH
		or	
Panamax	46,000 TPD	>72000 MTS	>2500 TPH
Supramax	43,000 TPD	>57000 MTs	>2500 TPH
Panamax / Supramax	40,000 TPD	>55000 MTs	>2000 TPH
Vessels below 40,000 TPD to be berthed only if no better productivity vessel to be berthed in next 2 days			

Figure 77: Detailed productivity norms for Year 1 and Year 2

The roadmap of how and when these norms will be implemented has been discussed with the end customers.

Along with the priority berthing with productivity norms, there also needs to be a clear definition of penal charges linked with poor performance for the vessel. The penal charges will be defined for a productivity rate that is slightly lower than the one defined for berthing norms.

	Class	Productivity (TPH)
0-6 months (October – 15 to March – 16)	Panamax	**1,856**
	Supramax	**1,523**
	Handysize	**1,314**
6-12 months (April – 16 to September – 16)	Panamax	**2,205**
	Supramax	**1,900**
	Handysize	**1,384**
12-18 months (October – 16 to March – 17)	Panamax	**2,275**
	Supramax	**2,276**

Figure 78: Penal charges linked to productivity norms

Vessels not meeting productivity threshold will be penalized USD750/hr for every additional hour.

Expected Impact

Enforcement of stringent productivity norms along with berthing policies prioritizing productivity will lead to improvement in gross productivity at MCHP. At a gross productivity of ~1,880 TPH and annual occupancy of 85%, MCHP berths can handle up to 28 Mn MT.

Due to increase in productivity, additional cargo handling capacity is being created in MCHP. At a per ton revenue realization of ~Rs. 150, this additional volume handling capacity is equivalent to a net profit of ~Rs. 45 Crs.

3.2.1.2 Initiative: PPT 1.2 Generate additional demand for thermal coal from existing customers and new customers

Initiative Overview

Increase in gross productivity at PPT will lead to decrease in occupancy for PPT. Therefore, in order to fill up capacity, there is a need to generate additional demand for coastal coal movement from Paradip.

Key Findings

Due to increase in cargo requirement at existing customers, MCHP will have potential cargo of ~27 Mn MT. Thus, additional cargo of up to ~9 Mn MT will need to be identified. Typical players from whom this can be raised include coastal plants of:

- Andhra Pradesh Generating Co
- Maharashtra Generating Co
- Gujarat Generating Co

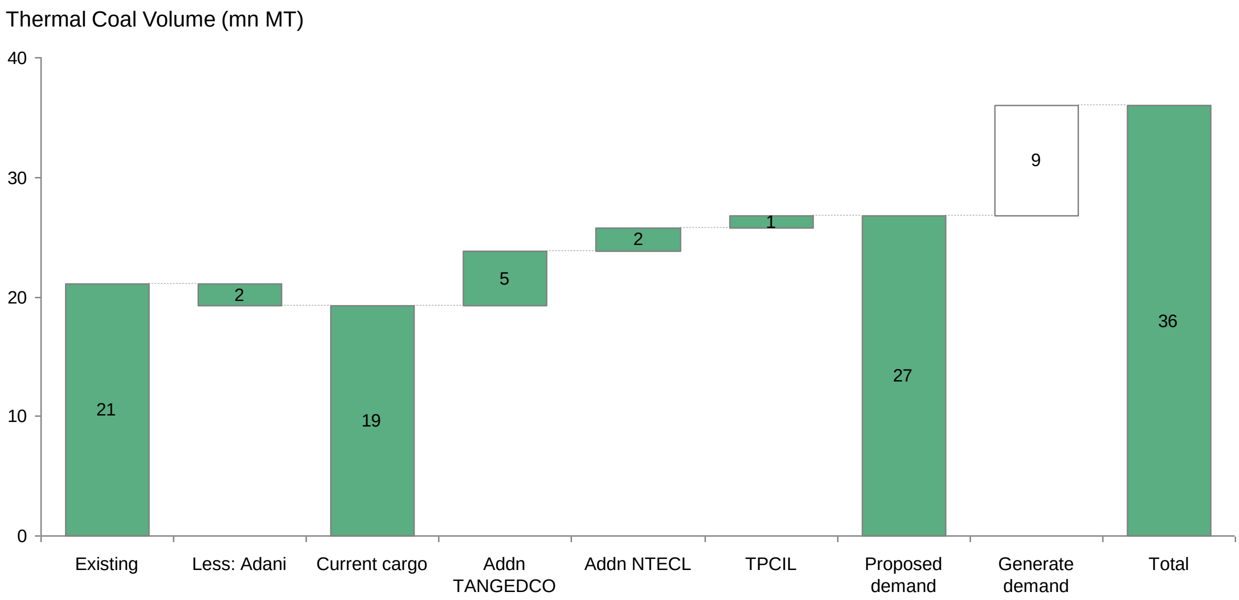


Figure 79: Thermal coal volume—need to generate ~9 Mn MT of cargo

Recommendations

Origin / Destination studies in Sagarmala have shown that APGENCO's cost of handling coal through shipping should be much lower than cost of handling coal through railways. Therefore, it is possible for APGENCO to have a modal shift in handling thermal coal.

Expected Impact

Additional 9 Mn MT of thermal coal cargo volume handled through MCHP berths. Additional demand at MCHP can create another ~Rs. 90 Crs for PPT.

3.2.2 Iron Ore Handling Plant (IHP)

Iron Ore Handling Plant (IHP) is a dedicated iron ore export terminal at PPT. However, due to fall in demand of iron ore exports, IHP had very low occupancy. In FY15, it had an overall occupancy of ~42%. IHP also has a wagon tippler to unload BOXN wagons. However, this is not in use today due to a labor dispute.

IHP currently under-utilized

Overall occupancy of ~42%

Existing conveyor system at IHP can be used for thermal coal loading

~4 – 5 mn MTs of coal exports possible through IHP
- Similar capacity release at MCHP

Low productivity shipments to be handled through IHP

1. **Handymax vessels with top-up cargo from Haldia**
2. **All BOXN cargo to be handled through IHP**
   - Reduction of loading stoppages and R&M
   - Handling cost matched with current handling cost at MCHP
3. **Smaller players' cargo routed through IHP stackyard & berths**
   - Rationalization of MCHP storage & utilization of IHP stackyard

Leading to improved productivity

7%-10% improvement in productivity at MCHP

Additional ~1lac sqm. land parcel

Figure 80: IHP berth utilization for thermal coal export can add capacity in the short term

3.2.2.1 Initiative: PPT 2.1 Use IHP for export coal handling

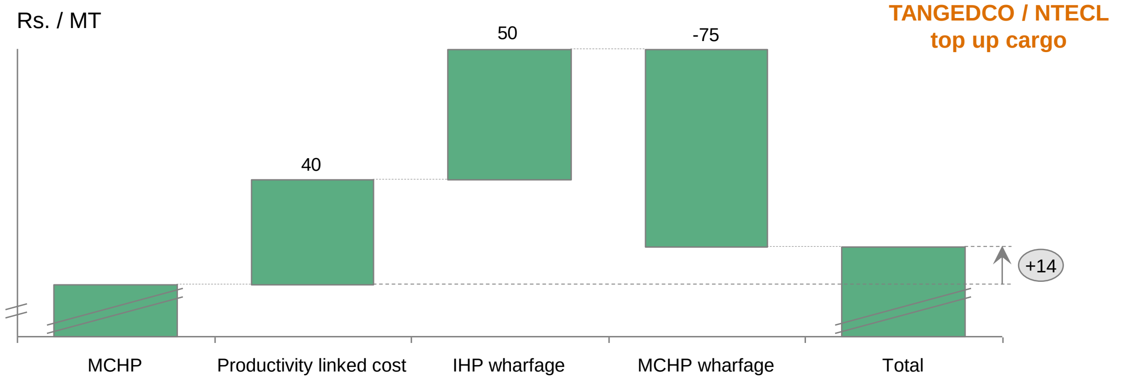
- **Initiative Overview**
- IHP is capable of handling export coal. In fact, in FY15 it handled 8 vessels for export thermal coal loading at productivity varying from 8,000 MT/day to 17,000 MT/day. Therefore, using IHP as an additional thermal coal terminal will increase thermal coal handling capacity for PPT.
- **Key Findings**

