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The Trincomalee Port Development Plan – Volume 3 (Part 1)

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For Sri Lanka Ports Authority

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National Port Master Plan – Volume 3

Trincomalee Port Development Plan

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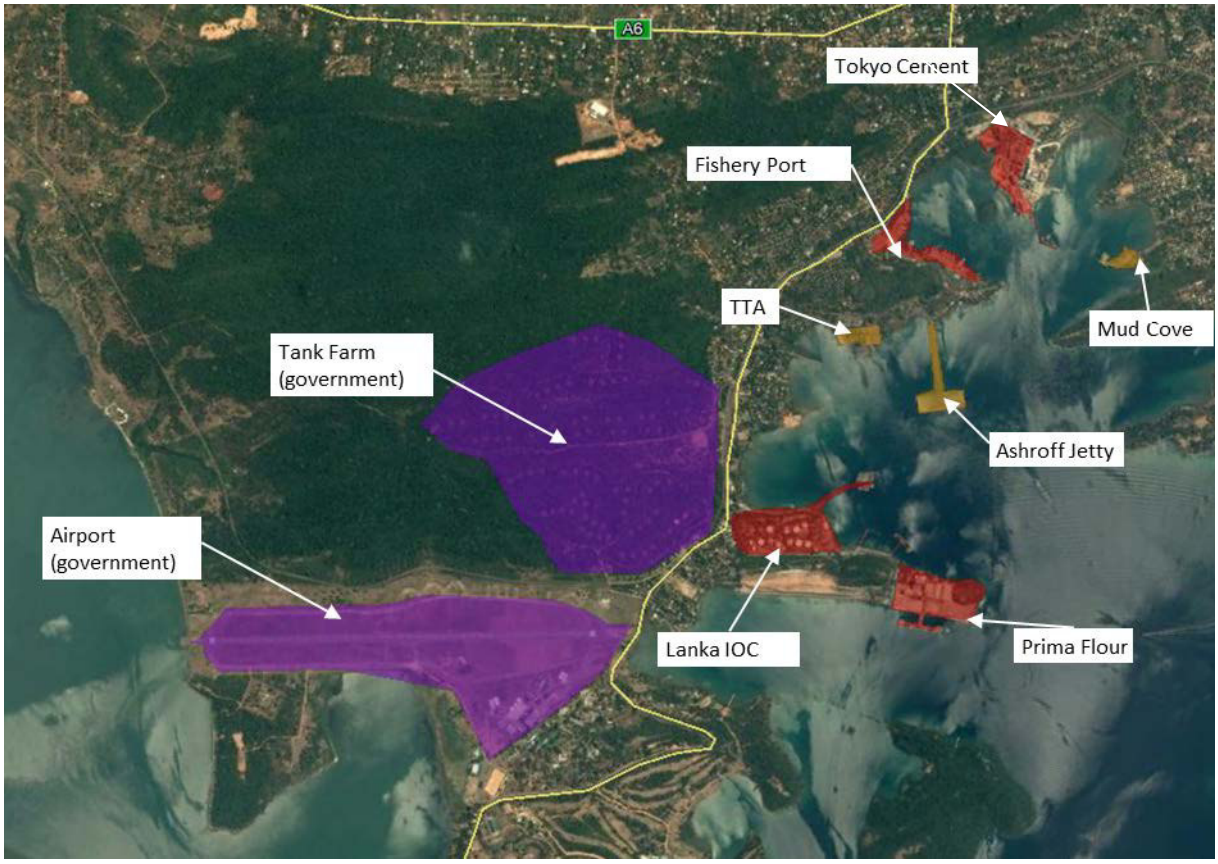
Executive Summary

Current Trincomalee Port Environment

The Port of Trincomalee, located at the North East Coast of Sri Lanka in a unique natural deep-water bay, is protected by terraced highlands with an entrance guarded by two headlands. The sheltered bay provides excellent conditions for berthing and ship-to-ship cargo transfers. The port was originally used as a naval base with naval berths and a naval airstrip. Today, the port handled 3.2 million tons in 2016 with the main commodities being dry bulk cargoes (wheat, clinker, gypsum and coal), liquid bulk (refined products) and breakbulk or general cargo (project cargo, steel products). The port of Trincomalee is an important port for Sri Lanka, with several dedicated port terminals - the Tokyo Cement facility, the Lanka IOC oil facility and SLPA oil berth, the Prima Flour grain facility, and the TTA tea facility - and a common berth for general cargo and dry bulks - the Ashroff jetty. Additionally, several old oil storage tanks, originating from WO-II, are situated on government land near the port. In 2016, the port handled 3.2 million tons, consisting mainly of dry bulks, such as cement, coal, gypsum, and grains; and liquid bulks, such as oil products. Additionally, the port offers auxiliary services, such as areas for ship-to-ship operations, layup facilities, crew change services, and other services to ships anchored in the bay.

The table below indicates the main facilities in the port and their respective functions.

Current Trincomalee Port Facilities



Current Trincomalee Port Facilities

	Tokyo Cement	Mud Cove	Ashroff	TTA	Oil Berth	Prima Flour	Naval Base	Fishery Port
Operator	*Private*	*SLPA*	*SLPA*	*SLPA*	*SLPA*	*Private*	*Navy*	*Multi-User*
Containers								
Ro-Ro								
Dry Bulk	■		■			■		
Liquid Bulk					■			
General Cargo			■	■				
Passengers			■					
Ship Repair		■						
Navy							■	
Auxiliary		■						■

Port Operational Activities

The table below summarizes the development of cargo throughput at the port of Trincomalee, considering both the volumes at the SLPA facilities and at the private facilities. The following can be observed:

- Dry bulk volumes account for the majority of throughput at the port.
- In terms of absolute figures, clinker was the largest growth driver over the period from 2010 to 2016. The majority of the clinker volumes are destined for the Tokyo Cement facility in Trincomalee and Puttalam based Siam Cement. Additionally, some volumes are transhipped to smaller vessels hrough midstream operations, in order to serve Siam Cement facility in Galle.

'000 Tons	2010	2011	2012	2013	2014	2015	2016	2017
Discharged								
Wheat in bulk	911	1,090	901	676	825	868	714	760
Clinker in bulk	738	985	1,369	1,244	1,383	1,419	1,593	1,678
Gypsum in bulk	12	43	107	80	114	86	112	166
Coal in bulk	106	105	89	99	113	93	103	90
Other (slag)	-	-	-	10	14	-	22	-
Liquid bulk (fuel)	191	113	179	166	173	182	281	417
Total Discharged	**1,960**	**2,337**	**2,646**	**2,276**	**2,621**	**2,649**	**2,825**	**3,120**
Loaded								
Wheat bran pallets	139	-	-	140	127	162	153	122
Clinker	-	-	-	-	-	217	536	619
Other	55	237	213	20	-	-	-	37
Total Loaded	**194**	**237**	**213**	**159**	**127**	**379**	**689**	**778**
Cargo Handled	**2,154**	**2,574**	**2,859**	**2,435**	**2,748**	**3,027**	**3,514**	**3,897**

Supporting Processes & Activities

IT

The capabilities of SLPA's current IT systems in Trincomalee are very limited. Some Oracle Financial system modules are implemented in the Port of Trincomalee, as an extension of the systems used by the SLPA Head Office in Colombo. However, due to poor internet connectivity, the system needs to be reset frequently to carry out data transactions.

Additionally, the Trincomalee based SLPA facilities lack essential IT systems, such as (i) a Harbour Master Information Management System that is linked to a Vessel Traffic Management System; (ii) online cargo payment and clearance systems for clients; and (iii) port operations management systems that tracks and manages berth availability, scheduling, warehouse availability, and tug availability.

Ship Repair

Some ship repair services are provided at the Mud Cove facility, which features some workshops and a privately operated floating crane to lift vessels onto the quay. The facility mainly caters to SLPA vessels, but several private vessels are also moored alongside the quay waiting for repairs.

Connectivity

The access channel to Trincomalee port passes through the natural deep-water bay; as such, the channel has a minimum depth of CD -22.0m and a width of 1,554m. The depth of the navigable waters within the harbour vary between CD -11.0m and CD -30.0 m. However, due to a lack of adequate lights, buoys, and lighthouses, vessels are only allowed to enter and exit the port during daytime.

In terms of landside connectivity, the Port of Trincomalee is connected to the nearby A6 and A15 highways. However, the roads connecting the port terminals to the highways pass through the city premises, due to a lack of dedicated port access roads; this results in congestion in and near the city.

Additionally, the privately-operated Prima Flour and Tokyo Cement terminals have direct rail access; the Ashroff facility currently lacks direct rail access, but the nearby China Bay rail station is used for some cargo rail operations towards Puttalam. The main road and rail connections are presented in the figure below.

Current Road and Rail Connections

Current Issues and Bottlenecks

Subsequently, the table below summarises the key issues in the port, which have been identified through (i) desk research, (ii) stakeholder meetings, and (iii) site investigations. The high severity issues are the main drivers for priority projects.

Table 1-1: Trincomalee - Key Observations and Bottlenecks

Category	Issue	Severity
Mud Cove		
Operations	Quay wall is in a deteriorated state	Low
Operations	Berthing space is constrained	Low
Operations	Slipway is not functional	Low
Operations	Mud cove is not conveniently situated for service jetties, as employees have to travel between Mud cove and Ashroff jetty.	Medium
Connectivity	Low quality access road	Medium
Operations	No Equipment	High
TTA & Ashroff		
Equipment	Belt systems required for new commodities such as Biomass and Ilmenite	High
Operations	There is a sunk barge in front of the TTA facility	Low
Connectivity	TTA quay wall is damaged / in a deteriorated state	Low
Connectivity	TTA quay wall has un-sufficient water depth for service crafts and tug boats	Low
Operations	Coal operations is cumbersome, from quay into container onto rail and truck	High
Operations	Gypsum operations is dusty activity as hoppers are not designed for it.	

