JAWAHALAL NEHRU PORT TRUST

A

REPORT

ON

STUDY RELATED TO PROBABILITY AND IMPACT OF DRILLING/COLLISION OF SHIPS NEAR TAPS SITE -

WITH REFERENCE TO THE DEVELOPMENT OF VADHVAN PORT ON THE WEST COAST OF INDIA, 12 KMS NORTH OF TAPS, TARAPORE.

Dated: 30th November 2018

Prepared by

SVS Marine Services Pvt. Ltd.

8th Floor, Raheja Arcade, Sector-11,
CBD Belapur, Navi Mumbai -400614
Maharashtra, INDIA.

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Contents

1. DOCUMENT INFORMATION

Project	Study related to probability and impact of drilling/collision of ships near TAPS site - With reference the development of Vadhvan port on the west coast of India, 12 km north of TAPS, Tarapore.
Report title	A Report on Study related to probability and impact of drilling/collision of ships near TAPS site -with reference the development of Vadhvan port on the west coast of India, 12 km north of TAPS, Tarapore.
Client	Jawaharlal Nehru Port Trust
Client Representative	Mr. Vishwanath Gharat Manager, (PP&D) Jawaharlal Nehru Port Trust (JNPT) Sheva, NAVI MUMBAI
Work order of client	Dated 28th September 2018 Duration ; Draft report –2 months. Final Report – 2 weeks after receipt of comments from JNPT.
Report STATUS	FINAL
Client Monitor Team	Capt. Subhash Kumar, Marine Advisor, JNPT
Commencement	Date 1st October 2018
Completion expected	30thNovember 2018.

“The consultants agree to use their best efforts on behalf of those for whom this “Report” is made, but it is distinctly understood that the assessment is made with the understanding that the consultants shall not have any liability for any error or omissions whether due to negligence or otherwise in excess of the actual charge made for their assessment and all persons interested in / or to be effected hereby accept this assessment on that basis”.

- Consultant.

2. SCOPE OF WORK AND TERMS OF REFERENCE (TOR)

This report has been prepared on the basis of the scope of work and terms of reference as mentioned in the Letter of JNPT dated 12th October 2018 and these are as follows:

- To study the drilling required in proposed Vadhvan Port.
- To study the impact of drilling in and out of the proposed Vadhvan Port limits.
- To study whether proposed Vadhvan Port will require drilling beyond proposed Vadhvan Port limit.
- To study the probability of the collision of ships entering into and sailing out of the proposed Vadhvan port limits.
- To study the probability of collision of ship near TAPS site with reference to ship calling at proposed Vadhvan Port limit.
- To examine number of ships calling at Dahej, Hazira, Bhavnagar and Alang, especially coasting from Mumbai side on the west coast of India.
- To study the impact of the collision of ship on TAPS facilities due to collision in proposed Vadhvan Port limits and vessel plying on West Coast of India.

2.1 METHODOLOGY

This report is prepared after studying various documents, records, circulars and notifications pertaining to Shipping.

- Study of Draft DPR of Vadhvan Port prepared by Consultant M/S Projen/Pentacle.
- Study various reports submitted by CWPRS on the siltation pattern, waves, Current, tide, wind etc.
- Master plan and first stage development of Vadhvan Port.
- Proposed size of vessels vis-à-vis channel depth and width, turning circles.
- Floating craft availability like Tugs, Pilot launches, Mooring launches, general service launches, etc.

- Bathymetric Chart with latest soundings.
- General layout of the channel and berths with dimensions.
- Record available on seabed, rock levels, current, tides, siltation etc.
- Interaction with Concerned officers of JNPT.
- Study result of Simulation studies carried out by DHI, Singapore.
- Furnish a report on the Technical/Marine studies as per TOR to enable JNPT to take up the matter with the Government for undertaking necessary investment decision in the matter.

3. GENERAL INFORMATION ON VADHVAN PORT:

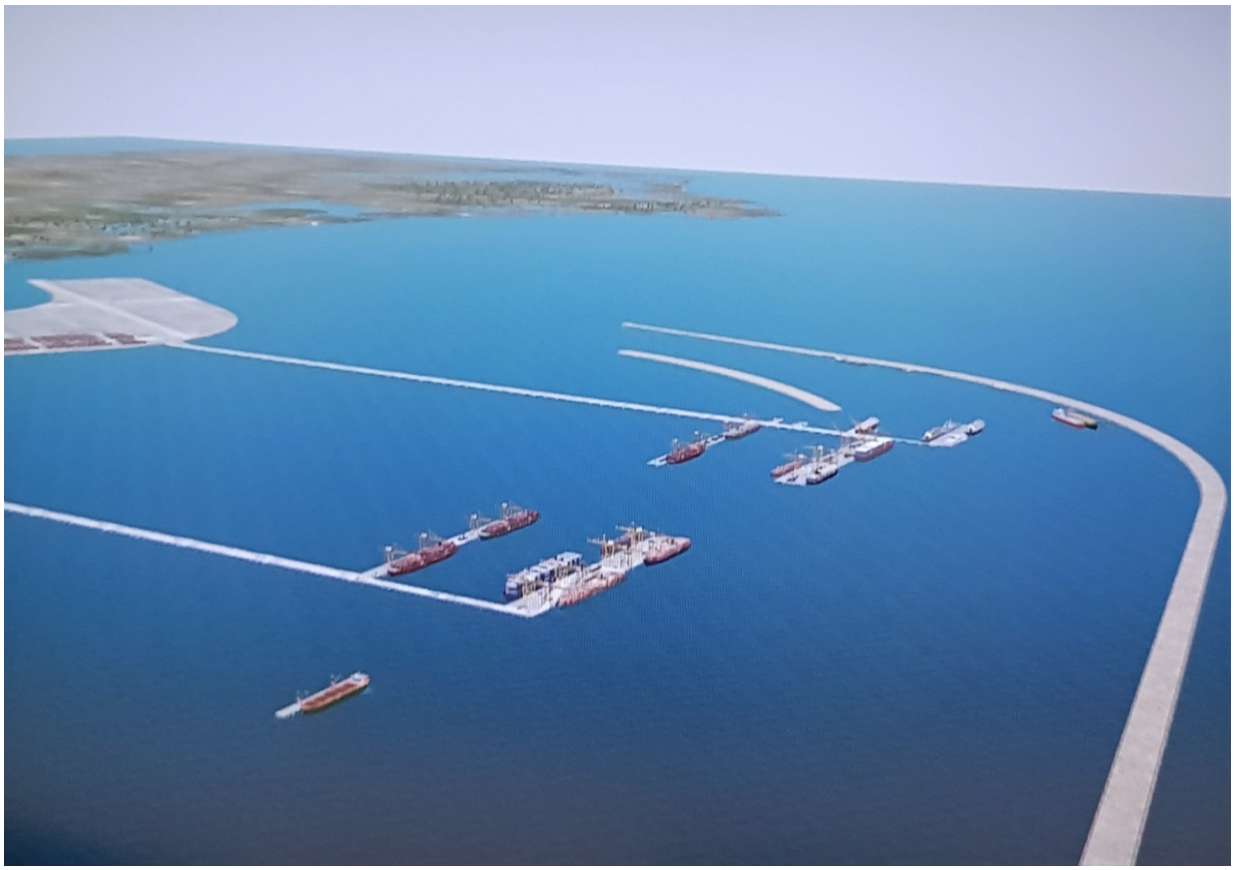
Jawaharlal Nehru Port Trust (JNPT) handles more than 40% of India's total container traffic and serves a vast hinterland comprising all of northern and western India. There is limited space in JNPT and thus it was proposed to develop a satellite port for JNPT. Satellite ports help to overcome issues such as limited land availability and draft adequacy. The proposed location for development of this satellite port is at Vadhavan, which is at about 160 km north of JNPT. Vadhavan is situated at 19°55' N and 72°39' E (Fig. 1) and has deep draft of about 20 m, which makes it feasible to handle bigger size of container ships. The most of near shore seabed is flat and rocky. The site is exposed to wave's incident from SW quadrant with significant wave height of about 3.5 m. The site has a tidal variation of about 5.5 m between Low Tide and High Tide. The final layout for this Satellite Port was evolved through extensive mathematical modeling studies for tidal hydrodynamics and wave tranquility. The proposed layout consists of one breakwater of length 10.1 km with a current deflecting wall of length 1.9 km at southern end of the breakwater and reclamations area of 1300 ha at the head land of Vadhavan.

3.1 PROJECT NEED

The growing sea borne EXIM trade is driving the need for efficient and large multi-purpose deep draft ports in India. In this context, Government of India through its Sagarmala program envisaged for developing a Greenfield deep draft port in Maharashtra.