Low parcel size of vessels arriving at Paradip

- As discussed, TANGEDCO / NTECL coal linkage with Eastern Coal Fields is ~1.0 Mn MT. This coal is handled mostly at Haldia port, where the vessel draught is between 7.0 – 7.5 m. Such vessels hold only up to 30,000 MT when they leave Haldia and come to Paradip to handle the remaining cargo. Such part-loaded vessels end up having a much lower productivity during operations. If moved to IHP, they will ensure better utilization of IHP berth by matching productivity of vessels with equipment productivity and also create additional cargo handling capacity at MCHP. There is, however, a need to manage operations through wagon tippler as this will reduce cost for the end customer. Till the time wagon tippler operations are not available, IHP can continue to operate shifting cargo for TANGEDCO / NTECL coming to IHP instead of MCHP.

Handling of this current "shifting cargo" at IHP will have another advantage. Because this coal is handled manually, there is a risk of contamination with foreign material that creates additional down time for MCHP operations. Removing this cargo from IHP will lead to an increase in overall MCHP productivity.

Higher cost at IHP due to lower productivity, can be balanced by reduction in wharfage costs at IHP



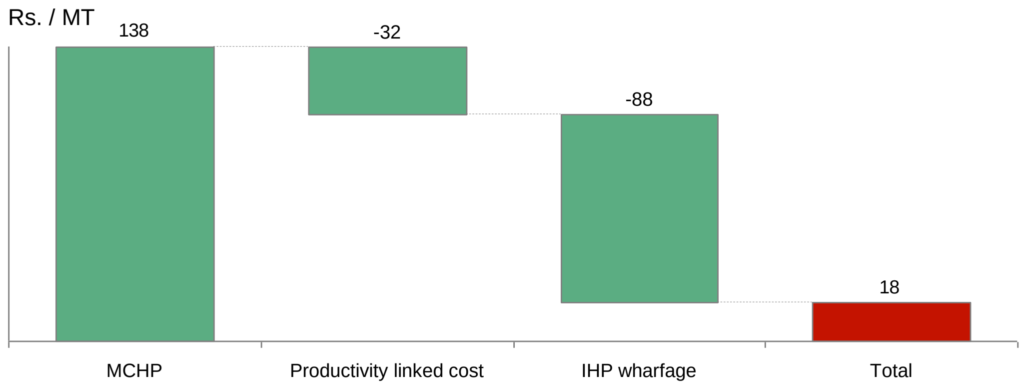
KEY ASSUMPTIONS

- MCHP productivity for top up vessels = 1083 MT / hour
- IHP productivity for export coal = 417 MT / hour
- Pre berthing delay at MCHP = 60.3 hours
- Pre berthing delay at IHP = 62.9 hours
- Parcel size = 24,617 MT
- Vessel per day cost = Rs. 600,000
- Vessel GRT = 29,935 MT
- Other rates taken from Paradip Port Scale of Rates

Figure 81: IHP berth is cheaper for top-up cargo operations

- In addition, smaller customers handling < 1 Mn MT at MCHP can be shifted to IHP to improve utilization of the berth and the land allocated to MCHP. Any rakes over and above the current 3 rakes/day through manual operations should be handled through wagon tippler operations.
- Productivity adjusted prices for IHP is slightly higher compared to MCHP. For MCHP, the customers would be paying between Rs. 125 – Rs. 145 depending on the volume of cargo handled. For IHP, the same amount would be ~Rs. 88. An additional hidden cost for the customer for IHP is the amount of time spent by the vessel. This productivity factor amounts to ~Rs. 32 / MT. Thus, even productivity adjusted IHP is cheaper compared to MCHP by Rs. 18 / MT.

IHP cheaper than MCHP handling by ~Rs. 18



KEY ASSUMPTIONS

- MCHP productivity for export coal for Panamax = 2083 MT / hour
- IHP productivity for export coal for Panamax = 583 MT / hour
- Pre berthing delay at MCHP = 60.3 hours
- Pre berthing delay at IHP = 62.9 hours
- Parcel size = 70,000 MT
- Vessel per day cost = Rs. 600,000
- Vessel GRT = 29,935 MT
- Other rates taken from Paradip Port Scale of Rates

Figure 82: IHP berth is cheaper compared to MCHP operations

Recommendations

IHP needs to start handling thermal coal exports. This will ensure better utilization of IHP, and also increase thermal coal handling capacity at PPT.

Expected Impact

IHP can handle up to 4.5 million tons of coal and this capacity will be released at MCHP. At current price of ~Rs. 88/MT and another additional potential to increase prices by Rs. 15 - 18 / MT, this would lead to an additional operating revenue of Rs. 40 Crs, which would flow almost directly to the operating surplus of the port as most costs are of a fixed nature.

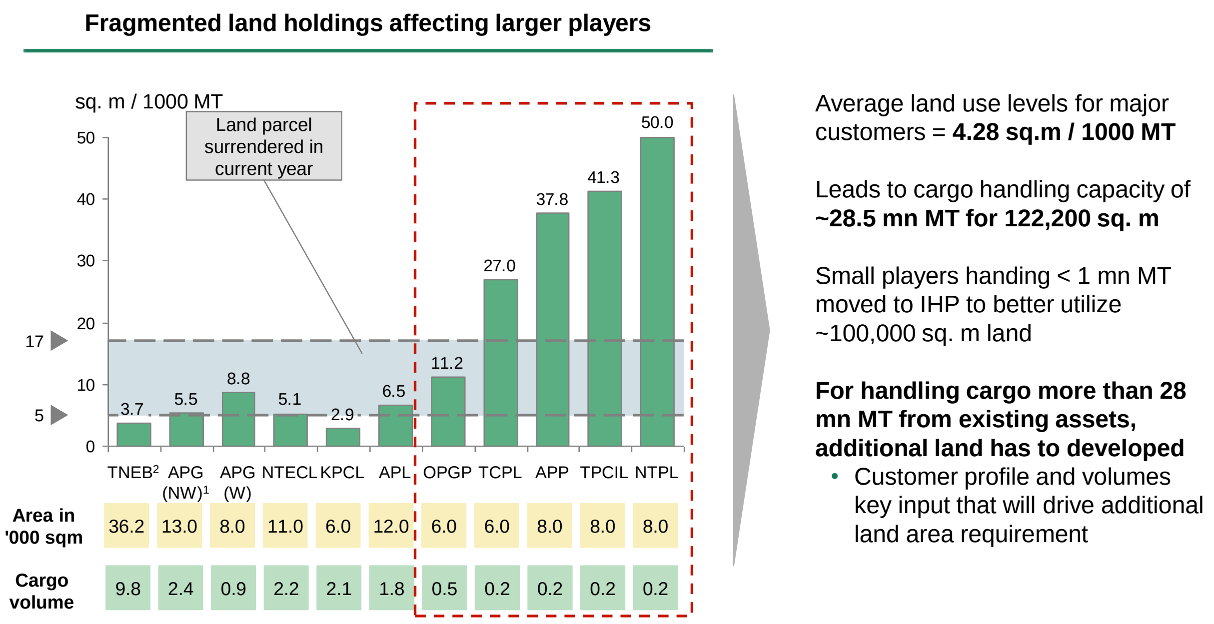
3.2.2.2 Initiative: PPT 3.1 Rationalize existing plots in MCHP, and develop additional land