Category	Issue	Severity
Operations	No equipment available (everything is with ship's gear) except for hoppers to handle the coal	High
Operations	Causeway to Ashroff Jetty results in inefficient operations	High
Connectivity	Low quality access road including road access to the Ashroff jetty	High
Operations	Ashroff jetty is not capable to receive mini-Capes or Capesize vessels due to length (250m) and depth constraints (-12.5m).	High
Operations	Gate configuration is poor	High
Operations	Limited flat land near the Ashroff jetty for operations and storage	High
Tokyo Cement		
Capacity	Production capacity from 1.8 M tons today to 2.8 M tons.	Low
Operations	The facility is only capable to receive small Handysize cement bulk carriers due to limited water depth but dredging works are underway to increase depths.	Low
Prima Flour		
Operations	The Flour mill is a modern complex with state of the art discharge facilities.	Low
Operations	To widen the access to the flour mill for trucks, land excavation works are under progress	Low
SLPA Oil Berth		
Operations	Deep-water oil jetty necessary to handle increasing demand	High
General		
IT	No computer system for port operations management, ship cargo management and invoicing are manual processes	High
IT	Manual pro-forma invoices are generated, communication mainly by fax.	High
IT	Purchasing & Expense vouchering is manually based	High
IT	Many items are still cash based such as port permits, vehicle permits, handling fees	
IT	Paper Dependent Transaction Recording System (Documents are filled by hand, hard copy based, and require signatures) leading to mistakes, slow decision channels and missing documents.	High
IT	There is no planning system and /or MIS system which tracks; (berth) availability, reservations, space, scheduling of pilots, tugs and to publish information on productivity & performance.	High
Zoning	Encroachment of SLPA Lands	High
Connectivity	Port connection roads are partially unpaved and have limited capacity	High
Connectivity	No rail connection to SLPA facilities yet	High
Zoning	There is no overarching land use plan for the SLPA lands in Trincomalee	High
Navigation	Night time operations are not possible due to missing navigational aids	High

Source: MTBS

Future Demand and Development

The Port of Trincomalee is expected to play an important role in the future economic development of the north-eastern part of the country which growth pattern was long hampered by civil war. Emphasis is focused around the key benefits of this port, natural deep water, shelter, unique tourist places and ample land for industrial and logistics in the proximity of the port.

At present the capacity of the common quay is limited, modern warehouses are lacking and the land for industrial development is not directly connected to the port. To upgrade the port and to maximise the deep-sea port potential, expansion of the Ashroff quay is required as well as unlocking the land available by providing new access roads and rail connections. This will facilitate settlements of industrial and logistical enterprises. The service activities in the bay require modern facilities at a one-stop shop location. This will enact on the functions for ship-to-ship transfer, ship lay-up and submersible activities. The tourism industry is expected to increase as well. A marina and a cruise berth are expected to cater developments in this respect. Space within the port is allocated to develop the boat repair industry under PPP structures. These sectors (tourism and boating) are also part of the National Export Strategy. An important element in the functioning of the port are the connectivity projects on road and rail integrated with the dry port concepts in the Colombo – Trincomalee Economic Corridor concept.

Port Operational Activities

The table below presents the forecast demand for the current main commodities, as well as several envisaged new commodities. Inter alia, the following volume growth drivers have been considered in the forecasts:

- **Coal** - Rail transport of Coal to cement plants near Puttalam**.** Cement manufacturers in the Northern part of the country demand coal. This is today moved by in containers and by truck or rail. The coal arrives by bulkcarriers and is containerized near the Ashroff jetty.
- **Grains** - The national demand for grains is expected to increase as Sri Lanka develops. The majority of the imports is expected to keep flowing to Trincomalee in the form of bulk imports. This is mainly handled at Prima Flour in the port of Trincomalee.
- **Clinker** - It is expected that national demand for cement and clinker will increase along with economic development. The share of cement and clinker that is handled at Trincomalee is assumed to remain stable.
- **Refined** Oils - A dip in refined oil demand is expected after 2025, as it is assumed that the envisaged refinery in Hambantota becomes operational in 2025. Hence, national crude oil imports are expected to increase, while refined oil imports are expected to decrease.
- **Cruise** - As Colombo is increasingly able to attract cruise business, due to the development of the passenger terminal, it is expected that there will be some spillover effects to other ports in Sri Lanka, resulting in growing cruise vessel arrivals.
- **New Commodities** - As Trincomalee port is developed and the wider region experiences substantial industrial development, it is expected that the port of Trincomalee will be able to attract the share of the nation's gateway demand that is destined for the Trincomalee area. Volumes for the other envisaged new commodities are based on substantiated private initiatives in the Trincomalee region, for which interest in the Port of Trincomalee has been expressed. Initially the gateway containerised demand will be slow and arrive by feeder or by coastal feeder and can be handled at the Ashroff jetty. Dry bulk demand such as fertilisers may also emerge when industries in this sector are developed.
- **Service jetties** - New service jetties shall increase the efficiency of this sector as services are concentrated at one location.

The forecast of commodities is presented in the next table showing strong increases across the majority of goods.

Commodity	Unit	2016	2025	2030	2050
Coal	'000 Tons	103	120	120	120
Grains	'000 Tons	867	1,457	1,509	1,709
Clinker	'000 Tons	1,712	2,297	2,560	3,113
Refined Oils	'000 Tons	238	1,064	507	1,358
Cruise	Vessels	4	7	12	21
Containers	'000 TEU	-	-	26	112
Fertilisers	'000 Tons	-	1,536	1,536	1,536
Biomass	'000 Tons	-	325	500	500
Ilmenite	'000 Tons	-	700	700	700
LNG	'000 Tons	-	-	-	-

Supporting Processes & Activities

IT

With the current business traffic and operations, any IT upgrade is recommended with reservation. The following important functions still needs priority and automation.

- The port requires a gate automation, that is linked to a terminal operating system. This is to streamline activities and make functions computer driven. The paperless digitally driven online approval that links with payment gateways contributes to reflect revenue and expenses when it occurs. There procedures are transparent and not human influenced.
- Harbour Master Management Information System is required for accurate billing and record keeping.
- Management Information Dashboard will give the availability utilization, and productivity and performances visible for decision making and quick responses.
- A Single Window Port Community System can be a branch of the Colombo based system. This can be introduced to speed the processing and interfacing with multiple roles and actions where different partners who are distributed, and distant to come into interaction to seek or provide a service to the Port. Later the Trincomalee Port Single Window Community system can become independent but integrated in a national system and collaborate only where transactions need to be updated across platforms to provide information to the respective parties.

Recommendations & Short-Term Priority Projects

Taking into consideration the forecasts and development requirements discussed in the previous sections, two sets of outputs have been compiled:

- **Recommendations** – Numbered in the sequence R1, R2, R3, etc.
- **Short-term priority projects** – Numbered in the sequence SP1, SP2, SP3, etc.

Recommendations are given on soft matters that are not infrastructure related, such as port reforms. The numbering is done to provide clarity on the numerous recommendations and their topics.

The short-term priority projects are mainly infrastructure projects that SLPA should undertake in within the next 10 years. Several projects will be selected for the pre-feasibility phase.
In the Annex V, an implementation plan is provided for the recommendations, the short term priority projects and the long term priority projects.

Recommendations

R1. **Mobile Harbour Cranes (MHC)** to be installed at Ashroff Jetty to improve service and performance level.
R2. **Hoppers** to be installed at Ashroff Jetty (together with Mobile Harbour Cranes) in order to improve the productivity during unloading. Hence, vessel operations will run seperately. Truck loading operations will not hamper the ship unloading anymore. Hoppers shall be equipped with dust control systems.
R3. **Conveyor belt system(s) and storage silos**. To improve loading and discharging productivity rates and to reduce the impact on the environment.
R4. **Mud Cove Rehabilitation.** The main recommendation is to dispose the facility to private parties which are interested to perform small boat repairs and boating activities. SLPA functions like mooring of tug boats and service vessels shall be replaced towards the Ashroff jetty.
R5. **Mud Cove Access road development.** The access road is to be upgraded and paved.
R6. **Tokyo Cement.** The recommendation for SLPA is to take into account the developments of expansion of Tokyo Cement on expected vessel traffic and ship manoeuvring.
R7. **SLPA Oil Berth expansion.** Create additional deep-water berthing capacity for 50-80,000 DWT vessels to facilitate Lanka IOC expansion.
R8. **IT improvements.** Fiber Optic Direct Link to the terminal office building;
R9. **IT improvements.** A redundancy support Computer Server Room to be established;
R10. **IT improvements.** Introduce and implement Harbour Master Management System;
R11. **IT improvements.** Introduce the cargo management application for general cargo after a study of the business model;
R12. **IT improvements.** Introduce a CCTV linked to performance monitoring platform;
R13. **IT improvements.** Automate the gates;
R14. **IT improvements.** Introduce a truck management and schedule system;
R15. **IT improvements.** Introduce a Port Community System;
R16. **IT improvements.** Integrate all port users to a single window system and an online approval portal with an electronic procedure and process manual;
R17. **IT improvements.** Enable e-Commerce ready web portal with information.
R18. In view of SLPA's intention to adopt the 'Green Port Concept' in its mode of operations, **it is recommended to start routine monitoring of environmental quality parameters as soon as possible**.
R19. **It is recommended to measure water quality at 5 locations in the port basin.**
R20. **Clear guidelines to be established for port concessionaires to contribute to a greener port**, including existing companies like Tokyo Cement, Prima Flour and IOC.