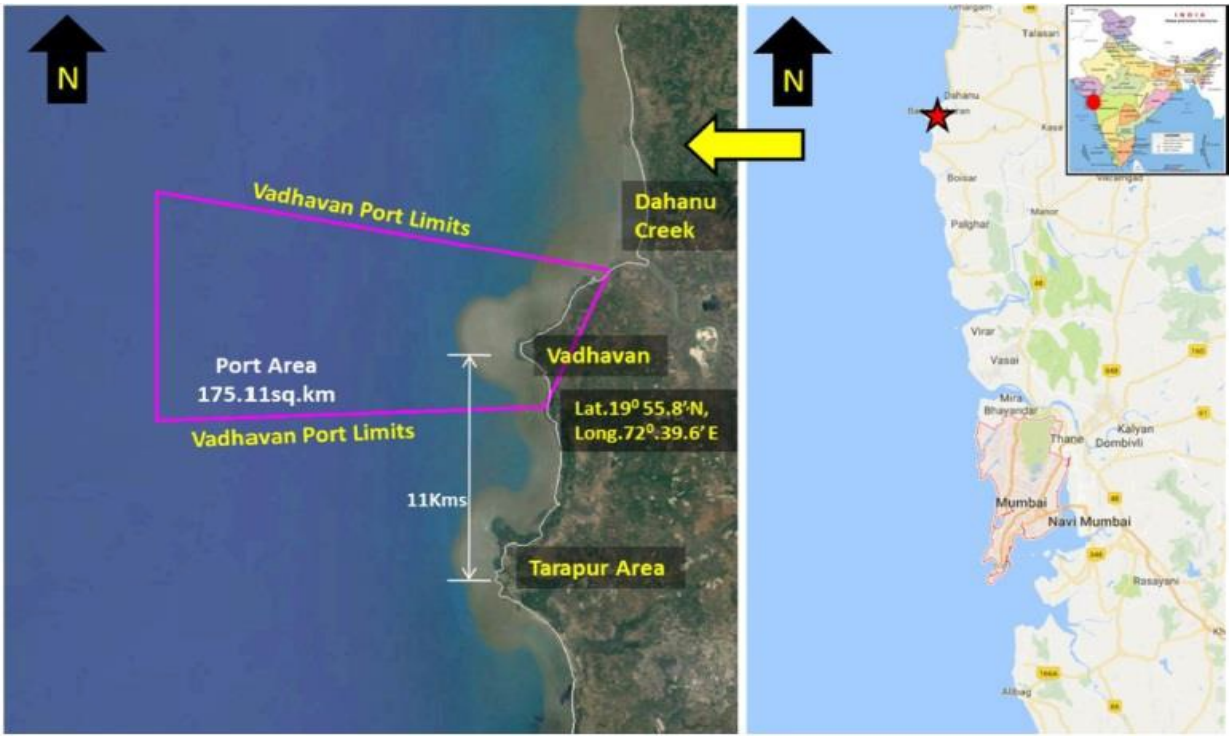
At present, Mumbai & JNPT are the two major ports operating in Maharashtra and these ports primarily caters to the hinterland of Maharashtra, Gujarat and northern region which includes NCR, Punjab, Rajasthan and UP. Out of these ports, Mumbai port has operational limitation like constraint in cargo evacuation, draft availability, inadequate port back up area etc. JNPT, which was developed as a satellite port of Mumbai port, has emerged as India's largest container port.

With development of 4th container terminal, JNPT will reach to its maximum capacity and would have little space available for future expansion. Also to cater future generation container vessels it is important that JNPT increases its draft from present level. This would require a significant capital expenditure and also not that much economical for JNPT to handle future generation of mega container ships. Thus there is a need of natural deep draft multi-purpose handling port.