Initiative Overview

In order to handle higher cargo volume from existing MCHP capacity, there is a need to improve the churn of cargo over the existing land parcel. Currently, there is a big difference between the volumes per unit area occupancy achieved by customers. In general, high-volume customers have a very good churn of volumes— often differing by a factor of more than 10.

Key Findings

Cargo turnover or churn varies from 2.9 sqm/1000 MT for KPCL and 3.1 sqm/1000 MT for TANGEDCO to values of 40–50 sqm/1000 MT for players such as TPCIL and NTPL. Higher value of this metric is a negative as it implies the customer is turning over inventory on the same land parcel much slowly. The five major customers who have exported ~95% of volume at MCHP have used only 70% of the storage yard, while the remaining five smaller customers who exported ~5% of volume have used 30% of the storage yard. This imbalance is affecting the effectiveness of the land parcel. Average land utilization of major customers (> 1.0 Mn MT cargo) is 4.28 sqm per 1000 tons, while for the smaller customers it is 27.7 sqm per 1000 tons.



1. APG Non washed coal is being managed by 3 different players 2. Currently includes ~3 mn MT / year of shifting cargo which in the future should move to IHP
Source: Land allocation data from PPT, BCG analysis

Figure 83: Land utilization by customers at MCHP

The typical international benchmark for this churn (sqm/1000 MT) is between 5.0 and 17.0. However, for parcels where end customers are fixed, this can be a much lower number due to low complexity of handling yard operation for fewer customers. Currently, most of MCHP's bigger customers are either better than international benchmark or in line with global performance.

Recommendations

We have assessed two options for the rationalization of the land:

1. **Common pool of land for smaller players**: Creating a common pool of land area of 20,000 sqm at MCHP for the usage of smaller players. This will release 16,000 sqm of land for bigger customers.
2. **Handling of smaller customers' cargo at IHP**: Cargo of smaller players can be moved through IHP. This will release 36,000 sqm of storage yard used by the smaller players.

Option 2 is the preferred option as it will help in effective utilization of MCHP while also storing cargo in the IHP land area that will improve utilization of IHP land parcel of 100,000 sqm. To handle 28.0 Mn MT of thermal coal over 122,200 sqm of land, a land churn of 4.35 sqm/1000 MT of land is required. Of the 4 biggest players, 2 are well below this threshold. With increase in cargo, APGENCO and NTECL can also have better land churn rates than the 5.1/6.7 sqm. Thus, the existing land parcel will be able to handle 28 Mn MT, provided the existing customer base remains the same.

If each player is able to reach a target of 3.7 sqm/1000 MT (TANGEDCO performance), the same land parcel will be able to support up to 33 Mn MT of cargo. Higher cargo volumes from the same customers can be supported with further improvement in land churns.

Further optimization of land use can be carried out by the following steps.

- Consolidation of land parcel for use by APGENCO. Currently, they have multiple cargo handling agents which leads to poor utilization of existing land parcel
- A further optimization can be done by getting Coal India to come and manage port level inventory of Washed and Non washed coal. This will result in a common inventory and hence a better utilization of the existing parcel. Also, this will reduce the following instance of efficiency loss in the coal network
    - Pre berthing delays of vessels due to waiting outside for inventory
    - Excess time spent for each vessel in bench change and stock pile change. This will further add productivity to vessel performance

Development of additional storage yard at MCHP

However, if additional cargo is obtained from additional players, land fragmentation will increase and it might be difficult for all customers to have a low churn rate. In this case, there might be a need to develop additional land to support MCHP berth. Initial assessment for developing another 61,000 sqm with all equipment and systems in place is around Rs. 200 crores (based on interviews of PPT management). However, this number may be revised upwards or downwards after a detailed technical feasibility is conducted. This detailed technical study is ongoing at the time of writing this report and its results are expected by Jan 2016.

Expected Impact

Improvement in yard performance will support MCHP berth to handle additional cargo. This additional cargo (above 21 Mn MT handled in FY15) can vary from 7 Mn MT to 15 Mn MT. This initiative has the potential to create additional capacity for the port that will increase port operating surplus by Rs. 27 Crs.

3.2.2.3 Initiative: PPT 3.2 Improve RRS monitoring to improve maintenance and reduce rake TRT

Initiative Overview

In addition to debottlenecking MCHP berth and yard, there is also a need to look at potential constraints on the receiving station end for MCHP. In FY15, the MCHP station received an average of 15 BOBRN rakes. At its peak, the MCHP station received around 22 rakes in a day.

Key Findings

In order to handle 28.0 Mn MT of cargo by MCHP linked to rake receiving station, there is a need for around 21 rakes in a day. And to take this cargo up to 36 Mn MT, 27 rakes need to be handled in a day.

21 rakes in a day correspond to each rake handling from entry to exit to be over in 2 hours with a buffer of ~15 minutes between each rake. Similarly, 27 rakes in a day correspond to each rake handling from entry to exit to be over in 1.5 hours with a buffer of 15 minutes between each rake.

While 21 rakes is possible in the existing setup with some system level constraints being met, 27 rakes would need additional steps for driving improvement. At 27 rakes / day with ~340 days of operations, the entire MCHP setup can potentially handle upto 33 mn MT of cargo. However, this is subject to obtaining sized coal cargo and availability of rakes in the system.

The current average rake turnaround time is 2:15 hours. Of this, around 30 minutes is spent in the incoming rake moving in and out of the receiving station. The remaining 1:45 hours is spent in actual unloading. The percentage split of time lost in different activities is as given below:

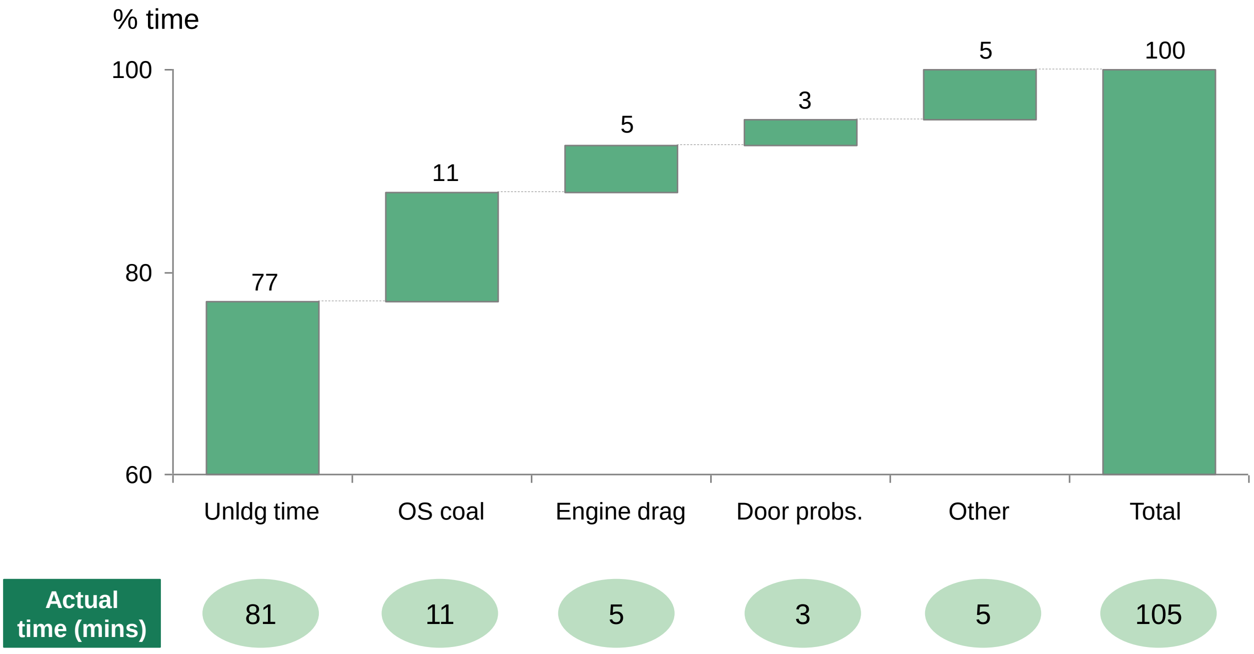


Figure 84: Split of time spent in different activities at MCHP receiving station

The leading cause of lost time on the rakes is due to the presence of over-sized coal in incoming rakes. To address this problem, a crusher cum silo system needs to be installed at the coal loading end in MCL coalfields. This initiative will save an additional 15 minutes of time lost due to over-sized coal, while also decreasing the time spent in actual unloading.

Recommendations

In order to maximize the handling from existing steps, different stakeholders need to take actions. PPT should liaison with each stakeholder to identify and track performance.

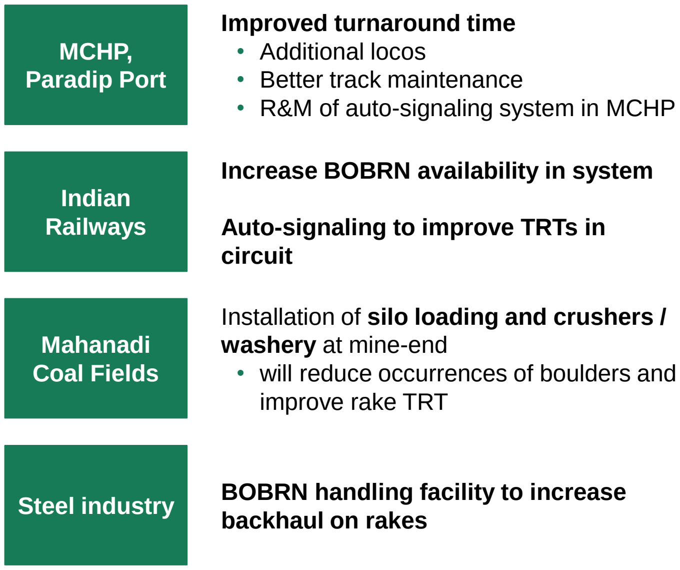


Figure 85: Actions needed to optimize rakes in Talcher-Paradip loop

There is a need for a coal loading silo with appropriate crusher system at all MCL mine heads (Bharatpur, Ananta) from where thermal coal is currently coming to Paradip Port. Currently, Bharatpur coal crusher system is expected to be operational from end March 2016 / early April 2016.

For further identification of specific areas of improvement in rake receiving station at MCHP, monitoring of rake performance and detailed data for exact causes of delays needs to be recorded. On the basis of interviews conducted with different team members, following ideas have emerged that need to be verified with additional data.

- Improvement of railway track cleaning: Inadequate cleaning of railway track often leads to engine slippage, increasing turnaround time for rake in the system.
- Use of double locos to draw engines: Inadequate power from single loco affects rake speed in the loop and, hence, affects turnaround time.
- Auto – signaling system: Upgrade auto-signaling system at rake receiving system at MCHP in PPT.

Expected Impact

Additional rake handling capacity will boost MCHP handling and will create additional operating surplus of ~Rs. 41 Crs. If the current system is not in a position to manage all 27 rakes even after complete debottlenecking and optimization, there may be a need to create additional railway lines/merry-go-round as per PPT 3.3. This will entail an additional development cost of ~Rs. 200 Crs (initial estimates).

3.2.2.4 Initiative: PPT 3.3 Development of additional railway merry-go-round at MCHP

Initiative Overview

There may be a need to create another rake receiving system at MCHP to handle additional cargo.

Key Findings

After debottlenecking, if the MCHP system is not in a position to handle 27 rakes, there may still be a requirement to create an additional rake receiving system for handling additional incoming coal cargo.

Recommendation

PPT should get technical and feasibility studies conducted for requirement of an additional merry-go-round at MCHP. However, actual decision of implementation should only be taken after the impact of MCL crushing is observed on the existing receiving stations.

There would also be a need to estimate the potential NPV of the new project. If capital expenditure is very high and incremental volume-handling capacity is not enough, there might be a case to not take up this project altogether, in lieu of mechanization of existing conventional berths or development of outer harbour.

Expected Impact

Potential increase in rake-receiving capacity at MCHP and subsequent increase in volume handling capacity.

3.2.2.5 Initiative: PPT 3.4 Setup auto-signalling system, add new line between Talcher–Paradip

Initiative Overview

There is a need to upgrade Talcher–Paradip railway line to ensure ease of cargo movement from MCL to Paradip port for coastal evacuation.

Key Findings

Without an auto-signalling system and additional rail lines, PPT will face evacuation constraints for its cargo.

Recommendation

This project should be taken up by the Indian Railways. It can be monitored as part of other inter-ministerial projects being taken up in Sagarmala.

Expected Impact

Increase in number of rakes handled, and ease of cargo evacuation from the port.

End-state of mechanized berths in Paradip

Operations	IHP	MCHP (CB-1, CB-2)
Berth	• Tangedco / NTECL current shifting cargo of 3MMT – Low productivity vessels of sub-Supramax vessels shifted to IHP – Linked to Haldia top up volume (~ 1.0 mn MT) • Small players (< 1 mn MT annual volume) shifted (~1.3 MMT)	• Remaining cargo (TANGEDCO – 7, NTECL – 2, APGENCO – 3, KPCL – 2) – No top-up allowed – Minimum parcel size defined 55,000 TPH – Additional cargo required from existing customers
Land	• Land for IHP used for shifting cargo and allocating for small players	• Additional parcel upto 40,000 sq. m available for allocation • New land to be developed for handling cargo beyond 28 mn. tons
Railways	• Meet labor requirement of 3 rakes using TANGEDCO / NTECL till labor issue is not resolved • Once resolved, use wagon tippler for operations • Use of wagon tippler for handling cargo for small players	• Additional rake capacity – 6 – 7 BOBRN = 9 – 10 mn MT – 3 – 5 BOXNs for double loading

Figure 86: End-state for existing mechanized berths in PPT

3.2.3 Conventional berths

PPT has 7 conventional berths—CQ1, CQ2, EQ1, EQ2, EQ3, SQ, and MPB—and another berth, CQ-3, which is mechanized for iron pellets. All import cargo is handled at these berths using ship cranes or HMCs combined with loaders and dumpers for evacuation. Together, these berths handled ~23 Mn MT of cargo in FY15. There are 4 harbor mobile cranes (HMC) operated across berths CQ1, CQ2, SQ, EQ1, EQ2, and EQ3 by private players. One crane is of 100 MT capacity, two are of 80 MT capacity, and one is of 60 MT capacity.