R21. **Establishment of a green policy** and implementation framework including measurement systems, monitoring and controlling emissions.
R22. **Establishment of HSSE department**. Attention for environmental issues within the operation of the port would be greatly served by establishing a dedicated, relatively independent Health, Safety and Environment (HSE) department.
R23. **Complying to international relevant conventions**.
R24. Set up an **environmental Management System in line with ISO 14001** certification for the different parts of its operations.
R25. **Port Connectivity.** Night time navigation should be made available as soon as possible.
R26. **Ashroff development:** two-phased jetty expansion suitable for larger bulk vessels (Capesize, max. 300 m long).
R27. **New deep-water oil jetty or CBM/SPM** to accommodate larger mainline vessels up to 80,000 DWT with a maximum draught of 13.0 m.
R28. **New 350 m long jetty** with a draught of 12.0 m **for a LNG floating storage** hub at Clappenburg Island.
R29. Long term: **marina and dedicated cruise berth** in front of the city; The cruise berth of 360 m long should be dredged at CD -11.0 m to allow for the largest cruise vessels with a maximum draft of 10 m currently in service.
R30. **Sampur:** in case coal or gas fire powered project will emerge, nautical mooring facilities will be required.
R31. **Ship lay-up locations** identified within Trincomalee Bay.
R32. Longer term future: **options for potential container terminal development**.
R33. **Upgrade the internal port road** of the Ashroff facility.
R34. Introduce an **improved gate system at the Ashroff facility**.
R35. Develop **additional road connections from the port to the A6**. This is split between a road directly moving north and a new road connection along the airbase heading north west following the boundary of SLPA's land (as shown in picture) or the rail track.
R36. **Extension of rail** to Ashroff Jetty
R37. Carry out detailed **commercial studies for (a selection of) the opportunities** to ascertain the demand and viability for Trincomalee to capture part of the demand.
R38. **Promote Trincomalee as deep-water port** having ample land development areas for industries and logistics
R39. Create **promotional plan for land use** and assign land plot specifications for future usage. Make difference between quay-connected activities and dry port related activities and distinguish between port related and non-port related business.
R40. Create **roll-out plan for land development** and prepare the first land plots for logistics and new industrial settlement areas
R41. Create **road connectivity** between newly developed areas, port and the A6.
R42. **Integrate the land use planning with the plan from urban planning**
R43. Set-up **commercial taskforce** to promote and lease-out the land plot(s) for port related industrial and logistics developments in Trincomalee. Create roadshows and promote business.

Short-Term Priority Projects

SP1. **Ashroff Jetty Upgrade Phase 1 -** A belt system is needed to reduce inefficiencies of trucking to the Ashroff Jetty and to accommodate future cargoes. Land reclamation, the extension of the quay, new road development, new equipment amongst other should be included in the plans.
SP2. **Navigation Aids** - For night time navigation the ports needs lights, buoys and lighthouses to ensure safety. Maintenance can be outsourced to private parties. SLPA will be remunerated for these costs by increased traffic to the port for which it will receive port dues.

SP3. **Port Access Road Development** - A road connection starting from A15 near Lanka IOC heading North West will make it possible for port traffic to bypass the city traffic to A6.

SP4. **Rehabilitation and Extension of the Rail Connection** to the Ashroff Jetty

SP5. Make **promotional plan** on land and connectivity for newly assigned industrial and logistics.

SP6. **SLPA Land Use Plan** - The Trincomalee Port Zoning Report is a step in identifying the ports future needs to continue to think about which lands are lands need to be uninhabited for port development. A displacement plan, set-up years in advance will ensure a smooth process.

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Preface

Trincomalee Port Development Plan

On the 30th of November 2016, the Asian Development Bank (ADB) and Maritime & Transport Business Solutions B.V. (MTBS; representing the Consultant) signed the contract for the development of a National Port Master Plan for Sri Lanka (ADB reference 50184-001).

The Trincomalee Port Development Plan covers the next 30 years and includes an investment plan for priority projects to be carried out in the next 10 years, following an assessment of the characteristics of existing port operations, and of existing and planned maritime and landside infrastructure.

The Trincomalee Port Development Plan is developed through the following reports:

- Trincomalee Port Zoning Report, providing a draft zoning map;
- Draft Trincomalee Port Development Plan, covering the Trincomalee Port Development Plan up to the list of priority projects; and
- Trincomalee Port Development Plan *(This report)*, including the pre-feasibility of priority projects, which were decided by the stakeholders, based on the Draft Trincomalee Port Development Plan.

Goals of this report

Trincomalee as a port is in full development and many uncertainties still exist. It is for this reason that the forecasts are not sufficient to base port development on. This report goes further than the forecasts in presenting development options which are for now to uncertain but changing circumstances might come into play. Several key goals to be addressed in this report are:

- To present options for attracting new business to the port;
- To outline the potential for SLPA land use;
- To detail the development areas in Trincomalee in a zoning map;
- To describe development options for the port;
- To outline short-term priority projects for SLPA; and
- To conduct pre-feasibility studies on selected projects

Reading Guide

- Chapter 1 introduces Trincomalee port and provides a general overview of the port and throughput data.
- Chapter 2 describes the current facilities of the port and focuses on the SLPA operated as well as privately operated facilities.
- Chapter 3 aims to provide an overview of the various IT systems used within the port environment of Trincomalee and describes the corresponding procedures.
- Chapter 4 provides an overview of the legal framework currently in place in Sri Lanka related to the social and environmental issues associated with port development and port modernisation.
- Chapter 5 describes the accessibility of the port of Trincomalee, both from a nautical perspective as well from a hinterland perspective.
- Chapter 6 explains the potential opportunities for the Port of Trincomalee.
- Chapter 7 presents the Trincomalee Zoning Map with its implication for the area and SLPA lands.

- Chapter 8 provides the needs assessment of the port based on national forecasts performed, both for the commodities currently handled in the port as well as for the new commodities potentially handled in the port.
- Chapter 9 assesses developments plans for the Trincomalee provided by SLPA. Port development plans within the scope of the forecast and qualitative analysis are assessed accordingly.
- Chapter 10 presents development options as identified by the consultant and SLPA.
- Chapter 11 presents the short-term priority projects identified and the projects selected for prefeasibility.
- Chapter 12 describes the Ashroff Jetty expansion project.
  Chapter 13 focuses on the Deep-Water Oil Jetty project.

1 Trincomalee Port Overview

1.1 Introduction

This section introduces the Port of Trincomalee and the port area to the general port environment:

- Paragraph 1.2 describes the importance of the city and region of Trincomalee to the nation and the Bay of Bengal. The unique deep-water bay provides strategic fuel imports to the nation. Its unique equal population mix of Sri Lankan ethnicities makes peace, stability and prosperity important to the region.
- Paragraph 1.3 introduces the port by giving a brief description of the main facilities within the port, the connection and its geographic location. Furthermore, it points out the specific role of the port and its role for Sri Lanka.
- Paragraph 1.4 details the cargo throughput per commodity over the last years at the port of Trincomalee and provides a brief historical overview of the vessel arrivals.
- Paragraph 1.5 provides an overview of key issues and constraints that hamper capacity and efficient operations in the port.

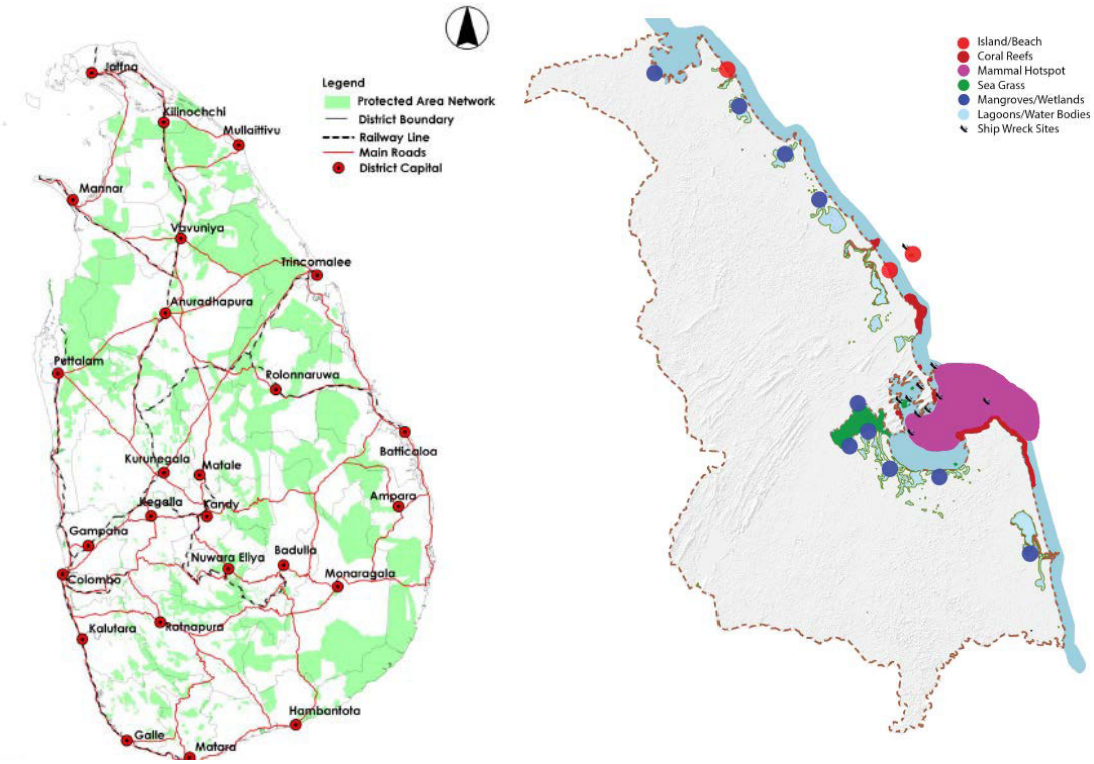
1.2 The Importance of Trincomalee Region