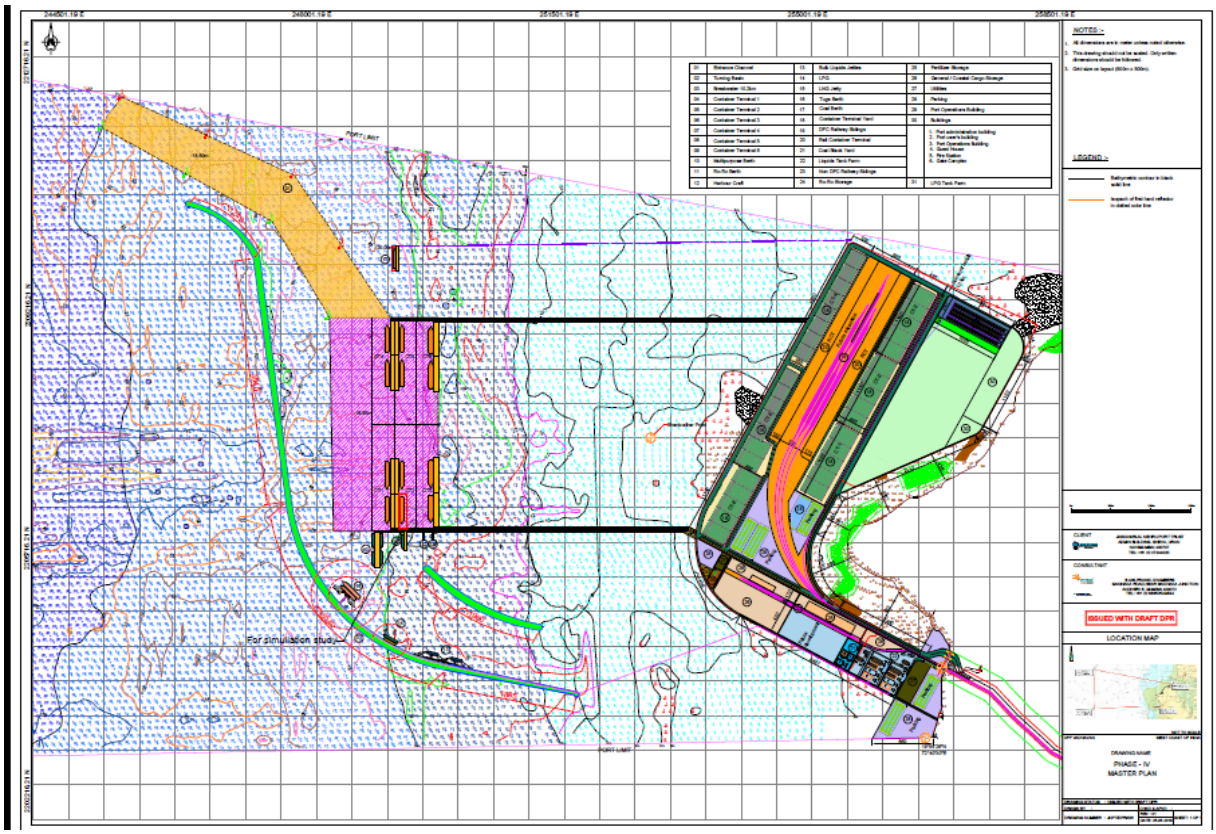


4. VARIOUS STUDY RESULTS OF DRAFT DPR OF VADHVAN PORT PREPARED BY CONSULTANT M/S PROJEN/PENTACLE.

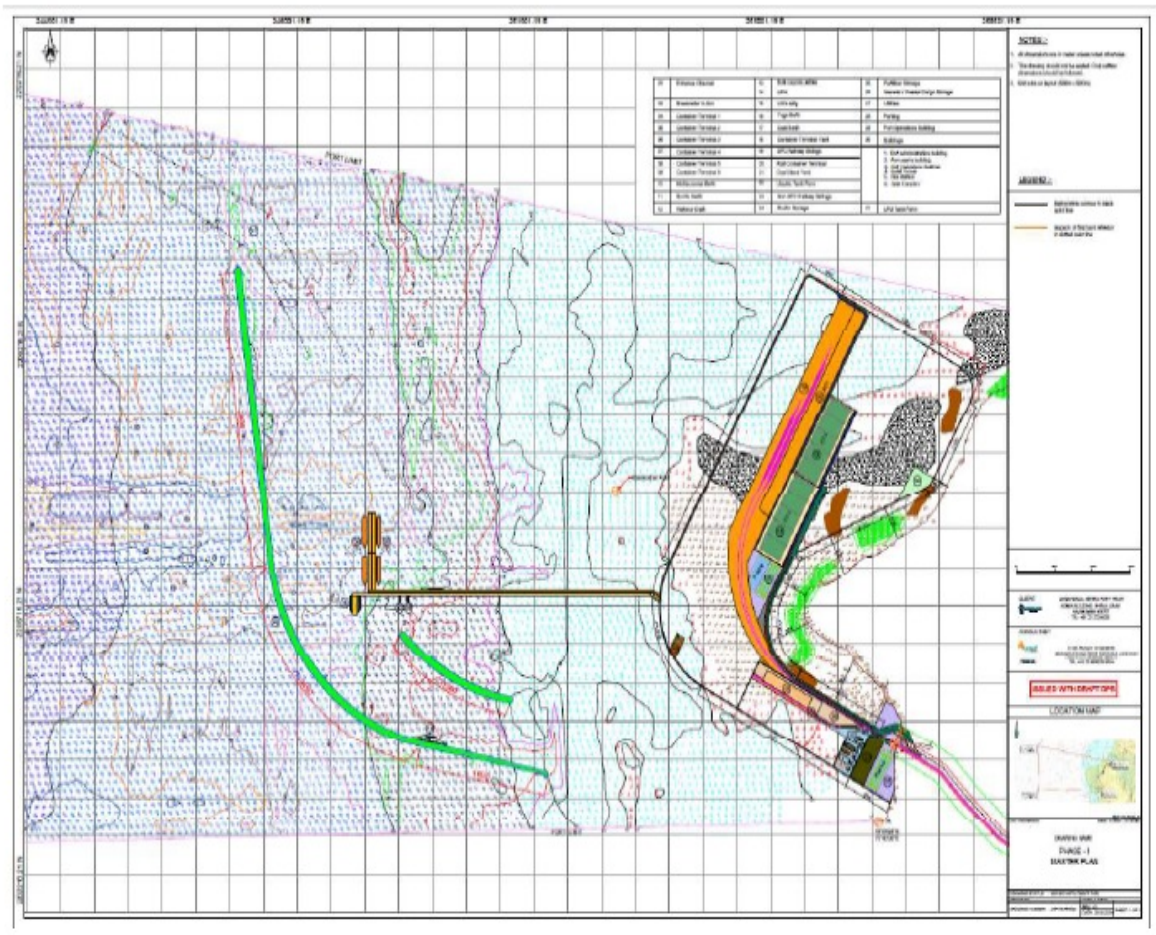
4.1 LOCATION OF VADHVAN PORT AND TAPS



4.2 MASTER PLAN LAYOUT OF VADHVAN PORT



4.3 FIRST PHASE DEVELOPMENT OF VADHVAN PORT



5. VARIOUS STUDY REPORTS SUBMITTED BY CWPRS ON THE SILTATION PATTERN, WAVES, CURRENT, TIDE AND WIND ETC.

5.1 PROPOSED SIZE OF VESSELS:

a) Container vessels : LOA – 400 M to 430 M

Beam – 60 M to 62 M

Draft – 16.0 M

Capacity – 18000 – 24000 TEU

b) Coal vessels: LOA – 287 M

Beam – 45 M

Draft – 17.0 M

Capacity – 1,80,000 MT

c) Fertilizer vessels: LOA – 209 M

Beam – 32 M

Draft – 12.5 M

Capacity – 50,000 MT

d) General Cargo Vessels: LOA – 193 M

Beam – 28 M

Draft – 12 M

Capacity – 30,000 MT

e) Edible oil & Chemical cargo vessels:	LOA – 174 M : Beam – 25 M Draft – 10 M Capacity – 20,000 MT
f) LPG vessels:	LOA – 265 M Beam – 42 M Draft – 13.5 M Capacity – 60,000 MT
g) LNG vessels:	LOA – 345 M Beam – 54 M Draft – 14 M Capacity – 2,66,000 MT
h) Car Carrier vessels:	LOA – 228 M Beam – 32 M Draft – 11 M Capacity – 8000 ceu

5.2 NUMBER OF VESSELS PER YEAR EXPECTED IN FULLY DEVELOPED CONDITION:

3585 ships would be calling at Vadhvan Port when it is fully developed. This would amount to about 10 ships every day on an average.

Frequency of ship calls

Table 1-16: Vessel calls per year

Commodity	Ship size (DWT/teu/ceu)	Average parcel size (t/teu)	Annual throughput (2040) (Mtpa/Mteu/ceu)	No. of ship calls per year
Container	18,000/ 24,000	4,500	12.30	2,733
Crude	300,000	250,000	21.00	84
LPG	60,000	25,000	4.50	180
LNG	266,000	260,000	5.00	20
Edible oil	20,000	10,000	1.61	161
Chemical	20,000	10,000	3.19	319
Thermal Coal	180,000	100,000	8.87	89
Fertilizer	50,000	45,000	1.66	37

Commodity	Ship size (DWT/teu/ceu)	Average parcel size (t/teu)	Annual throughput (2040) (Mtpa/Mteu/ceu)	No. of ship calls per year
Ro-Ro	8,000	2,500	214,400.00	86
General cargo	30,000	25,000	5.73	229
Coastal traffic	20,000	15,000	4.28	285

5.3 OPERATING LIMITS FOR SHIPS

Wind: 20 knots any direction

Waves:Pilot transfer: 2.0 m

Visibility: Shall not be less than 1 nautical mile.

5.4 SPEED LIMITS:

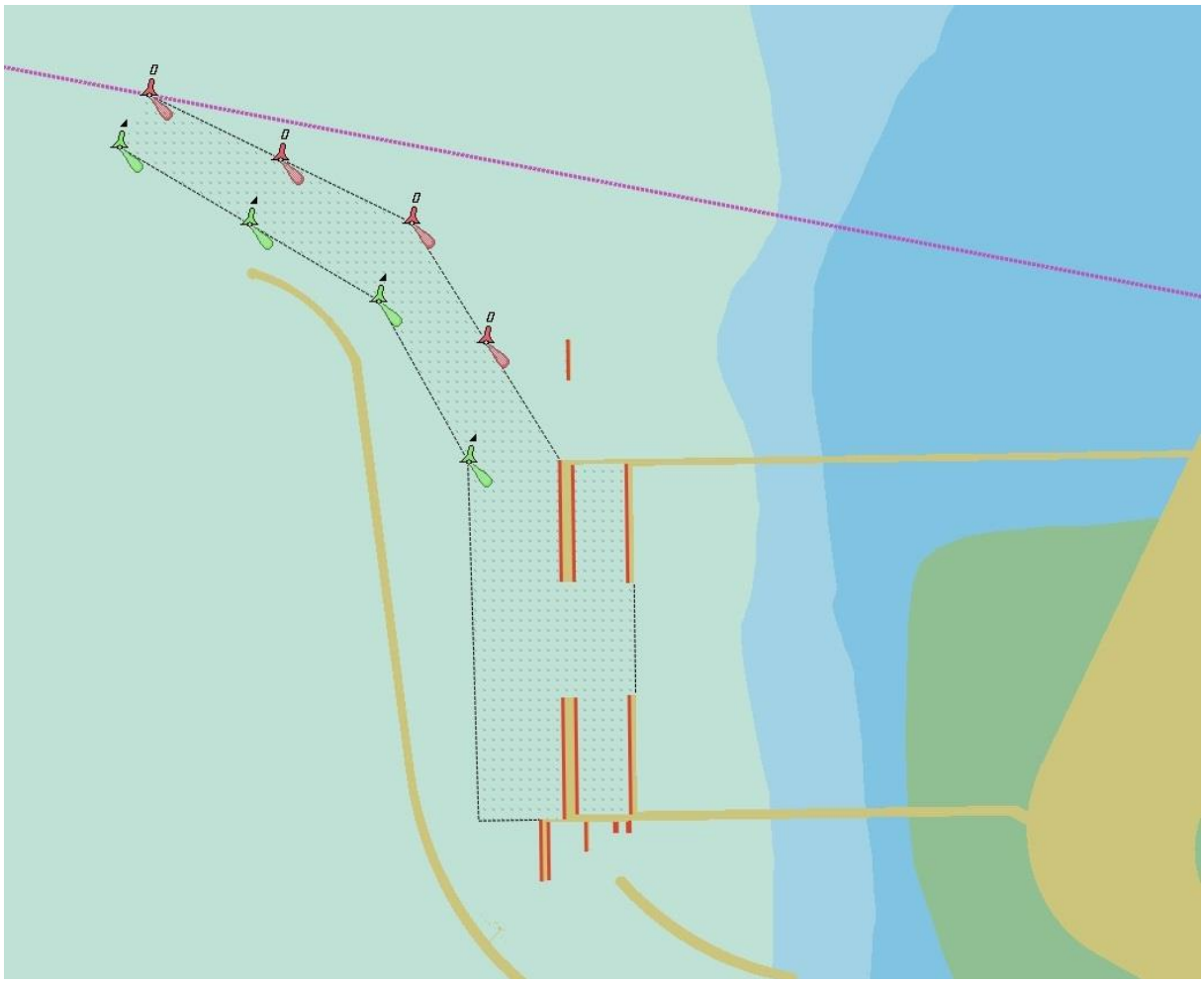
In the Channel	:	10 knots
In the Channel, while passing ships	:	8 knots
Approaching berth	:	2 knots

5.5 CHANNEL DEPTH:

Minimum 17 M at CD during First Phase of development and 20.0 M during Final Phase.

The channel depth from Fairway to breakwater till 1.5 KM is from 20 M to 18.5 M.