Figure 87: Conventional berths layout and draughts for respective berths at PPT

Currently, conventional berths occupancy rate is high and for most berths it is between 80–85%.

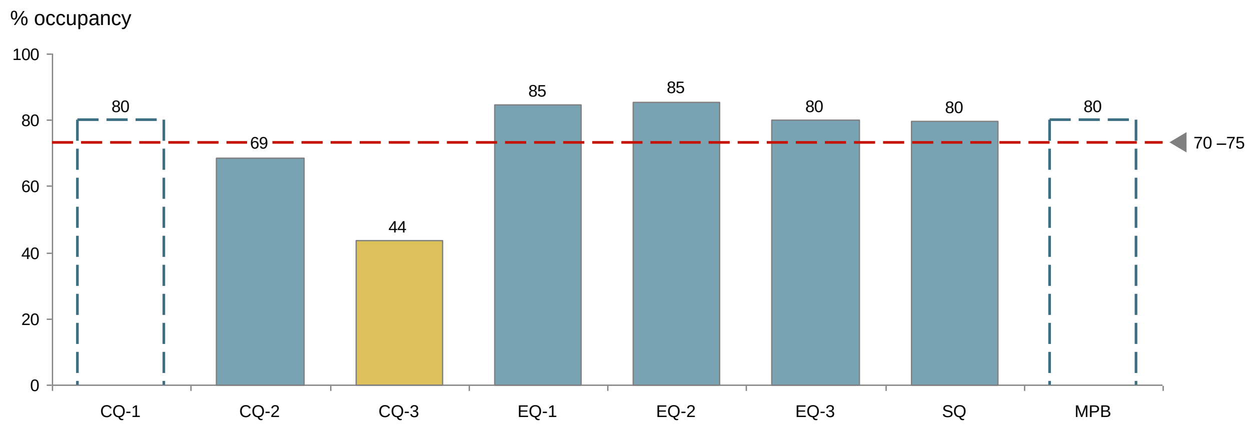


Figure 88: Conventional berths have very high occupancy

However, the productivity at these conventional berths, which is in the range of 8-10K tons per day, is low compared to other major ports including NMPT, VOC and other Indian private ports such as Krishnapatnam and Karaikal.

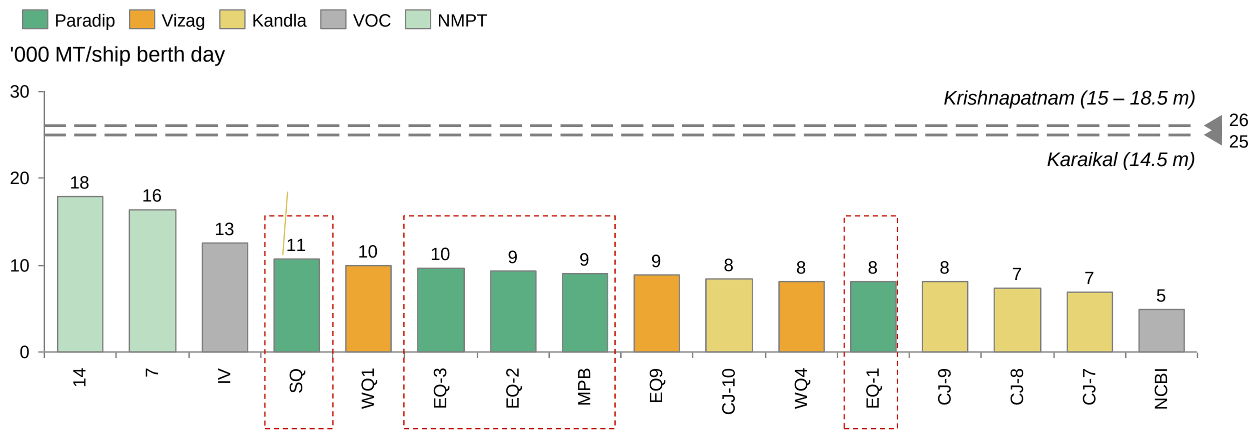


Figure 89: Productivity benchmark at conventional berths

Also, PPT berths have the highest average NWT across berths. A deep dive of the key reasons for this high non-working time indicated the following broad categories of issues affecting productivity at the berths:

- Low number of HMCs operating between conventional berths
- Poor availability of existing HMCs further compounding problems
- Lack of adequate storage space and high cargo affecting evacuation performance from wharf
- Lack of adequate number of dumpers to execute the wharf evacuation process

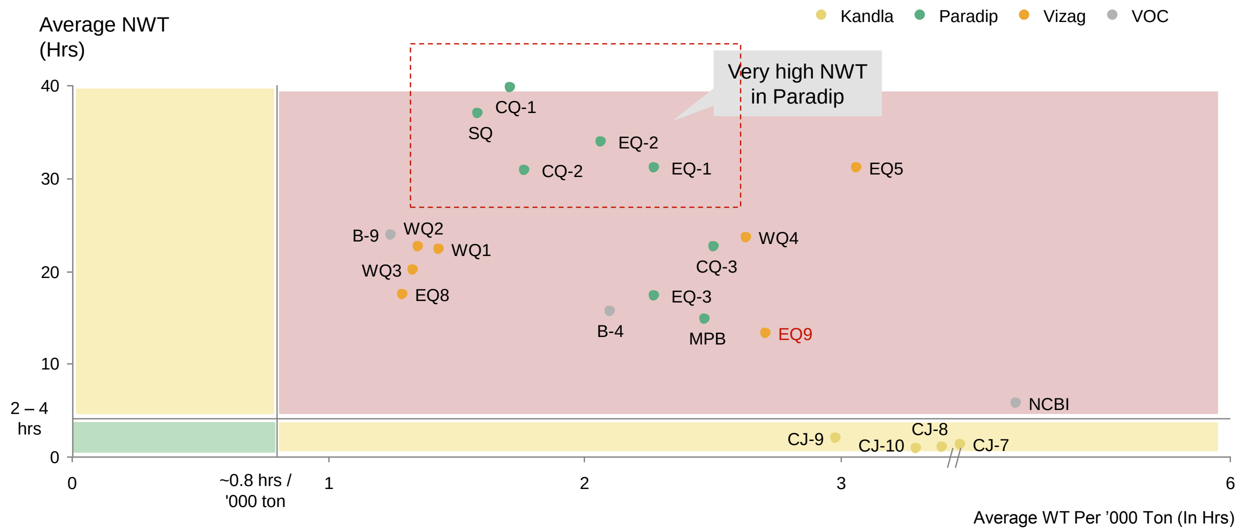


Figure 90: Non-working time for PPT conventional berths is among the highest across all ports