To briefly state the importance of the region of Trincomalee, 5 pillars can be identified:

1. **Ecology & Environmental Characteristics –**The Trincomalee is home to many nature reserves, including the Naval Headworks national park, which form a habitat of the jungle eco-system that includes a large population of elephants. Additionally, the Trincomalee area is home to some of the largest environmentally protected areas, due to the environmental value of the region. The figure below shows the density of protected areas in the Trincomalee region (left) and the marine ecosystems that can be found in the Trincomalee area.

   The marine ecosystems include coral reefs, mangroves and sea grass beds, which are important to maintain the number and variety of fish and other marine species. The indicated mammal hotspot is a breeding ground for blue whales, sperm whales, and dolphins.

Figure 1-1: Visualisation Protected Areas Sri Lanka (Left) and Protected Areas (Right)



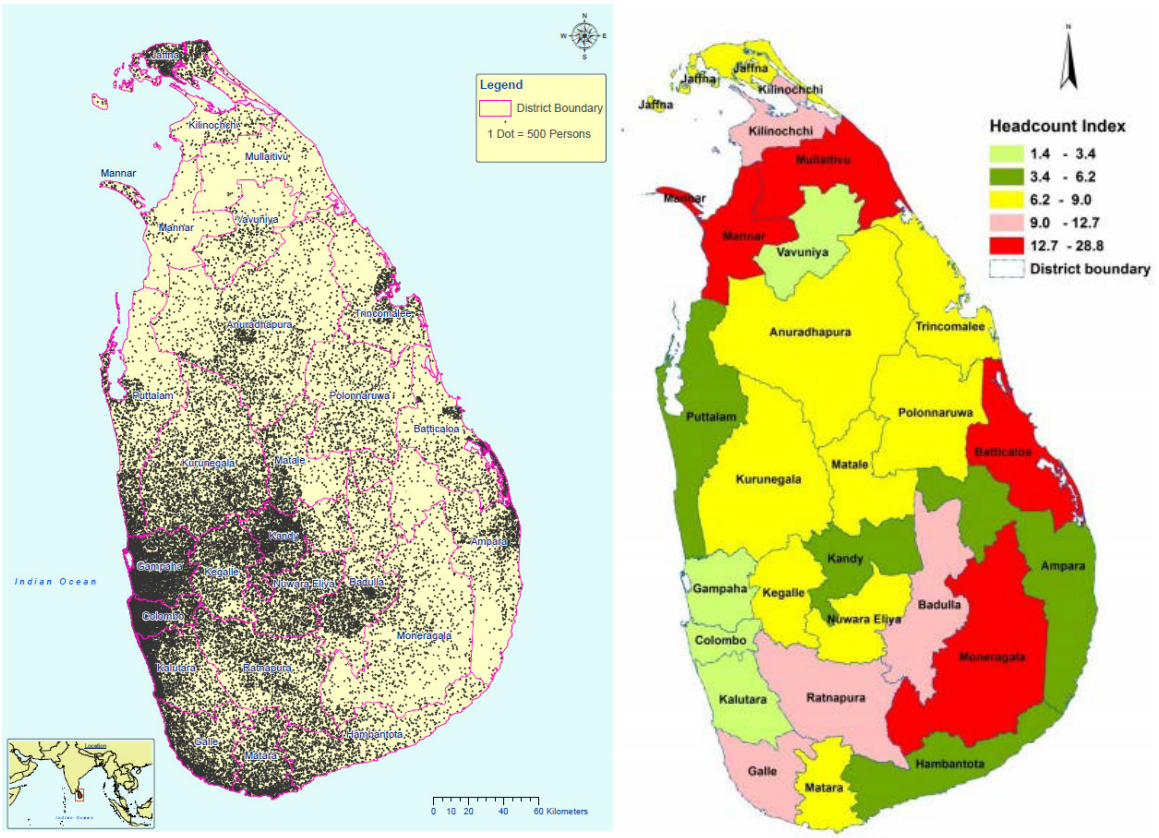
2. **Population & Ethnicity –** The total population of the Eastern district is about 1.6 M people, of which approximately 400 thousand people live in the city of Trincomalee. Of these 400 thousand people living in Trincomalee 26.7% are ethnically Sinhalese, 30.7% are Tamil and 41.8% are Sri Lankan Moor. This roughly equal mix of the three dominant Sri Lankan ethnic populations makes the area unique. The government is pursuing an active policy of peace and stability in the area. Additionally, the following can be noted concerning the Trincomalee area:
   - Compared to the western region, the Trincomalee region is relatively sparsely populated; this is also visualized in Figure 1-2 (left).

- 9.0% of the population in Trincomalee lived under the poverty line, as measured through the 2012/2013 Household Income and Expenditure Survey[1]; a 9.0% poverty count places the Trincomalee area in an average position nationwide, as can be observed from Figure 1-2 (right).
- In 2015, 124,000 of the 129,000 people in the potential labour force were employed; this implies an employment rate of 95.4%
- The Trincomalee population increased from approximately 140 thousand inhabitants in 1963 to approximately 400 thousand inhabitants in 2015. As can be observed from Table 1-1, population growth has decelerated from an average growth rate of 3.91% between 1963 and 1971 to an average growth rate of 1.27% between 207 and 2015.
- In 2015, the Trincomalee area achieved a GDP per capita of USD 2,317

Table 1-1 Trincomalee Population Development

Year	Population	Period Growth (%)	CAGR (%)
1963	138,553	-	-
1971	188,245	35.86	3.91
1981	255,948	35.97	3.12
2007	334,363	30.64	1.03
2015	397,000	10.66	1.27

Figure 1-2 Sri Lanka Population Density (Left) and Sri Lanka Poverty Distribution (Right)



Source: Department of Census and Statistics

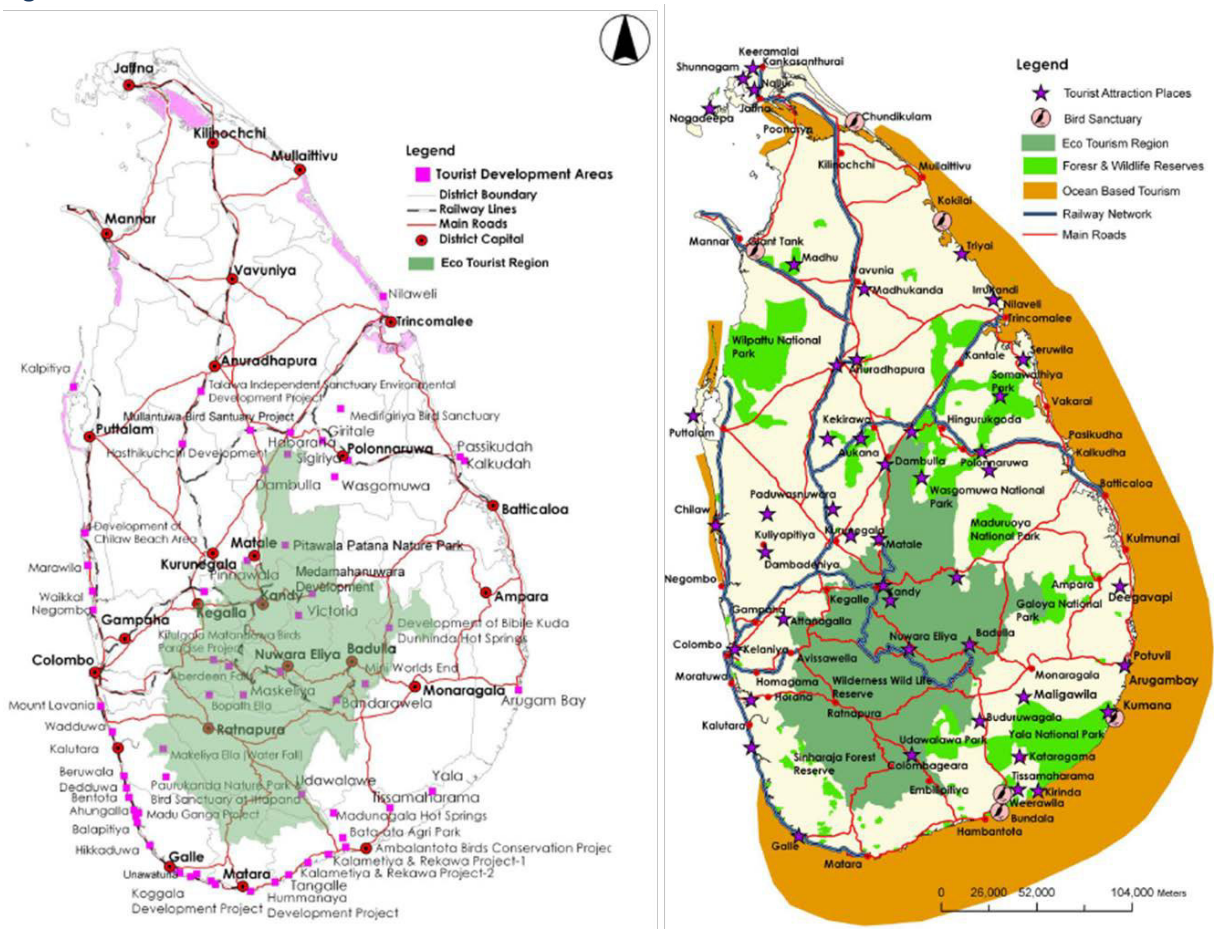
[1] The Sri Lankan Poverty Line, as articulated by the Department of Census & Statistics, is set at USD 1.50 per person per day (2005 PPP)

3. **Military** – During the civil war, Trincomalee housed an important military base for the nation. Still the navy has a large presence in Trincomalee in Fort Frederick. The Sri Lankan Air Force uses the airport situated next to the port. The region is thus of national security importance. Internationally, the Bay of Bengal sees increasing military activity from competing nations like China, India and the US.