The inner channel is minimum 17.0 M.



5.6 WIDTH:

Designed for two ways traffic as per PIANC guidelines.

The width of the channel is 500M and broadened to 600 M at the bend.

5.7 TURNING CIRCLES:

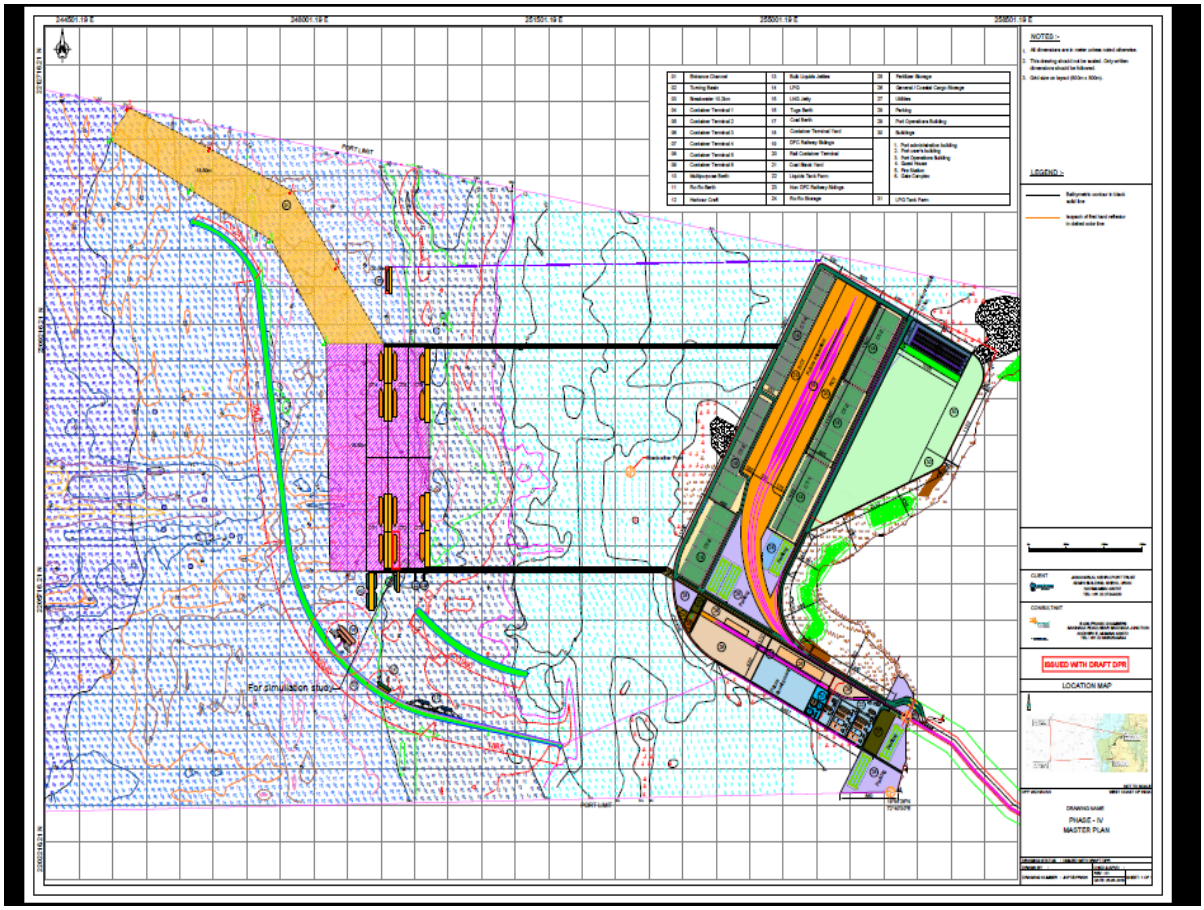
Sufficient space is available near each berth for the vessels to turn. Minimum diameter for turning is available between 900 M to 1000 M.

5.8 BATHYMETRY:

The entire port limit has been surveyed and depth sounded and charted by the DPR Consultants. The 2 M contour is 2 KM from the coastline and 10 M contour is 4 KM from the coastline. All berths are located to be between the contours of 15 to 20 Metres.

The channel depth is between 16.5 M to 20 M. The depth at the berth pocket will be maintained at 18.5 M.