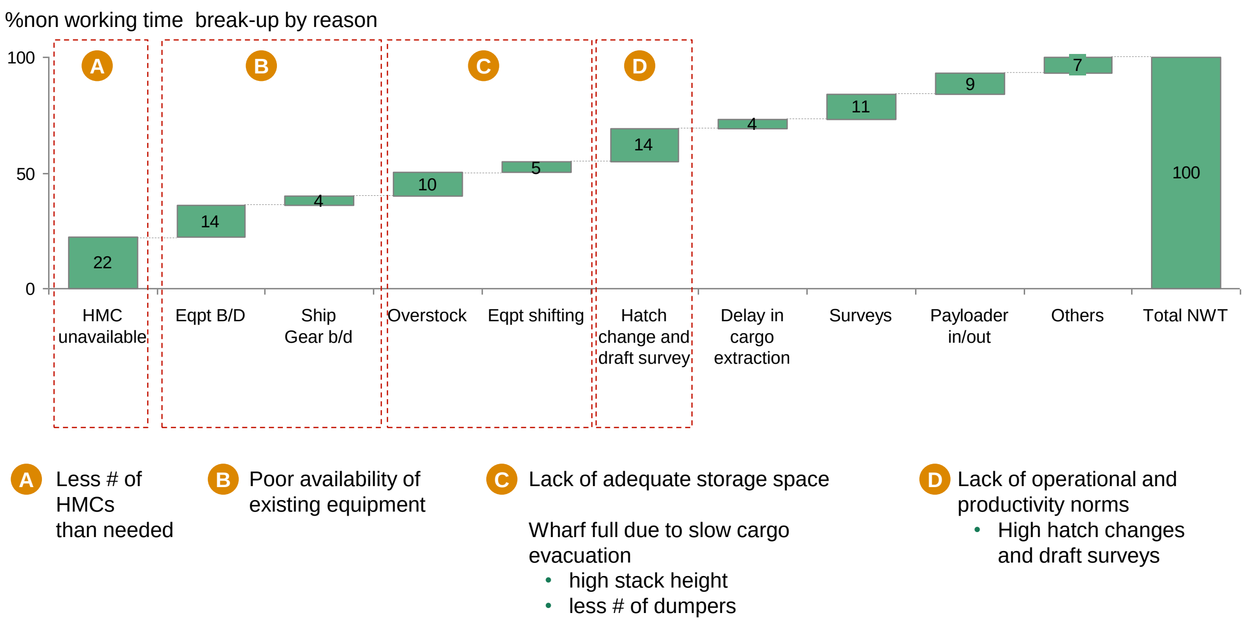


Figure 91: Non-working time split for conventional berths at PPT

Initiative: PPT 4.1 Operate 8 Harbour Mobile Cranes across EQ 1-3, CQ1-2, SQ, MPB berths

Initiative Overview

Currently, 4 harbor mobile cranes (HMCs) are being operated and shared between 6 conventional berths at PPT. However, they are not sufficient to serve the current demand at conventional berths. As a result, HMCs need to be shared between vessels as not all vessels have an HMC operating on them at all times. Geared cranes with ship cranes, therefore, rely on lower productivity ship cranes for evacuation. In addition, availability of HMCs is low compared to benchmark due to frequent breakdowns, which results in low productivity at conventional berths compared to other major ports.

Key Findings

Currently, 2 out of 4 HMCs at PPT are of Orissa Stevedores Ltd. (OSL) with rated capacities of 80 tons and 100 tons. Other 2 HMCs are operated by Chennai Radha Engineering Works (CREW) with rated capacities of 60 tons and 80 tons.

Among the four HMCs, OSL-1 and OSL-2 are available ~70% of the time due to frequent breakdowns, while CREW-1 is available for 90% of the time, and CREW-2 for 85% of the time. Due to high occupancy at PPT berths, the average number of hours each berth has a vessel is ~7,000 hours. Due to the presence of low number of HMCs, <50% of vessels could use HMCs in FY15. This had a significant impact on the productivity of existing berths. Using the total number of vessel hours and the average working time for each HMCs historically, there is a need to add around 6 new HMCs across the conventional berths. Of these, PPT has already awarded contracts for 4 new HMCs.

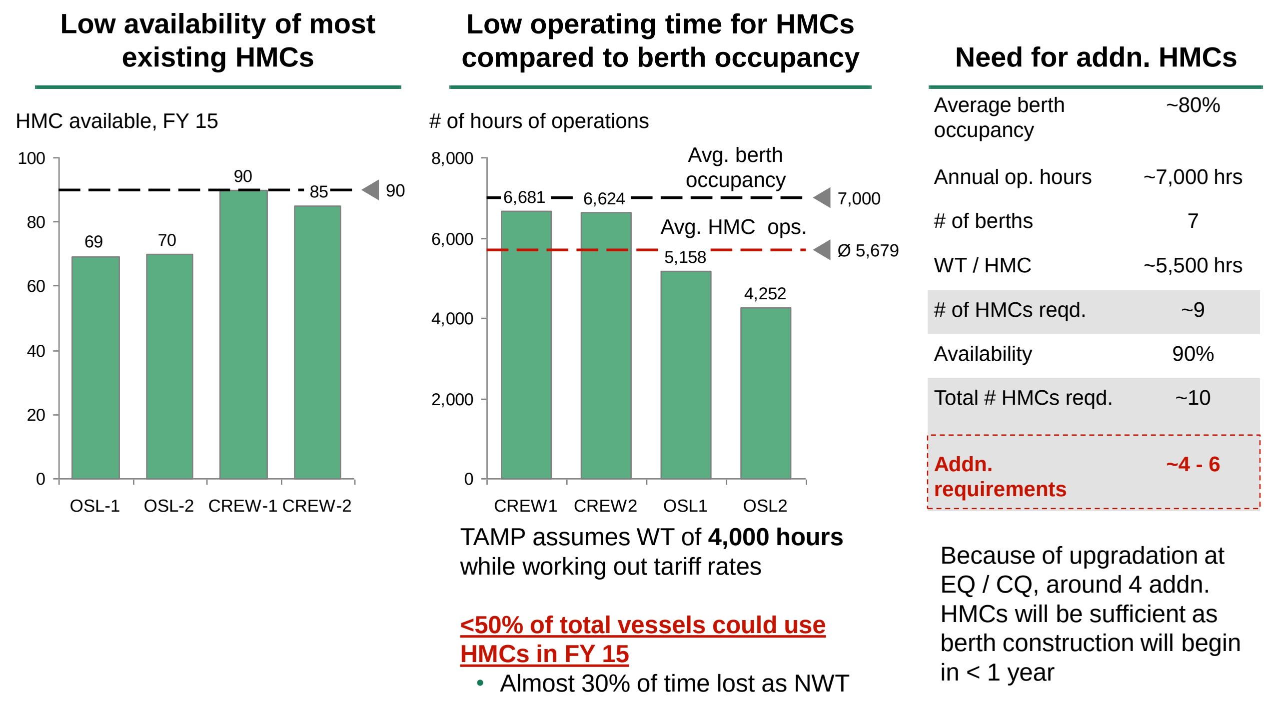


Figure 92: Existing HMCs have low availability, inadequate HMC hours compared to berth requirement and, hence, there is a need for additional HMCs

However, there is also a plan to mechanize EQ 1-3, CQ 1-2 and the construction activity is expected to start soon. Thus, instead of 7 berths, around 1.5 berths will be immediately decommissioned. Hence, instead of 10 HMCs, there will be a need of only 8 HMCs and the remaining 4 HMCs should be sufficient to handle cargo from all vessels.