4. **The Port –** Trincomalee port is an important port for the supply of bulk goods including grains, cement and refined oils. Due to the natural water depths the port is ideally positioned to handle dry bulk and liquid bulk cargoes. The commodities are moved from Trincomalee to the nation. In thus respect the port is better situated for these commodities compared to the Port of Colombo where draft limitations exists on the dry bulk berths and where city congestion plays a major role. Dry bulk commodities are ideally transported by rail and Trincomalee has a rail facility near the port in China Bay. Efficiency on the railtracks and tracks into the port can enhance the strenghts of the Port of Trincomalee.

5. **Tourism –** Trincomalee has attractive nature and beach resorts to attract tourists. The figure below visualizes the tourism development areas in Sri Lanka; it can be observed that Trincomalee is considered an important tourist destination for ocean based tourism and forest and wildlife reserve tourism.

Figure 1-3 Sri Lanka Tourism Areas

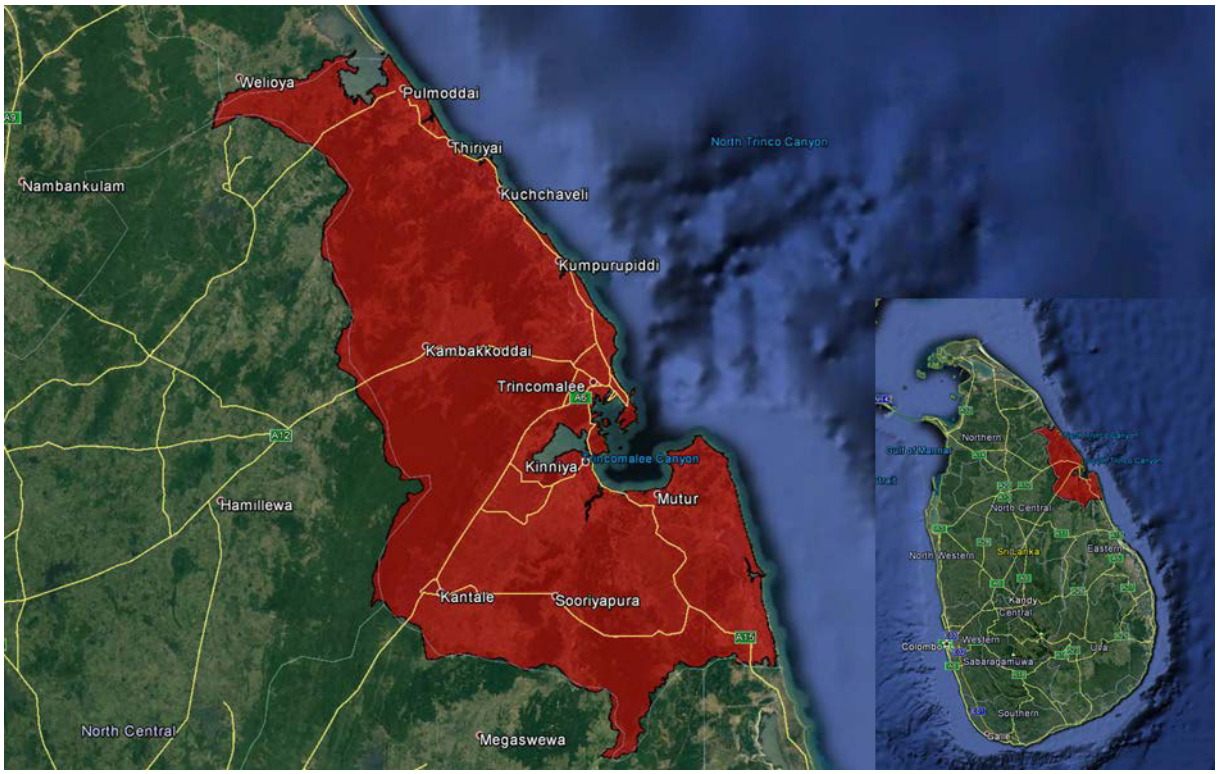


1.3 Port of Trincomalee

1.3.1 General Port Description

The port of Trincomalee comprises of several scattered facilities in a natural deep-water bay on the north-astern side of the country. The port of Trincomalee provides natural sheltered waters as it is protected from seasonal winds and rough water. The port was originally used as a naval base with naval berths and a naval airstrip. With the establishment of the Port Cargo Corporation in 1958, the institutional setting of Colombo port changed and the port developed itself as the country's main tea export facility. Prior to the introduction of today's Port Authority, the port was operated as a tool port. Today the port of Trincomalee is an important port for Sri Lanka with several dedicated port terminals (Tokyo Cement facility, IOC oil facility, the Prima Flour grain facility, TTA tea facility) and a common berth (the Ashroff jetty) for general cargo and dry bulks. In the forest near the port several old liquid oil storage tanks (originated from WO-II) are situated on government land. The port handled 3.2 million tons in 2016 consisting of mainly dry bulk commodities such as cement, coal, gypsum, grains and liquid bulks like fuel products. Furthermore, the port is offering an ideal location for ship-to-ship operations, layup, crew change and other services to ships anchored in the bay.

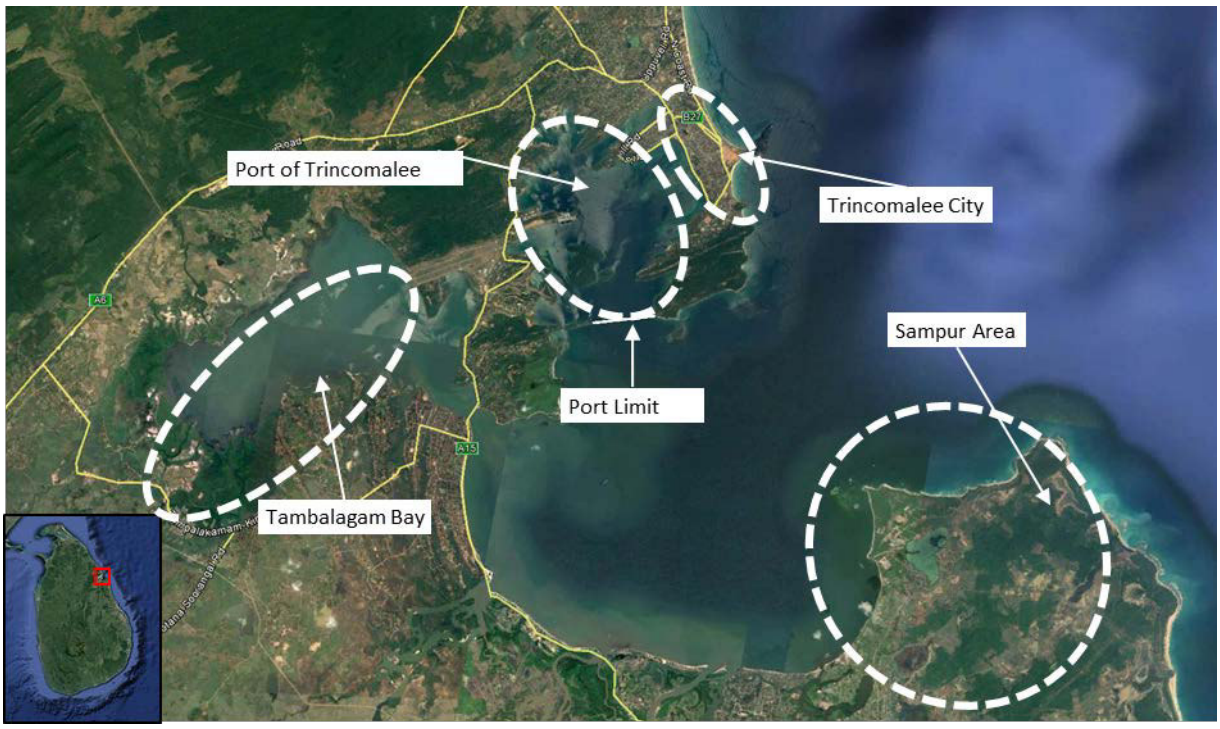
Figure 1-4: Map Trincomalee Administrative Region



The city, located in the east, and the area around Trincomalee is unique, because of the mix of the population which is an equal mix of the country's ethnic and religious groups. A common fish port is situated in the north part of the Bay connecting to fish markets in the city. The Trincomalee city is increasingly of interest for tourists also due to the availability of nice sandy beaches on the east coast and scenic areas south of the port limits. To the west of the main port area, Tambalagam Bay, a shallow water bay, is situated. The Sampur area in the south, is not inhabited and it is a potential development area for the Ceylon Electricity Board.