5.9 GENERAL LAYOUT OF THE CHANNEL AND BERTHS WITH DIMENSIONS:

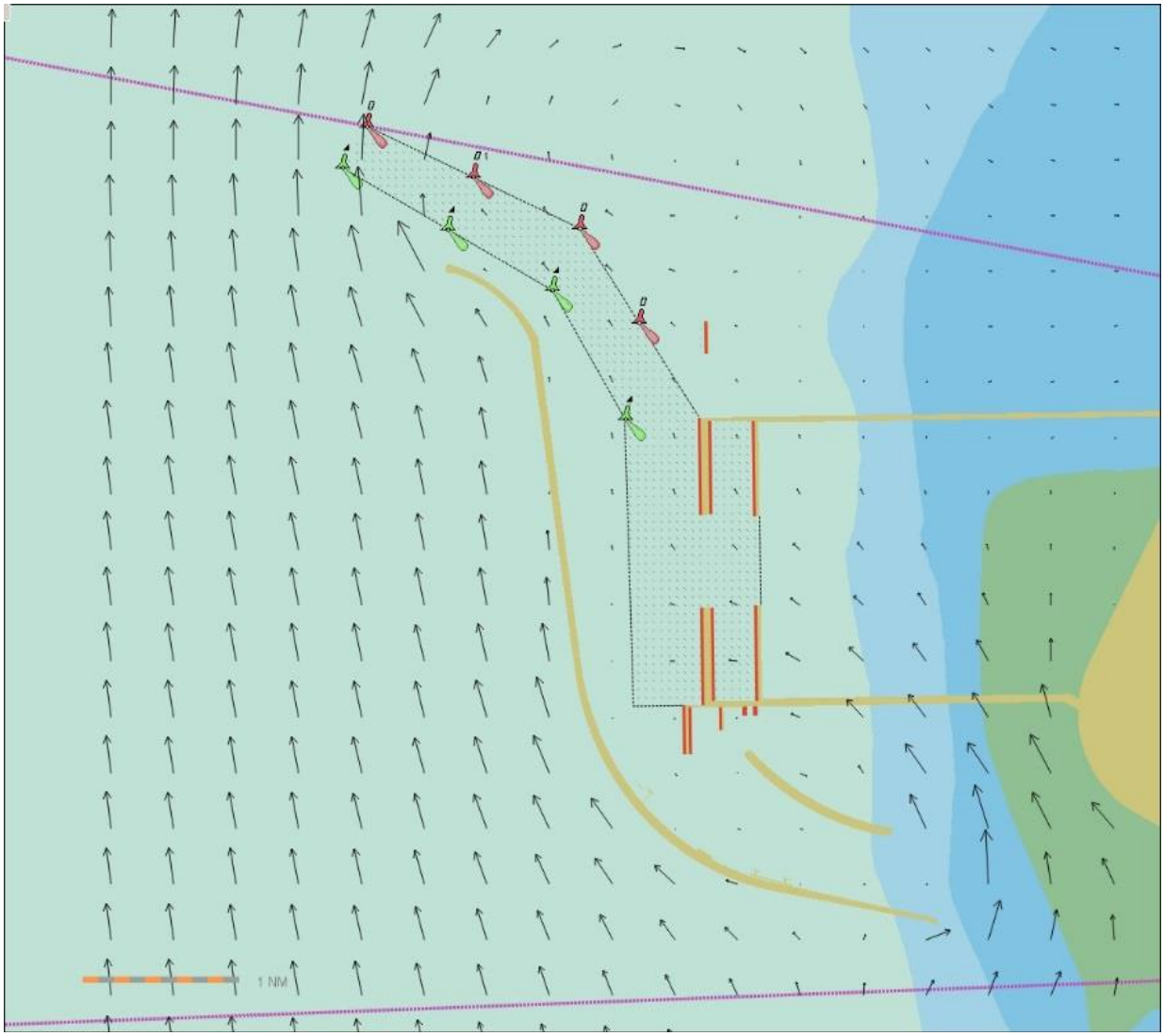


Berth dimensions

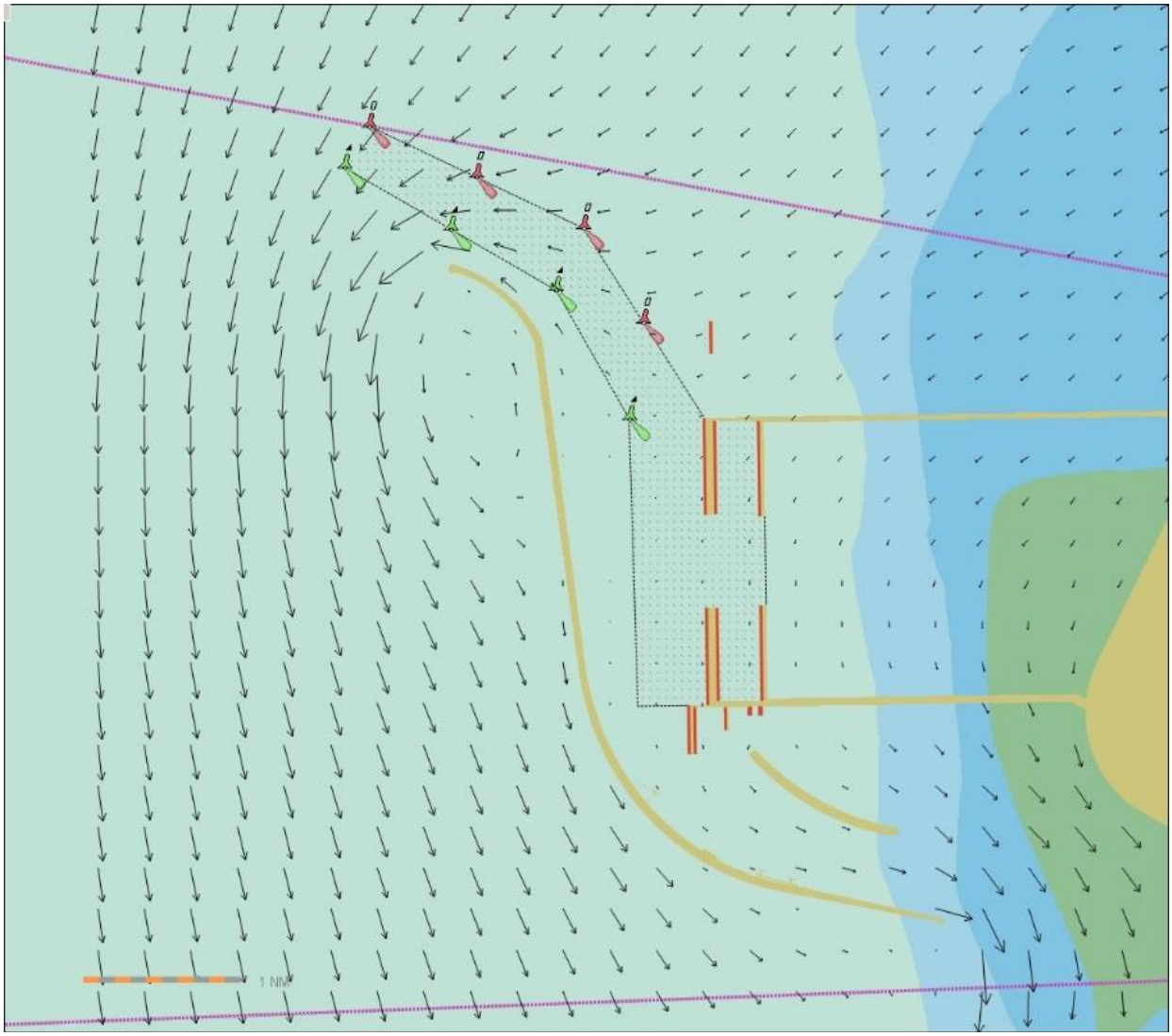
	Initial phase	Ultimate phase
No. of berths	: 2	12
Length	: 2,000m	6,000m
Width	: 60m	60m
Depth at berth pockets	: -18.5m CD	-18.5m CD

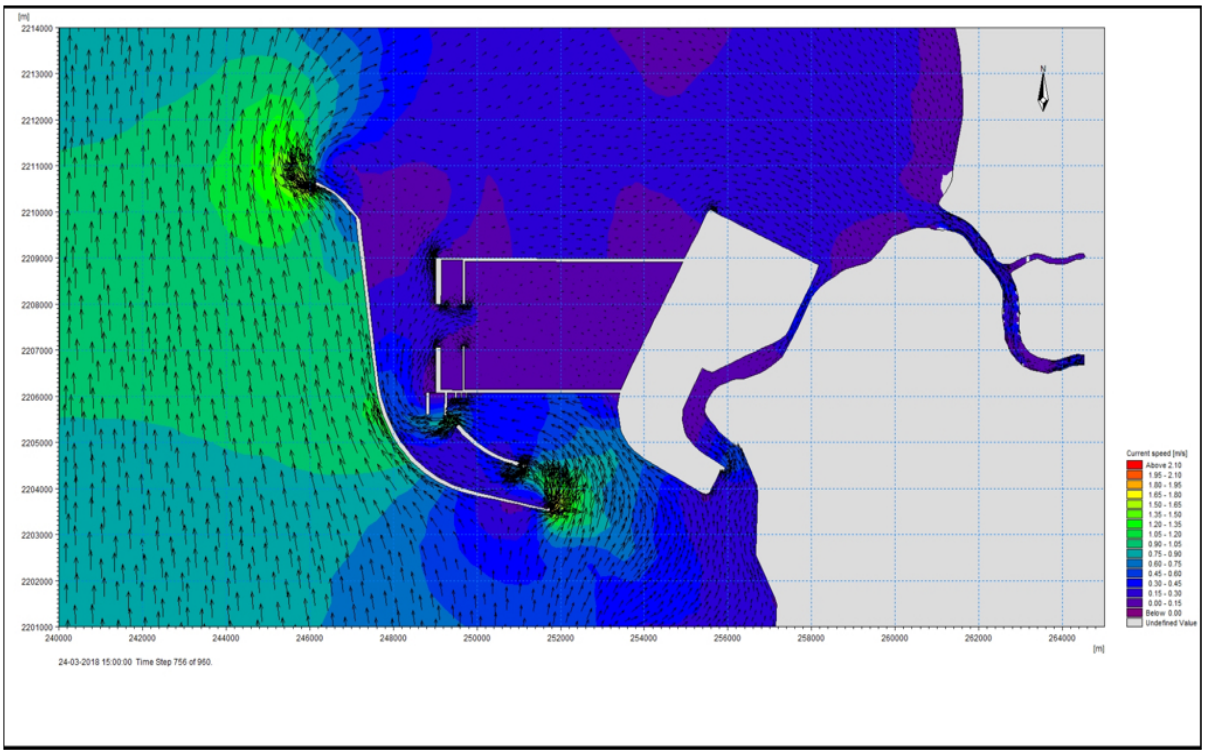
5.10 CURRENT:

5.10.1 North Flowing Maximum Flood Current:



5.10.2 South Flowing Maximum Ebb Current:





5.11 WAVES:

In the near shore region of Vadhvan in 10M of water depth, the predominant wave directions are from the sector between 220 to 300 deg N with maximum significant wave height of the order of 2.5 M.

5.12 TIDES:

The tides in Vadhavan are semidiurnal in nature and a macro tide with tidal range of more than 4m during spring. The tidal levels (w.r.t. Chart Datum) near Vadhavan as per the NHO Chart No.210 are as follows:

Mean High Water Spring (MHWS): + 4.8 m
Mean High Water Neap (MHWN): + 3.7 m
Mean Sea Level (MSL): + 2.8 m
Mean Low Water Neap (MLWN): + 2.0 m
Mean Low Water Spring (MLWS): + 1.2 m

5.13 SHORELINE CHANGES, SEA BED, ROCK LEVELS, SILTATION ETC:

Most of near shore seabed is flat and rocky. The site is exposed to wave's incident from SW quadrant with significant wave height of about 3.5 m. **The site has a tidal variation of about 5.5 m between Low Tide and High Tide**. The final layout for this port was evolved through extensive mathematical modeling studies for tidal hydrodynamics and wave tranquility. **The proposed layout consists of one breakwater of length 10.1 km with a current deflecting wall of length 1.9 km at southern end of the breakwater and reclamations area of 1300 ha at the head land of Vadhavan.**

Alongshore sediment transport takes place when wave approach obliquely to the shore and eventually break. The wave breaking releases energy which brings sediment into suspension and alongshore littoral current transport of the sediments. The cycle of sediment transport by the waves to and from the coast is continuous which has aided in maintaining the equilibrium of the coastline over the geological times.

Mathematical Model studies carried out by CWPRS, Pune for shoreline changes for the proposed port of vadhvan indicated as follows:

1. In the near shore region of Vadhvan in 10M of water depth, the predominant wave directions are from the sector between 220 to 300 deg N with maximum significant wave height of the order of 2.5 M.
2. Studies for estimation of littoral drift distribution indicated that, average net transport in a year is of the order of 0.07 million cum and is towards north.