Recommendations

Add 4 additional HMCs across the conventional berths. The current award of contract for 4 HMCs is given out and the HMCs will be commissioned by November 30, 2015.

Expected Impact

Additional HMCs on the berth will lead to an increase in berth productivity, thereby creating additional occupancy on the berths to increase capacity. This initiative will lead to capacity creation of ~6 Mn MT, which will add around ~Rs. 36 Crs of additional operating surplus for the port.

3.2.3.1 Initiative: PPT 4.2 Penal charges linked to productivity norms for different cargo

Initiative Overview

As discussed earlier, conventional berths have high non-working time on the berths. In order to improve operational control on the performance, there is a need to set productivity norms for each HMC. Once norms for HMCs have been established, norms for vessels would also need to be established.

Key Findings

PPT does not have any productivity norms to drive equipment and vessel performance till FY15. There is an urgent need to set up productivity norms for driving higher berth and vessel productivity.

Recommendation

Productivity norms should be set to increase productivity and reduce non-working time. Norms have to be set for both HMC operations and vessel operations. These norms have to be set for each cargo type. Adequate penal berth charges need to be put in place after a pilot of productivity norms has been completed at the port.

Expected Impact

Setup of additional productivity norms and penal charges will support initiative PPT 5.1 in increasing cargo volumes by 6 Mn MT through conventional berths.

3.2.3.2 Initiative: PPT 5.1 Develop additional storage capacity and full rake sidings

Initiative Overview

Wharf evacuation from the cargo is delayed due to low dumper productivity. At most of the existing siding plots, due to high cargo storage and high stack height, dumper unloading is very slow, creating long queues for the dumpers just before entering the stack yard. Addressing the issue of high cargo stack heights will lead to increased dumper productivity, ensuring faster wharf evacuation and reduced non-working time for the HMC.

Key Findings

Most of the hig- volume port customers (SAIL, Bhushan, TATA Steel, and JSPL) suffer from this problem of high stack height. Also, siding plots are in high demand due to the ease of evacuation of cargo from the plots.

Recommendations

Creation of additional storage yard with sidings would ease congestion and storage constraints in existing plots. From the current port map, additional land parcel of ~200,000 sqm has been identified for development of additional plots. This will also have sufficient length to have full rake sidings.

Figure 93: Land parcel for new siding storage plots development

Expected Impact

Construction of the new plots can be completed in ~1 year, and estimated capex for plot development and sidings should be ~Rs. 20 Crs. This will lead to an increase in dumper productivity, reducing non-working time for HMCs on the berths and increasing cargo unloading productivity. This increase is expected to be around 4 Mn MT of cargo.

3.2.3.3 Initiative: PPT 5.2 Incentivize performance through yard management norms and penalty structure, reallocate siding plots per cargo volumes

Initiative Overview

The absence of any norms for storing cargo in port land within the custom area affects overall port productivity.

Key Findings

Absence of land use norms at the port creates disincentive for customers to evacuate cargo efficiently. For siding plots or plot lands close to berths, absence of norms creates situations where slow moving cargo is stored on the plots, affecting overall port productivity. Also, a linear tariff structure of storing cargo creates no urgency to evacuate cargo faster.

Recommendations

To address efficiency of using port land, the following needs to be done:

- Norms for storing cargo in port land within custom areas need to be put in place
- Telescopic pricing for storing cargo on land to incentivize faster evacuation and higher productivity

- Priority for using plots close to sidings and berths should be defined to ensure high volume customers are given preference

Expected Impact

Norms for storing cargo will lead to an increase in efficiency of using port lands, and will also drive increased dumper productivity—reducing non-working time for HMCs on the berths, which in turn will support initiative PPT 5.2 in handling additional cargo at PPT berths.

3.2.3.4 Initiative: PPT 5.3 Add new dumpers to the fleet and reduce shift changeover times

Initiative Overview

PPT does not have adequate dumpers to meet the higher productivity requirement of HMCs for evacuating cargo from wharf. The poor unloading speed at storage yards further compounds this problem. Inadequate number of dumpers currently deployed in the port is another problem plaguing conventional operations. Also, time lost in shift changes affects dumper productivity and working time.

Key Findings

The turn round time (TAT) of dumpers from wharf to yard without waiting at the yard is 28–30 minutes. This includes the waiting time on wharf for loading, loading time, time to the yard from wharf, cargo unloading time at the yard, and time to wharf from yard. On an average, 15–20 minutes is spent by each dumper in a trip waiting at the yard. Increase in cargo handling can lead to an increase in this waiting time before yard. As a result, the total number of trips per dumper in each shift is low (usually around 9–10).

Also, dumper operations are stalled for 1.5–2.0 hours during shift changes, as the current shift drivers leave almost 1 hour prior to the shift ending time, and the next shift drivers start 45 minutes to 1 hour later. This also hinders continuous HMC operations.

Recommendations

Dumper evacuation from wharf to yard should match the HMC productivity rate. Considering the current TRT of trucks and different queue waiting times, we have estimated the total number of dumpers required at the port.

Considering HMC output at 750 MT/hour, each shift should have a minimum of 400 trips. With current truck TRT of one hour, port will need about ~710 dumpers in total. Hence, there is a need to add another 340 dumpers to the existing fleet.

To maximize the number of trips per dumper in each shift, non-working time of ~2 hours between shift changes has to be addressed. Port has to initiate discussions with stakeholders to increase the dumper operating hours per shift to 7.5 hrs.

Description	Scenario 1: 10 mins	Scenario 2: 20 mins	Scenario 3: 30 mins	Scenario 4: 40 mins
	Waiting time at stockyard			
Average dumper TRT[1] (without waiting)	~28 mins	~28 mins	~28 mins	~28 mins
Total dumper TRT	~38 mins	~48 mins	~58 mins	~68 mins
Shift operating hours	~6.5 hours	~6.5 hours	~6.5 hours	~6.5 hours
# of trips	~10.3 trips / shift	~8.1 trips / shift	~6.7 trips / shift	~5.7 trips / shift
Tons by HMC / shift[2]	6,000 tons / shift	6,000 tons / shift	6,000 tons / shift	6,000 tons / shift
# of trips / shift[3]	400 trips / shift	400 trips / shift	400 trips / shift	400 trips / shift
# of dumpers / group	~36	~46	~55	~55
Total # of groups needed	10 + 2 (buffer for internal movement)	10 + 2 (buffer for internal movement)	10 + 2 (buffer for internal movement)	10 + 2 (buffer for internal movement)
Total # of dumpers	~468	~588	~708	~840
Addn. no. of dumpers	**~100**	**~220**	**~340**	**~470**

Figure 94: Dumper requirement estimates

End-state of conventional berths at Paradip

Through addressing all bottleneck constraints on the conventional side, conventional berths at PPT can potentially handle ~10–12 Mn MT of additional cargo. However, once some of these berths go for upgrade, the actual volume released will be lower. However, the volume loss, which might happen if productivity at other berths is not upgraded, will be stemmed and cargo loss would be minimized.