The port is connected via the southern route A15 and the highway A6 to the south-western part of the country. A railway line runs parallel to the A6 along the airport and the port to the city. A rail shunting yard is situated at China Bay.

Figure 1-5: General Trincomalee Area



1.3.2 Port of Trincomalee and its role for Sri Lanka

The Port of Trincomalee, located at the North East Coast of Sri Lanka in a unique natural deep-water bay, is protected by terraced highlands with an entrance guarded by two headlands. The sheltered bay provides excellent conditions for berthing and ship-to-ship cargo transfers. The port main commodities are dry bulk cargoes (wheat, clinker, gypsum and coal), liquid bulk (refined products) and breakbulk cargo (project cargo, steel products). The port handled 3.2 million tons in 2016. The facilities in the port consist of a private cement berth, a private grain berth, an oil jetty operated by a private company, and a common breakbulk quay, the Ashroff quay. Occasionally, passenger vessels and luxury cruise vessels call at this berth. The Navy has a base on the eastern side of the Bay.

Port of Trincomalee is expected to play an important role in the future economic development of the north-eastern part of the country which growth pattern was long hampered by civil war. Emphasis is focused around the key benefits of this port, natural deep water, shelter, unique tourist places and ample land for industrial and logistics in the proximity of the port.

At present the capacity of the common quay is limited, modern warehouses are lacking and the land for industrial development is not directly connected to the port. To upgrade the port and to maximise the deep-sea port potential, expansion of the Ashroff quay is required as well as unlocking the land available by providing new access roads and rail connections. This will facilitate settlements of industrial and logistical enterprises. The service activities in the bay require modern facilities at a one-stop shop location. This will enact on the functions for ship-to-ship transfer, ship lay-up and submersible activities. The tourism industry is expected to increase as well. A marina and a cruise berth are expected to cater developments in this respect. Space within the port is allocated to develop the boat repair industry under PPP structures. These sectors (tourism and boating) are also part of the National Export Strategy. An important element in the functioning of the port are

the connectivity projects on road and rail integrated with the dry port concepts in the Colombo – Trincomalee Economic Corridor concept.

The development focus encompasses the following main points:

- Allow night time navigation to the main berthing facilities in the port to enhance productivity;
- Ensure port zoning is aligned with the urban developments plans;
- Support the nations economic development through upgrading port facilities and improvement of warehouses and accessbility both in private as well as in public domain;
- Support the port's main oil distribution and bunkering function;
- Creating accessibility to land areas designated for future industrial and or logistical activities by road and rail;
- Land development for industrial and logistics port related activities near the port;
- Upgrade service jetties for support boats (tugs, pilots, crew boats) and create modern warehouses and workshops;
- Expand the touristic function by planning a cruise berth and a marina in front of the city;
- Increase the services of the port in ship-to-ship transfer, lay-up and submersible operations;
- Provide LNG capabilities for the future, both for power supply as well as for bunkering activities;
- Connectivity to the Trincomalee economic corridor, connecting the port with new logistics areas and dry ports developed near or at the corridors; and
- The port is expected to provide sustainable services with respect to the environment and to use natural resources in an efficient way with reduced spillage, emissions and negative effects for the environment.

The above listing is summarised in the table below on strategic developments at Trincomalee Port:

Table 1-2 Trincomalee Port Strategic Developments

Sector	Activity	Timing
Productivity of facilities	Night-time navigation Upgrade Ashroff jetty New deep-water oil berth Upgrade cement berths Container terminal	Short term Short term Short term Short term (private) Long term (PPP)
Equipment and handling processes	Equip common quays with mobile harbour cranes, improve operational procedures	Short term
Technology and IT	Technology and IT solutions to facilitate productivity.	Short term
Industry and logistics	Industrial land and logistics land development	Short term phase I
Connectivity	Upgrade connection to port (road and rail) New connections to new industrial and logistics land areas	Short term Short term phase I
Energy sector	New deep-sea oil jetty or CBM/SBM Allocation of LNG floating facility	Short term Long term

	Development of Gas CBM or SBM	Long term (depending on power station)
Tourism	Development of Marina's Development of Cruise terminal	Short term (PPP) Long term
Boating	Development for small crafts ship repair and boating industry	Long term (PPP)
Shipping services	Development of service jetties Develop ship lay-up business	Short term Short term

- **Production facilities.** Both the common terminal as well as the private oil jetties will be upgraded with new deep-water berths. This will allow the Ashroff jetty to serve the expected economic developments in the north east part of the nation including construction of the Trincomalee corridor projects as well as general building and city expansions.
- **Equipment and handling processes.** The port shall have mobile harbour cranes to increase the handling performances at the quays. Together with mobile equipment, sustainable efficiency improvements can be achieved.
- Technology and IT. Modern IT applications are available to upgrade and improve administration, approvals and reduce the paperworks.
- **Industry and logistics.** The national export strategy is expected to create new foreign direct investments in the industrial sectors of light to medium industries as well as some heavy industry developments (power stations, fertilisers plants). The land for these activities has to be prepared: levelling, basic instructure facilities (water, power and drainage) and rail and road connections to be secured.
- **Connectivity**. Both the port as well as the newly developed areas for the industrial zones and logistics zones have to be created. This will happen in phases to unlock these terrains. So an important element in the functioning of the port are the connectivity projects on road and rail, integrated with the dry port concepts in the Colombo – Trincomalee Economic Corridor concept.
- **Energy sector.** The industrial and logistics areas and the rising demand for power from the city and the wider region will need additional power. A new power station is projected in Sampur area. This power station (either gas or coal) will need to be supplied by resources through new berthing facilities. This could be a CBM/SBM or a floating station as well. In case of coal, a dedicated coal jetty would be required. Gas is seen as preferred solution above coal due to the higher CO_2 emissions of coal. Solar power is also an alternative, this would give more limited output but expensive berthing facilities can be avoided.
- **Tourism.** The toursim market in Trincomalee is expected to increase. The area has beautiful beaches, interesting sceneries and cultural life. The water activities in the Bay are still limited but especially Marble Bay and Sweat Bay are nice locations to visit by small leisure crafts. A marina near the city and a cruise berth shall unlock the tourism value of Port of Trincomalee.
- **Boating**. The boating sector in Trincomalee is very limited today. An area near Mud Cove is assigned for the development of boating and small craft shipyards. This can be developed under PPP structures. The access road to these areas need to be upgraded as well.
- **Shipping services**. Today the shipping services to vessels is dispersed around the Bay due to lack of central services jetties. Near the Ashroff jetty, both service jetties as well as offices and restroom for employees will be erected to ensure an efficient and effective service of ships in the bay (tug services, pilotage, crew services, ship lay-up services, etc.)

1.4 Throughputs and Marine Traffic

Dry bulk imports account for most of the throughput in Trincomalee. Liquid bulk is increasing in volumes but is relatively small. Below the table shows the Trincomalee Port throughput. The throughput is bundled per activity and commodity. The cargo on the Ashroff jetty is mostly destined for the Siam Cement facility near Puttalam and consists mainly of coal and clinker. There is also a mid-stream operation to load clinker to vessels destined for Galle.

Table 1-3: Trincomalee Non-Container Throughput 2013-2017 per Operation

Commodity		2013	2014	2015	2016	2017
		('000) Tons	('000) Tons	('000) Tons	('000) Tons	('000) Tons
Ashroff Jetty	Coal, Clinker, Gypsum, Slag	160	170	220	430	514
Mid-Stream	Clinker	-	-	270	535	503
Prima Jetty	Flour	820	950	1,030	860	881
Tokyo Jetty	Gypsum / Clinker	1,290	1,460	1,320	1,444	1,535
Oil Jetty	Gas Oil and Refined products	170	170	180	280	417
Total		**2,440**	**2,750**	**3,020**	**3,549**	**3,850**

Source: SLPA

Below the table outlines the throughput per commodity. The main driver for growth in cargo handled can be attributed to the increased demand in clinker for both the Tokyo Cement facility and the Siam Cement facility in Galle (through mid-stream operations).

Table 1-4: Trincomalee Throughput 2010-2017 per Commodity

'000 Tons	2010	2011	2012	2013	2014	2015	2016	2017
Discharged								
Wheat in bulk	911	1,090	901	676	825	868	714	760
Clinker in bulk	738	985	1,369	1,244	1,383	1,419	1,593	1,678
Gypsum in bulk	12	43	107	80	114	86	112	166
Coal in bulk	106	105	89	99	113	93	103	90
Other (slag)	-	-	-	10	14	-	22	-
Liquid bulk (fuel)	191	113	179	166	173	182	281	417
Total Discharged	**1,960**	**2,337**	**2,646**	**2,276**	**2,621**	**2,649**	**2,825**	**3,120**
Loaded								
Wheat bran pallets	139	-	-	140	127	162	153	122
Clinker	-	-	-	-	-	217	536	619
Other	55	237	213	20	-	-	-	37

Total Loaded	**194**	**237**	**213**	**159**	**127**	**379**	**689**	**778**
Cargo Handled	**2,154**	**2,574**	**2,859**	**2,435**	**2,748**	**3,027**	**3,514**	**3,897**

Source: SLPA

Cargo ships remain the main category of ships calling at Trincomalee port. Although the port today is limitedly called for repair or bunkering the number of vessels is increasing supported by higher throughputs and more lay-up/service vessels.