Study for simulation of shoreline changes indicated that the construction of proposed off shore breakwater of 10.1 KM length will result in negligible deposition of sand behind the breakwater and will have negligible impact on the adjacent shoreline as well

5.14 METEOROLOGICAL DATA:

5.14.1 FAIR SEASON

The fair season is from 1st September to 15th October and 1st December to 26th May. However, reasonable fine weather may be expected from 1st September to 26th May. But local disturbances sometimes occur within these periods, which are officially declared fair as they do not persist more than few hours at any given time.

5.14.2 FOUL SEASON

The foul; season is from 26th May to 31st August and 16th October to 30thNovember. The SW monsoon may be expected to break at the beginning of June. For some days before the monsoon breaks the sky is heavily overcast and there is lightening activity in the evening in the SE direction. However, the sky is clear again by midnight. The actual monsoon breaks with strong SE'ly winds prevailing for about 3 weeks then gradually veering to south and finally to SW direction. As the monsoon progresses the wind gradually hauls to West ward .Spells of quiet fine dry weather are not uncommon during the monsoons

5.14.3 CYCLONIC WEATHER

The Vadhvan Port may get exposed to cyclonic weather during the months of April, May, October and November.

5.15 FLOATING CRAFTS:

5.15.1 TUGS :

2 nos. 65ton bollard pull ASD tugs and 2 nos. 100 ton bollard pull ASD tugs proposed.

5.15.2 PILOT LAUNCHES:

2 nos. Pilot Launches with a speed of 20 Knots proposed.

5.15.3 MOORING LAUNCHES:

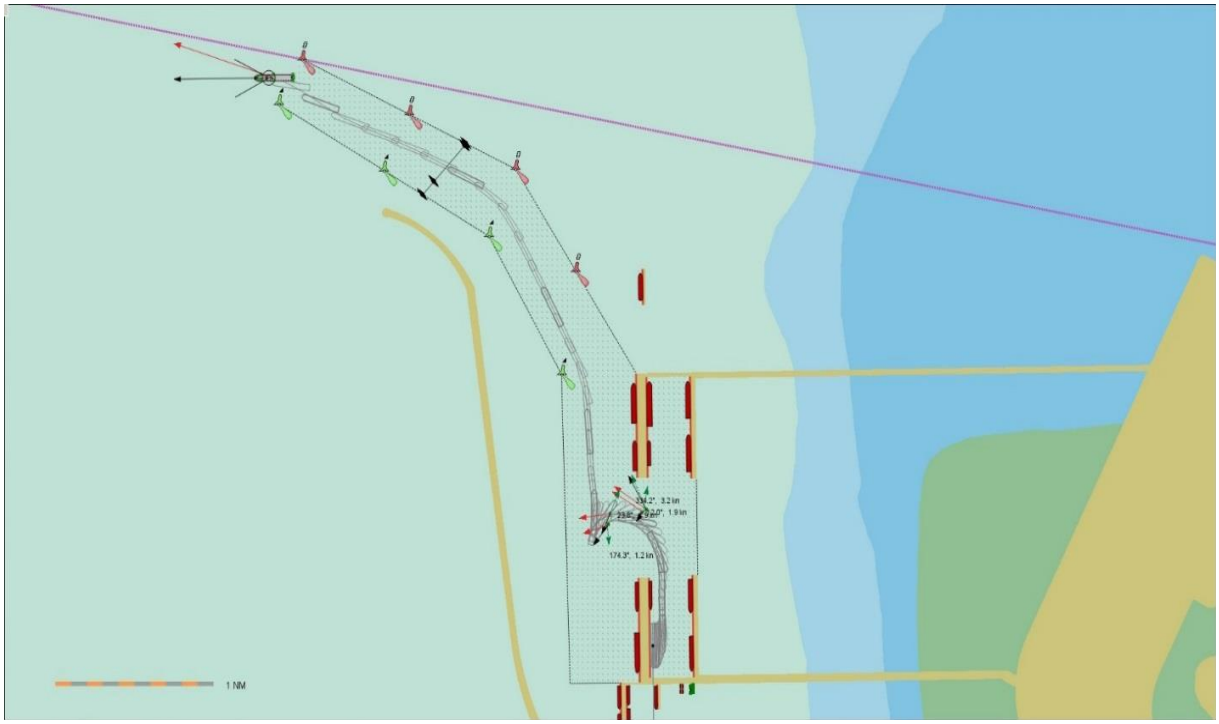
2 nos. mooring launches proposed.

5.15.4 GENERAL SERVICE LAUNCHES:

1 no. multipurpose launch proposed.

6. STUDY RESULT OF SIMULATION STUDIES CARRIED OUT BY DHI, SINGAPORE:

6.1 VESSEL MANEUVERING BETWEEN FAIRWAY AND CONTAINER BERTH:



6.2 EMERGENCY SCENARIOS;

The following four emergency scenarios, which could result in collision or grounding, were included in the simulation run matrix.

1. During arrival, as vessel was swinging off CT-4 the vessel engine fails.

2. During arrival, as vessel was backing toward the berth at about 2 knots, the aft center lead tug got an engine failure and could not assist in the swing.

3. During arrival, as vessel near the approach channel entrance, the vessel suffered a total black-out with no engine propulsion and steering power.

4. During departure, as vessel was backing-out stern first in-between CT-2 and CT-3, the vessel suffered a total black-out with no engine propulsion and steering power.

6.3 SUMMARY OF THE SIMULATON STUDY:

In summary, the simulation results and key conclusions of the 3D simulation study are as follows:

- The results of the 3D simulation study concluded that the proposed berth CT-2 is optimally and favorably aligned with the tidal current making it easy for vessel to berth and un-berth at the jetty. There was no significant concern with the berthing and unberthing of the largest designed vessel at the proposed jetty/berth.

- All normal operation scenario runs were successfully undertaken in a controllable manner within acceptable level of safety.

- The swinging area/turning space between jetty/berth CT-4 and CT-1 for vessel to execute a swing during the berthing / un-berthing maneuver was found to be adequate for the largest designed vessel and provides sufficient clearance and distance for possibility to correct minor maneuvering mistakes without compromising safety.

- The optimum speed for the vessel before a swing maneuver was found to be below 2.0 knots.

Four ASD tugs of 65 tons bollard pull were marginally adequate in handling the largest designed vessel to berth and un-berth at the proposed berth CT-2.

6.4 RECOMMENDATIONS AS PER SIMULATION STUDY:

- Consider suspending berthing and un-berthing operations when wind speed exceeds 20 knots or when the risk is deemed to be high.

- It is recommended to limit the operable wind speed and tidal current to low initially during the handling of large vessel with deep draft and large windage area. This restriction can possibly be relaxed when routine and experience has been acquired.

- Consider imposing all large and deep draft vessel berthing to Vadhavan port have an operational ECDIS (Electronic Chart Display and Information System) and a Doppler side log.

7. PRESENT TRAFFIC OFF TAPS SITE:

The vessels sailing on the west coast of India are generally bound for Pipavava, Dahej and Hazira. These vessels are generally small and passes close to TAPS site but keep beyond the 10 M depth contour.

10 M contour is only 2.5 KM from Tarapore coast, whereas 14 M and 20 M contours are 5 KM and 11 KM respectively.

In 2016, 1966 vessels had called Saurashtra Ports and in 2017, about 1993 vessels had called. This would amount to about 11 ships passing TAPS every day.

7.1 Vessels being handled at Pipavava, Dahej and Hazira Port (Quarter wise)

(Data taken from J M Baxi Website)

	Oct-Dec17	July-Sept17	April-June17	Jan-Mar17	**Total**
Pipavava	145	159	125	146	**575**
Dahej	203	212	195	169	**779**
Hazira	207	209	180	43	**639**

Oct-Dec16	July-Sept16	April-June16	Jan-Mar16	Oct-Dec 15	**Total**
118	144	122	226	94	**704**
174	183	158	147	43	**705**
209	253	22	30	43	**557**

7.2 VESSELS BOUND FOR ALANG PORT SCRAP YARD PASSING TAPS SITE:

There are number of vessels bound for Alang Scrap yard on the west coast of India, passes the site of TAPS very closely. These ships are already a potential danger to TAPS as they are out of class and mostly being towed. There are number of cases especially during the monsoon season where ship's tow line parts and the ship drifts towards the shore and run aground and sometimes sink resulting in oil pollution.