	Current Performance (FY15)		Projected Performance		
Berth	**Occupancy[2] (%)**	**New Prod.[3] (TPD)**	**Occupancy (%)**	**Prod. (TPD)**	**Addn. Cap.[1] (mn MT)**
EQ-1	**88%**	**7,789**	**62%**	**14,000**	**1.2**
EQ-2	**87%**	**8,229**	**55%**	**14,000**	**1.5**
EQ-3	**84%**	**8.682**	**54%**	**14,000**	**1.6**
CQ-1	**90%**	**10,145**	**59%**	**14,000**	**1.5**
CQ-2	**77%**	**10,066**	**51%**	**14,000**	**2.0**
SQ	**85%**	**9,184**	**52%**	**14,000**	**2.0**
MPB	**89%**	**10,541**	**60%**	**16,000**	**1.5**
CQ-3	***40%***	***13,430***	***40%***	***9,000***	***1.5***
				Total	**~10.0 – 12.0 mn tons**

Figure 95: End-state for conventional berths at Paradip

3.2.3.5 Initiative: PPT 6.1 Mechanization of EQ 1-3 and CQ 1-2

Initiative Overview

In addition to the identified cargo handling capacity, PPT will still need to cater to additional cargo (both import and export). Therefore, there is a need to look at mechanization of existing berths to improve cargo handling capacity at existing berths.

Key Findings

PPT has an existing plan of berth development. As part of this plan, there is a new import coal berth with a capacity of 10 Mn MT being developed by Essar. Also, a general clean cargo/container terminal with a capacity of 5 Mn MT is being developed by J M Baxi. Finally, there are plans to develop an iron ore berth of 10 Mn MT capacity as well.

Berth	Current Ops.	Cargo (FY 15)	Draft	Future Cap.	Status
Coal berth	New berths			~ 10 mn	• Import coal handling by Essar • Ready by FY'19 • Berth draft = 18.1 m • Exp. investment = ~ Rs. 479 crs.
Multi-purpose				~ 5 mn	• Container handling by JM Baxi • Ready by FY'19 • Berth draft = 18.1 m • Exp. investment = ~ Rs. 431 crs
Iron ore berth				~ 10 mn	• Iron ore handling by JSW SW • Ready by FY'20 • Berth draft = 18.1 m • Exp. investment = ~ Rs. 740 crs.

Figure 96: Existing berth development plan at PPT

PPT's hinterland handles a very large volume of thermal coal cargo. Thus, additional berths would be needed to handle this cargo volume. PPT has currently planned to go for mechanization of EQ 1/2/3 for thermal coal export and mechanization of CQ 1/2 for coking coal handling.

<table>
<tr><th>Berth</th><th>Current Ops.</th><th>Cargo (FY 15)</th><th>Draft</th><th>Future Cap.</th><th>Status</th></tr>
<tr><td>EQ - I</td><td rowspan="5">Currently all General Cargo Conventional berths</td><td>~2.5 mn</td><td>11.0 m</td><td>~ 10 mn</td><td rowspan="3">• Export thermal coal
• RFQ prepared, contract to be awarded by Jan-16
• Berth draft upgraded to 14.5 m
• Exp. investment = ~Rs. 1,500 crs</td></tr>
<tr><td>EQ – II</td><td>~2.6 mn</td><td>11.5 m</td><td>~ 10 mn</td></tr>
<tr><td>EQ – III</td><td>~2.7 mn</td><td>12.5 m</td><td>~ 10 mn</td></tr>
<tr><td>CQ – I</td><td>~3.5 mn</td><td>14.5 m</td><td rowspan="2">~ 10 mn</td><td rowspan="2">• Import coal
• RFQ prepared, contract to be awarded by Mar 2016
• Exp. investment = ~Rs. 1,300 crs</td></tr>
<tr><td>CQ – II</td><td>~3.0 mn</td><td>14.5 m</td></tr>
</table>

Figure 97: Mechanization plan for conventional berths at PPT

Recommendations

PPT should go ahead with the mechanization plan for EQ 1–3 because there is additional cargo. However, mechanization of CQ 1–2 needs to be reevaluated depending on estimates of cargo handling in the hinterland. Also, this will ensure that berths in inner harbor are available for break bulk / other cargo handling. Shelving of CQ 1/2 would save a potential capex of Rs. 1,300 crs (under PPP). Subsequently, if more berths are being developed in the outer harbor, further development of deep draft coking coal handling berths can be taken up.

Expected Impact

Mechanization will increase volumes at each of the above berths by more than 6 Mn MT. This will result in additional operating surplus of ~Rs. 60 Crs for each berth, and a total of Rs. 180 Crs once these berths are fully operational (assuming only EQ 1/2/3 are mechanized).

3.2.4 Additional cargo handling capacity at Paradip Port

As per Sagarmala O/D studies, PPT's hinterland in <5 years will have ~95 Mn MT of export volumes. Even with debottlenecking capacity added and new mechanization capacity of berths, there will be an additional requirement of 4–5 berths.

Thus, there is a need to develop an Outer Harbor / Satellite port at Paradip to cater to this demand. While these berths are being developed, additional demand from upcoming industrial clusters in the hinterland can also be identified, and new deep draught berths can be developed to cater to this emerging demand.

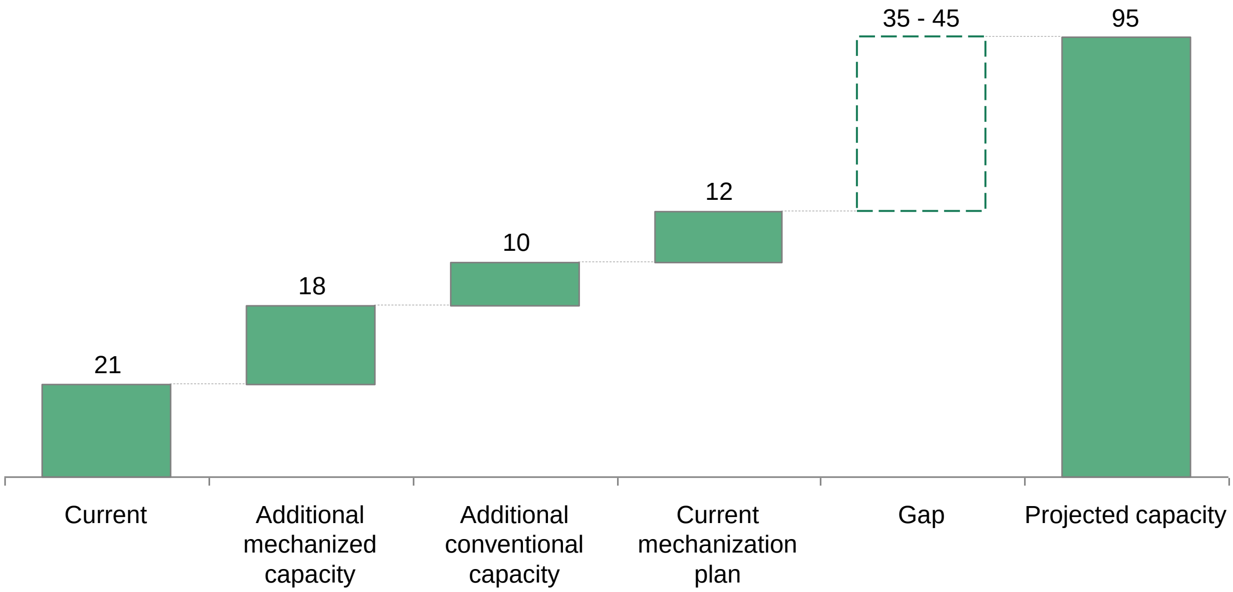


Figure 98: Additional volume handling capacity needed at Paradip Port