Table 1-5: Trincomalee Throughput 2010-2017 Ship Arrivals

	2010	2011	2012	2013	2014	2015	2016	2017
Cargo ships	97	116	139	113	120	158	207	224
Ships for repairs	8	2	3	3	1	1	1	2
Ships-bunkering	0	2	6	6	1	2	4	0
Passenger Vessels	1	2	8	4	2	3	4	5
Other ships	3	4	5	8	3	-	-	2
Total ships arrived	**109**	**126**	**161**	**134**	**127**	**164**	**216**	**233**

Source: SLPA

1.5 Key Observations and Bottlenecks

The table below provides an overview of key issues and constraints that hamper capacity and efficient operations in the port of Trincomalee. The high severity issues need addressing through a short-term priority project.

Table 1-6: Trincomalee - Key Observations and Bottlenecks

Category	Issue	Severity
Mud Cove		
Operations	Quay wall is in a deteriorated state	Low
Operations	Berthing space is constrained	Low
Operations	Slipway is not functional	Low
Operations	Mud cove is not conveniently situated for service jetties, as employees have to travel between Mud cove and Ashroff jetty.	Medium
Connectivity	Low quality access road	Medium
Operations	No Equipment on quay	High
TTA & Ashroff		
Equipment	Belt systems required for new commodities such as Biomass and Ilmenite	High
Operations	There is a sunk barge in front of the TTA facility	Low
Connectivity	TTA quay wall is damaged / in a deteriorated state	Low
Connectivity	TTA quay wall has un-sufficient water depth for service crafts and tug boats	Low
Operations	Coal operations is cumbersome, from quay into container onto rail and truck	High
Operations	Gypsum operations is dusty activity as hoppers are not designed for it.	
Operations	No equipment available (everything is with ship's gear) except for hoppers to handle the coal	High
Operations	Causeway to Ashroff Jetty results in inefficient operations	High
Connectivity	Low quality access road including road access to the Ashroff jetty	High
Operations	Ashroff jetty is not capable to receive mini-Capes or Capesize vessels due to length (250m) and depth constraints (-12.5m).	High
Operations	Gate configuration is poor	High
Operations	Limited flat land near the Ashroff jetty for operations and storage	High
Auxiliary	Dedicated berthing for tugs, pilot and workboats needs to be accommodated	High
Tokyo Cement		
Capacity	Production capacity from 1.8 M tons today to 2.8 M tons.	Low
Operations	The facility is only capable to receive small Handysize cement bulk carriers due to limited water depth but dredging works are underway to increase depths.	Low
Prima Flour		

Category	Issue	Severity
Operations	The Flour mill is a modern complex with state of the art discharge facilities.	Low
Operations	To widen the access to the flour mill for trucks, land excavation works are under progress	Low
Oil Berth		
Operations	Deep-water oil jetty necessary to handle increasing demand	High
General		
IT	No computer system for port operations management, ship cargo management and invoicing are manual processes	High
IT	Manual pro-forma invoices are generated, communication mainly by fax.	High
IT	Purchasing & Expense vouchering is manually based	High
IT	Many items are still cash based such as port permits, vehicle permits, handling fees	
IT	Paper Dependent Transaction Recording System (Documents are filled by hand, hard copy based, and require signatures) leading to mistakes, slow decision channels and missing documents.	High
IT	There is no planning system and /or MIS system which tracks; (berth) availability, reservations, space, scheduling of pilots, tugs and to publish information on productivity & performance.	High
Zoning	Encroachment of SLPA Lands	High
Connectivity	Port connection roads are partially unpaved and have limited capacity	High
Connectivity	No rail connection to SLPA facilities yet	High
Zoning	There is no overarching land use plan for the SLPA lands in Trincomalee	High
Navigation	Night time operations are not possible due to missing navigational aids	High

Source: MTBS

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2 Port Facilities

2.1 Introduction

This section introduces the Port of Trincomalee and the port area to the general port environment:

- Paragraph 2.2 provides a schematic overview of the port facilities and the corresponding commodities handled at each facility.
- An overview of the various facilities operated by SLPA is presented in section 2.3.
- Section 2.4 focuses on the privately-operated facilities at the Port of Trincomalee.

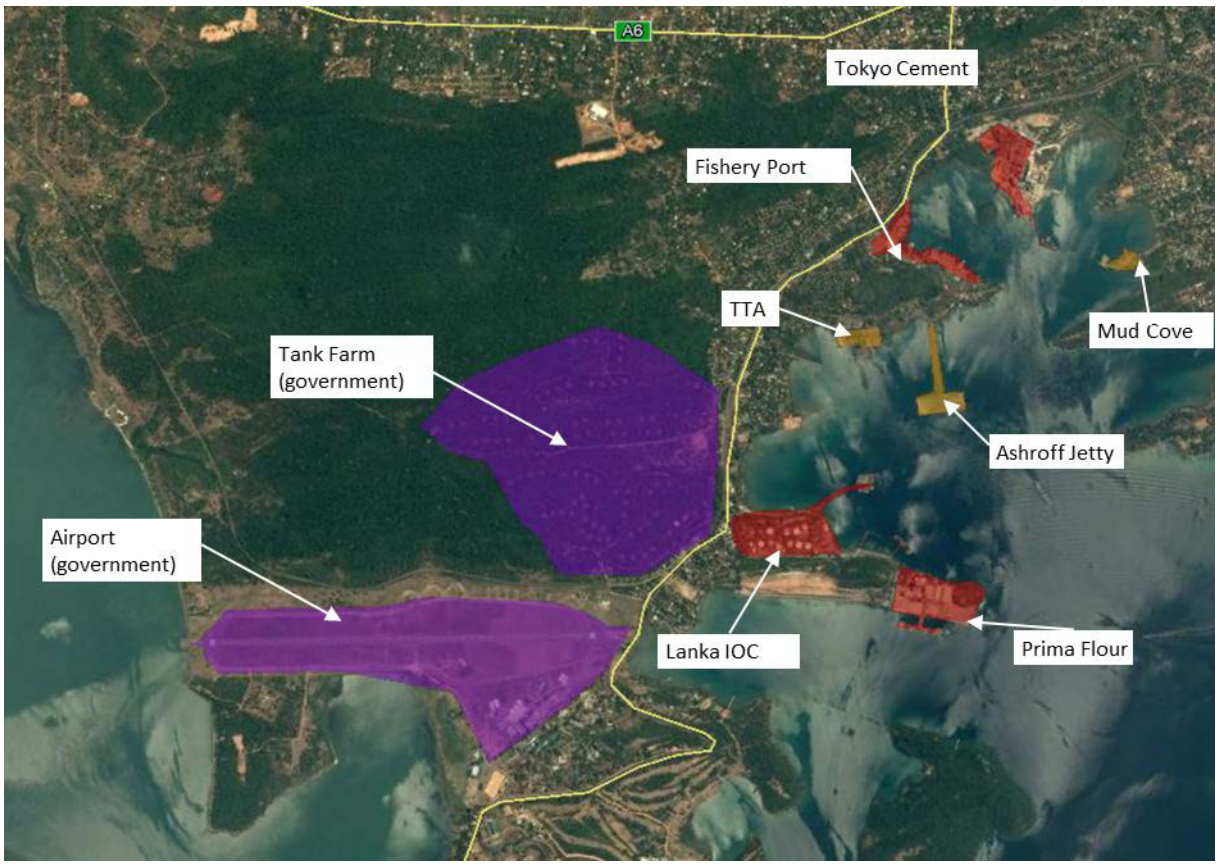
2.2 Port Facilities

The main cargo facility owned and operated by SLPA is the Ashroff jetty and the shore based TTA facility. In the Northwest corner of the port a common user fish port is located. The Mud Cove facility acted as a regional maintenance and repair facility, providing a slipway and some basic workshops, but right now services are limited to SLPA vessels. The naval base is an important asset in the port and located south of the city on the east side of the bay. The naval base encompasses an airstrip located west of the bay.

The SLPA managed TTA facility and Ashroff Jetty are currently used for imports of coal, clinker, and gypsum and general cargo, most of which are destined for a cement plant. Occasionally cruise vessels berth at Ashroff. The TTA facility is also used for service ships which supply vessels with goods and facilitate crew changes. The tugs are based at TTA as well.

In the port area SLPA also offers ship lay-up services. The deep and protected bay provides excellent anchorage conditions necessary for ship lay-up, and maintenance or repair at anchorage.

Figure 2-1: Facilities at Trincomalee Port



	Tokyo Cement	Mud Cove	Ashroff	TTA	Oil Berth	Prima Flour	Naval Base	Fishery Port
Operator	*Private*	*SLPA*	*SLPA*	*SLPA*	*SLPA*	*Private*	*Navy*	*Multi-User*
Containers								
Ro-Ro								
Dry Bulk	■		■			■		
Liquid Bulk					■			
Gen. Cargo			■	■				
Passengers			■					
Ship Repair		■						
Navy							■	
Auxiliary		■						■

Dry bulk imports account for most of the throughput in Trincomalee. Below the table shows the Trincomalee Port throughput. The throughput is bundled per activity and commodity. The cargo on the Ashroff jetty is

mostly destined for the Siam Cement facility in Puttalam and consists mainly of coal and clinker. There is a mid-stream operation to load clinker to vessels destined for Galle.