The chart below show the number of ships bound for Alang Port:-

Summary Of Total Tonnage Beached Vessel At Alang From 01st April, 2015 To 31st March ,2016 :

MONTH	NO. OF VESSELS	TOTAL TONNAGE (MT.)
APRIL, 2015	14	127,254.90
MAY, 2015	17	150,591.48
JUNE, 2015	23	194,541.97
JULY, 2015	13	99,281.52
AUGUST, 2015	09	80,561.30
SEPTEMBER, 2015	17	214,321.90
OCTOBER, 2015	04	32,461.00
NOVEMBER, 2015	12	114,768.93
DECEMBER, 2015	20	186,210.78
JANUARY,2016	36	406,434.24
FEBRUARY, 2016	49	457,746.34
MARCH, 2016	34	350,952.95
TOTAL	**248**	**2,415,127.31**

Summary Of Total Tonnage Beached Vessel At Alang From 01st April, 2016 To 31st March ,2017

MONTH	NO. OF VESSELS	TOTAL TONNAGE (MT.)
APRIL, 2016	30	298,756.77
MAY, 2016	16	172,601.55
JUNE, 2016	19	217,311.16
JULY, 2016	15	139,010.97
AUGUST, 2016	21	228,789.91
SEPTEMBER, 2016	22	274,198.56
OCTOBER, 2016	30	335,047.32
NOVEMBER, 2016	17	166,249.17
DECEMBER, 2016	25	313,765.86
JANUARY,2017	29	303,174.15
FEBRUARY, 2017	15	158,931.55
MARCH, 2017	20	163,978.27
TOTAL	**259**	**2,771,815.24**

Summary Of Total Tonnage Beached Vessel At Alang From 01st April, 2017 To 31st March ,2018

MONTH	NO. OF VESSELS	TOTAL TONNAGE (MT.)
APRIL, 2017	31	290,594.04
MAY, 2017	15	113,284.20
JUNE, 2017	20	206,227.30
JULY, 2017	14	152,578.50
AUGUST, 2017	08	94,637.98
SEPTEMBER, 2017	17	257,401.16
OCTOBER, 2017	20	271,032.38
NOVEMBER, 2017	16	89,428.03
DECEMBER, 2017	25	249,339.26
JANUARY,2018	32	310,304.99
FEBRUARY, 2018	30	194,613.73
MARCH, 2018	25	197,065.41
TOTAL	**253**	**2,426,506.98**

Total Summary of Last 3 Years

Year	Nos of Vessel	Total Tonnage (MT)
01-04-2015 to 31-03-2016	248	2,415,127.31
01-04-2016 to 31-03-2017	259	2,771,815.24
01-04-2017 to 31-03-2018	253	2,426,506.98
Total Vessel & Total Tonnage (MT)	760	7,613,449.53

It can be seen from 2015 to 2018 in the last 3 years about 250 ships per year has been scrapped. This amounts to 2ship passing TAPS every 3 days.

8. EFFECT OF DRILLING AT TAPS SITE:

8.1 DRILLING REQUIREMENT IN THE PROPOSED VADHVAN PORT:

Drilling is required in the port during piling work for the construction of various berths and jetties. Some amount of minor drilling by Augar boring is required during the basic survey of the Port site to ascertain seabed condition and rock levels.

8.2 IMPACT OF DRILLING IN AND OUT OF THE PROPOSED VADHVAN PORT LIMITS:

It is proposed to construct breakwaters and basic infrastructures by Vadhvan Port. All activities of the port will be out sourced. The terminals and berths will be constructed by various private firms on PPP mode. In all probability, the construction of terminals will start only after part of the breakwater is ready so

as to provide tranquility at the berth site. The drilling therefore will be carried out in enclosed environment.

As per the CWPRS, Pune's report on the study of **SHORELINE CHANGES, SEA BED, ROCK LEVELS, SILTATION ETC,** the following has been observed:

The most of near shore seabed is flat and rocky. The site is exposed to wave's incident from SW quadrant with significant wave height of about 3.5 m. **The site has a tidal variation of about 5.5 m between Low Tide and High Tide**. **The proposed layout consists of one breakwater of length 10.1 km with a current deflecting wall of length 1.9 km at southern end of the breakwater and reclamations area of 1300 ha at the head land of Vadhavan.**

Alongshore sediment transport takes place when wave approach obliquely to the shore and eventually break. The wave breaking releases energy, which brings sediment into suspension and alongshore littoral current transport of the sediments. The cycle of sediment transport by the waves to and from the coast is continuous which has aided in maintaining the equilibrium of the coastline over the geological times.

Mathematical Model studies carried out by CWPRS, Pune for shoreline changes for the proposed port of Vadhavan indicated as follows:

1. In the near shore region of Vadhvan in 10M of water depth, the predominant wave directions are from the sector between 220 to 300 deg N with maximum significant wave height of the order of 2.5 M.
2. Studies for estimation of littoral drift distribution indicated that, average net transport in a year is of the order of 0.07 million cum and is towards north.

Study for simulation of shoreline changes indicated that the construction of proposed off shore breakwater of 10.1 KM length will result in negligible deposition of sand behind the breakwater and will have negligible impact on the adjacent shoreline as well.

In view of this, the effect of drilling on flat and rocky seabed will have no impact at the site of TAPS.

8.3 REQUIREMENT OF DRILLING BEYOND PROPOSED VADHVAN PORT LIMIT:

There is no requirement of drilling beyond the proposed Vadhvan Port limit.

9. OBSERVATIONS:

Based on the scope of work and our methodology adopted, a detailed study was made on the subject after referring the study reports submitted by CWPRS, Pune and DPR Consultants M/S Projen – Pentacle. Our observations are as follows:

1. Drilling is required in the port during piling work for the construction of various berths and jetties. Some amount of minor drilling is required during the basic survey of the Port site to ascertain seabed condition and rock levels. However, drilling is done by Augar boring which does not create any vibration.
2. It is proposed to construct breakwaters and basic infrastructures by Vadhvan Port. All other activities of the port will be out sourced. The terminals and berths will be constructed by various private firms on PPP mode. In all probability, the construction of terminals will start only after part of the breakwater is ready, so as to provide tranquility at the berth site. The drilling, therefore, will be carried out in enclosed environment. The pile drilling is either done by Augar boring or hammer and chisel drilling. Augar boring does not have any vibration and the impact of vibration due to chisel and hammer can only travel upto 20 M distance.
3. The most of near shore seabed is flat and rocky. The site is exposed to wave's incident from SW quadrant with significant wave height of about 3.5 m. The site has a tidal variation of about 5.5 m between Low Tide and High Tide. The proposed layout consists of one breakwater of length 10.1 km with a current deflecting wall of length 1.9 km at southern end of the breakwater and reclamations area of 1300 ha at the headland of Vadhavan.
4. Alongshore sediment transportation takes place when wave approach obliquely to the shore and eventually break. The wave breaking releases energy, which brings sediment into suspension and alongshore littoral current transport of the sediments. The cycle

of sediment transport by the waves to and from the coast is continuous which has aided in maintaining the equilibrium of the coastline over the geological times.

5. In the near shore region of Vadhvan in 10M of water depth, the predominant wave directions are from the sector between 220 to 300 deg N with maximum significant wave height of the order of 2.5 M.
6. Studies for estimation of littoral drift distribution indicated that, average net transport in a year is of the order of 0.07 million cum and is towards north.
7. Study for simulation of shoreline changes indicated that the construction of proposed off shore breakwater of 10.1 KM length will result in negligible deposition of sand behind the breakwater and will have negligible impact on the adjacent shoreline as well.
8. In view of the above and since vibration cannot travel more than 20 M, the effect of drilling on flat and rocky sea bed will have no impact at the site of TAPS.
9. The construction of breakwater does not require any drilling operation.
10. There is no requirement of drilling beyond the proposed Vadhvan Port limit.
11. The port is designed to handle largest container ships of LOA -430 M with a draft of 18.0 M and capacity of 24000 TEU. It is also designed to handle coal vessel of 1,80,000 MT, LPG of 60,000 MT and LNG of 2,66,000 MT.
12. About 3585 ships would be calling at Vadhvan Port when it is fully developed. This would amount to about 10 ships every day on an average.
13. The operating limit for ships will be restricted to wind speed of 20 Knots from any direction, visibility not less than 1 nautical mile.
14. The speed limit for the ships in the channel will be restricted to 10 knots and while passing vessels in the channel it will be further reduced to 8 knots. The berth approach speed will not be more than 2 knots.
15. Channel depth will be Minimum 17 M at CD during First Phase of development and 20.0 M during Final Phase. The channel depth

from Fairway to breakwater till 1.5 KM is from 20 M to 18.5 M. The inner channel is minimum 17.0 M.

16. Designed for two ways traffic as per PIANC guidelines. The width of the channel is 500M and broadened to 600 M at the bend.
17. Sufficient space is available near each berth for the vessels to turn. Minimum diameter for turning is available between 900 M to 1000 M.
18. The entire port limit has been surveyed and depth sounded and charted by the DPR Consultants. The 2 M contour is 2 KM from the coastline and 10 M contour is 4 KM from the coastline. All berths are located to be between the contours of 15 to 20 Metres. The channel depth is between 16.5 M to 20 M. The depth at the berth pocket will be maintained at 18.5 M.
19. The total berth length during the first phase wilfl be 2000 M and increased to 6000 M during the final phase.
20. In the near shore region of Vadhvan in 10M of water depth, the predominant wave directions are from the sector between 220 to 300 deg N with maximum significant wave height of the order of 2.5 M.
21. The tides in Vadhavan are semidiurnal in nature and also a macro tide with tidal range of more than 4m during spring. The tidal levels (w.r.t. Chart Datum) near Vadhavan as per the NHO Chart No.210 are as follows :

    Mean High Water Spring (MHWS) : + 4.8 m
    Mean High Water Neap (MHWN) : + 3.7 m
    Mean Sea Level (MSL) : + 2.8 m
    Mean Low Water Neap (MLWN) : + 2.0 m
    Mean Low Water Spring (MLWS) : + 1.2 m

22. The most of near shore seabed is flat and rocky. The site is exposed to wave's incident from SW quadrant with significant wave height of about 3.5 m. The site has a tidal variation of about 5.5 m between Low Tide and High Tide. The final layout for this port was evolved through extensive mathematical modeling studies for tidal hydrodynamics and wave tranquility. The proposed layout consists of one breakwater of length 10.1 km with a current deflecting wall

of length 1.9 km at southern end of the breakwater and reclamations area of 1300 ha at the head land of Vadhavan**.** Alongshore sediment transport takes place when wave approach obliquely to the shore and eventually break. The wave breaking releases energy which brings sediment into suspension and alongshore littoral current transport of the sediments. The cycle of sediment transport by the waves to and from the coast is continuous which has aided in maintaining the equilibrium of the coastline over the geological times.

23. Mathematical Model studies carried out by CWPRS, Pune for shoreline changes for the proposed port of Vadhvan indicated as follows:

- In the near shore region of Vadhvan in 10M of water depth, the predominant wave directions are from the sector between 220 to 300 deg N with maximum significant wave height of the order of 2.5 M.
- Studies for estimation of littoral drift distribution indicated that, average net transport in a year is of the order of 0.07 million cum and is towards north.

24. Study for simulation of shoreline changes indicated that the construction of proposed off shore breakwater of 10.1 KM length will result in negligible deposition of sand behind the breakwater and will have negligible impact on the adjacent shoreline as well.
25. The Port in the initial stage will have 2 nos. 65ton bollard pull ASD tugs and 2 nos. 100 ton bollard pull ASD tugs, 2 nos pilot launches with a speed of 20 Knots, 2 nos. mooring launches and 1 no. multipurpose launch.
26. During Navigational simulation studies at DHI, Singapore, four emergency scenarios which could result in collision or grounding were included in the simulation run matrix and based on that key conclusion of the 3D simulation was that the proposed berths are optimally and favorably aligned with the tidal current making it easy for vessel to berth and un-berth at the jetty. There was no significant concern with the berthing and unberthing of the largest designed vessel at the proposed jetty/berth.

27. The swinging area/turning space between jetty/berth for vessel to execute a swing during the berthing / un-berthing maneuver was found to be adequate for the largest designed vessel and provides sufficient clearance and distance for possibility to correct minor maneuvering mistakes without compromising safety.
28. The vessels sailing on the west coast of India are generally bound for Pipavava, Dahej and hazira. These vessels are generally small and passes close to TAPS site but keep beyond the 10 M depth contour which is only 2.5 KM from Tarapore coast, whereas 14 M and 20 M contours are 5 KM and 11 KM respectively.
29. In 2016, 1966 vessels had called Saurashtra ports and in 2017, about 1993 vessels had called. This would amount to about 11 ships passing TAPS every day.
30. There are number of vessels bound for Alang Scrap yard on the west coast of India, passes the site of TAPS very closely. These ships are already a highly potential danger to TAPS as they are out of class and mostly being towed. There are number of cases especially during the monsoon season where ship's tow line parts and the ship drifts towards the shore and run aground and sometimes sink resulting in oil pollution.
31. It can be seen that from 2015 to 2018 in the last 3 years about 250 ships per year has been scrapped. This amounts to 2 ship passing TAPS every 3 days.
32. The probability of the collision of ships entering into and sailing out of the proposed Vadhvan port limits is negligible. However the port will have its Disaster Management Plan to combat any exigency. There is no chance of any ship approaching Vadhvan port to go close to TAPS since the entry to port is from 20 M depth.
33. The probability of collision of ship near TAPS site already exists due to the facts that number of ships sailing on the west coast of India are passing close to TAPS site. But ships calling at Vadhvan port cannot go close to TAPS. The Vadhvan Port is deepwater port and the ships draft will be mostly 18 M, whereas TAPS intake and outlet pipeline are in very shallow water.

10.RECOMMENDATIONS:

a) Drilling is required in the port during piling work for the construction of various berths and jetties. Some amount of minor drilling is required during the basic survey of the Port site to ascertain seabed condition and rock levels. However, drilling is done by Augar boring which does not create any vibration.

b) It is proposed to construct breakwaters and basic infrastructures by Vadhvan Port. All other activities of the port will be out sourced. The terminals and berths will be constructed by various private firms on PPP mode. In all probability, the construction of terminals will start only after part of the breakwater is ready so as to provide tranquility at the berth site. The drilling therefore will be carried out in enclosed environment. The pile drilling is either done by Augur boring or Hammer and Chisel drilling. Augur boring does not have any vibration and the impact of vibration due to Chisel and Hammer can only travel upto about 20M distance.

c) The construction of breakwater does not require any drilling operation.

d) There is no requirement of drilling beyond the proposed Vadhvan Port limit.

e) The effect of drilling on flat and rocky seabed at the Vadhvan port harbour will have no impact at the site of TAPS as explained above and in details under chapter 8.

f) During Navigational simulation studies at DHI, Singapore, four emergency scenarios which could result in collision or grounding concluded that the proposed berths are optimally and favorably aligned with the tidal current making it easy for vessel to berth and un-berth at the jetty. There was no significant concern with the berthing and unberthing of the largest designed vessel at the proposed jetty/berth.

g) As per the guidance of the navigational simulation study, the operating limit for ships will be restricted to wind speed of 20 Knots from any direction, visibility not less than 1 nautical mile. The speed limit for the ships in the channel will be restricted to 10 knots and while passing vessels in the channel it will be further reduced to 8 knots. The berth approach speed will not be more than 2 knots. The channel is designed for two ways traffic as per PIANC guidelines. The width of the channel is 500M and broadened to 600 M at the bend. Sufficient space is available

near each berth for the vessels to turn. Minimum diameter for turning is available between 900 M to 1000 M. In view of this, the probability of the collision of ships entering into and sailing out of the proposed Vadhvan port limits is negligible.

h) In the near shore region of Vadhvan in 10M of water depth, the predominant wave directions are from the sector between 220 to 300 deg with maximum significant wave height of the order of 2.5 M. Hence, if at all there is a collision, there would be no impact to TAPS as any oil spilled from the ship will drift to deeper depth and not towards TAPS site.

i) The port will have its Disaster Management Plan as per which any disaster in the port will be controlled. There would be offshore and On-shore disaster management plan, as per which any contingency in TAPS, the port could provide additional resources.

j) The vessels sailing on the west coast of India are generally bound for Pipavava, Dahej and hazira. These vessels are generally small and passes close to TAPS site but keep beyond the 10 M depth contour which is only 2.5 km from Tarapore coast, whereas 14 M and 20 M contours are 5 KM and 11 km respectively.

k) In 2016, about 1966 vessels had called Saurashtra ports and in 2017, about 1993 vessels had called. This would amount to about 11 ships passing TAPS every day, which are already potential danger to TAPS.

l) There are 250 vessels per year bound for Alang Port Scrap yard on the west coast of India, passes the site of TAPS very closely. These ships are already a highly potential danger to TAPS as they are out of class and mostly being towed. There are number of cases especially during the monsoon season where ship's tow line parts and the ship drifts towards the shore and run aground and sometimes sink resulting in oil pollution.

m) The probability of the collision of ships entering into and sailing out of the proposed Vadhvan port limits is negligible. However, the port will have its own Disaster Management Plan to combat any exigency. There is no chance of any ship approaching Vadhvan port to go close to TAPS since the entry to port is from 20 M depth.

n) The probability of collision of ship near TAPS site already exists due to the facts that number of ships sailing on the west coast of India are passing close to TAPS site. But ships calling at Vadhvan port will in no case go close to TAPS. The Vadhvan Port is deep water port and the

ships draft will be mostly 18 M, whereas TAPS intake and outlet pipe line are in very shallow water.

11.CONCLUSION:

Based on the study related to probability and impact of drilling/collision of ships near TAPS site with reference to the development of Vadhvan port on the west coast of India, 12 kms north of TAPS, Tarapore, it is concluded that the possibility of collision between ships either in navigational channel or inside the breakwaters, in either case there will be no impact or adverse effect on the TAPS facility as explained in Observation and Recommendation chapters. Further, as pointed out in the report, there will not be any impact on TAPS facilities due to drilling in Vadhavan port limits.

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