Table 2-1: Trincomalee Non-Container Throughput 2013-2017 per Operation

	Commodity	2013	2014	2015	2016	2017
Volume		('000) Tons	('000) Tons	('000) Tons	('000) Tons	('000) Tons
Ashroff Jetty	Coal, Clinker, Gypsum, Slag	160	170	220	430	514
Mid-Stream	Clinker	-	-	270	535	503
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Tokyo Jetty	Gypsum / Clinker	1,290	1,460	1,320	1,444	1,535
Oil Jetty	Gas Oil and Refined products	170	170	180	280	417
Total		**2,440**	**2,750**	**3,020**	**3,549**	**3,850**

Source: SLPA

2.3 SLPA Facilities

2.3.1 Ashroff Jetty & TTA

The Facility

Both the Ashroff jetty and the TTA quay are operated by SLPA. There is no dedicated handling equipment available at the quay side at both facilities. The port handles dominantly by direct handlings, hence, ship's gear is used for all loading and discharging activities directly into trucks. As ship's gear is slower than mobile harbour cranes, it results in relatively low productivity rates and rather poor performance levels.

Figure 2-2: Ashroff & TTA

Berth	Berth Length	Water Depth	Cargo / Purpose
Ashroff Jetty – Main Berth	250m	CD -12.5m	Clinker; wheat grain; coal; gypsum
Ashroff Jetty – Side Berth 1	90m	CD -8.5m	Clinker; wheat grain; coal; gypsum
Ashroff Jetty – Side Berth 2	90m	CD -8.5m	Clinker; wheat grain; coal; gypsum
TTA Quay	190m	CD -3.0m	Barges / pilot vessels
Ceylon Quay	50m	CD -2.5m	Barges / pilot vessels

Observations

- The jetty has one berth with reasonable water depth of CD -12.5m, good enough to receive Handysize and Handymax sized vessels as main vessel types. Occasionally Panamax bulk carriers of around 75,000 DWT are accommodated but only when they are partially loaded and smaller than 250m in length.
- The jetty is not capable to receive mini-Capes or Capesize vessels due to length (250m) and depth constraints (-12.5m).
- Coal import handling

  Ship's gear, operated with SLPA staff, is used to unload the vessel. For operational and safety reasons, maximum 2 ship cranes will work simultaneously on a vessel. Direct unloading with ship gear of coal into a truck through hoppers is a slow and more complicated process. SLPA also provides labour required for tally and supervision at the apron of the Ashroff quay. The shipper of the cargo appoints a stevedoring company,

responsible for hoppers and the horizontal transport between the quay side and the (intermediate) storage area, by means of (external) trucks. At the storage area, the stevedoring labour will stuff the coal into containers for further transportation. Final delivery of the containers to the client's destination is done via rail and or truck.

- Clinker import

  When arriving at anchorage point or within Trincomalee harbour, mother vessels carrying clinker (originating from Taiwan, China and Indonesia) will make a first stop in order to unload clinker into smaller feeder vessels of about 10,000 DWT. These feeder vessels will further transport the clinker destined to Galle. After the transhipment operation, the mother vessel will berth at Ashroff quay where it will be further unloaded. SLPA crane drivers will operate the ship's cranes and the stevedore will take care of the rest of the operational activities, i.e. horizontal transport with trucks from Ashroff quay to the cement factories in the country.
- Gypsum import

  The unloading process of gypsum is very similar to clinker handling. While there is no transhipment operation required for gypsum, the main vessel will immediately berth at the Ashroff quay. Ship's cranes are manned and operated by SLPA and the horizontal transport between Ashroff jetty and the destination (inland cement plants) is done via (external) trucks, and hoppers, operated by the stevedore.
- General Cargo

  Occasionally, general cargo is handled at the Ashroff quay. Basically, this concerns various types of construction materials discharged from the vessel with ship's gear onto the jetty.
- Passengers

  From time to time, cruise vessels berth at Ashroff quay. The quay is hardly suitable for passenger reception and requires to be cleaned in advance of the cruise call. Coaches can move onto the jetty which is an advantage for berthing a cruise vessel.
- Tea export

  Originally, the TTA facility was designed and used for tea exports by private companies. Currently, this trade is completely containerised and handled at Colombo Port. The TTA facility is obsolete today, except for some service activities.
- Berthing space of TTA

  Today, the TTA quay is used as berthing space for barges and tugs: 3 barges - mainly used for coal transport – and 4 tugs – used for marine services. The facility has un-sufficient water depth for service crafts and tug boats.

Table 2-2: Trincomalee - Key Observations and Bottlenecks

Category	Issue	Severity
TTA & Ashroff		
Equipment	(Mobile) Belt systems required for new commodities such as Biomass and Ilmenite are required	High
Operations	There is a sunk barge in front of the TTA facility	Low
Operations	TTA quay wall is damaged / in a deteriorated state. TTA facility is obsolete and not used. Too limited water depth alongside for tug boats and service crafts.	High
Operations	Coal operations is cumbersome, from quay into container onto rail and truck	High
Operations	Gypsum operations is dusty activity as hoppers are not designed for it.	

Category	Issue	Severity
Operations	No equipment available (everything is with ship's gear) except for hoppers to handle the coal	High
Connectivity	Ashroff facility has low quality access road and road on facility towards the quay	High
Operations	Causeway to Ashroff Jetty results in inefficient operations	High
Auxiliary	Dedicated berthing for tugs, pilot and workboats needs to be accommodated	High

Recommendations and Short-Term Priority Projects

R1. Mobile Harbour Cranes (MHC). The current use of ship's gear for vessel unloading activities results in very low productivity levels. Typically, on general cargo berths or dry bulk terminals, the terminal operator installs mobile harbour cranes to operate the vessels. This type of equipment is very flexible and can be used for various types of cargo/commodities. Crane manufacturers offer a range of standard ('off the shelf') mobile harbour cranes with varying sizes and load capacity, depending on the specific requirements. Depending on the type, the crane performance during coal unloading operations varies between 1,000 and 1,750 ton per hour.

R2. Hoppers. On top of the use of ship's cranes, direct vessel unloading into trucks slows down the process even more. From operational point of view, the vessel unloading process and the subsequent horizontal transport need to be disconnected. Therefore, hoppers are used on most terminals where dry bulk products are discharged. The crane unloads the vessels, drops the cargo into the hopper and can immediately return to the vessel side for the next unloading cycle without waiting for a truck and without time consuming manoeuvring above the truck. Similar to mobile harbour cranes, hoppers can be found in different sizes and functionalities for each specific commodity including systems for dust prevention.

R3. Conveyor belt system(s) and storage silos. To develop an export trade of biomass products in the future, dedicated storage facilities will be required as well as environmental friendly transportation systems between the storage area and the quay side. Typically, for grain, wheat and other types of biomass products, silos are used to store the products. This allows efficient use of required storage area in an all-weather environment. Modern dry bulk grain terminals are equipped with a (covered) conveyor belt system between the quay side and the landside storage area. This improves loading and discharging productivity rates and reduces the impact on the environment.

SP1. **Ashroff Jetty Upgrade Phase 1 -** A belt system is needed to reduce inefficiencies of trucking to the Ashroff Jetty and to accommodate future cargoes. Land reclamation, the extension of the quay, new road development, new equipment, berthing for tugs and workboats amongst others should be included in the plans.

2.3.2 Mud Cove

The Facility

The facility at Mud cove consists of an L-shaped structure with a berth on the outer side of 500m and a berth on the inner side of 40m. The berths are used for small boats and craft vessels due to the limited depths of CD -3.5m. Mud cove facility is used for service vessels, mooring tugs and for small ship repairs having a slipway of about 40m able to carry ships up to 100 tons or 18m. The facility has several buildings in various deteriorated stages covering an electrical shop, welding unit, warehouses for stores and administration buildings. A small service station for fuel and a small motor garage exists. Due to the damage by the tsunami of 2014 the slipway is inactive. The facility can be reached by a poorly maintained road from the city crossing urban areas.

Figure 2-3: Mud Cove

Berth	Berth Length	Water Depth	Cargo / Purpose
Mud Cove Jetty Berth 1	50.0m	CD -3.5m	Small maintenance / repairs
Mud Cove Jetty Berth 2	40.0m	< CD -3.5m	Small maintenance / repairs
Slipway (inactive)*	30.5m		Vessel repairs (up to 100 ton / 18m LOA)

*The slipway is currently in a deteriorated state, due to damages caused by the 2004 Tsunami. Inter alia, the winch needs to be repaired.

Observations

The following observations have been made at Mud Cove

Category	Issue	Severity
Mud Cove		
Operations	Quay wall is in a deteriorated state	Low
Operations	Berthing space is constrained	Low
Operations	Slipway is not functional	Low
Operations	Limited water depths up to CD -3.5m	Low
Connectivity	Low quality access road	Medium
Operations	No Equipment	Low

Recommendations and Short-term Priority Projects

R4. The main recommendation is to dispose the facility to private parties which are interested to perform small boat repairs and boating activities. SLPA functions like mooring of tug boats and service vessels shall be replaced towards the Ashroff jetty.

R5. The access road is to be upgraded and paved.

This recommendation leads to the following short-term priority project:

Mud Cove Rehabilitation / Access road development - Mud Cove is in a deteriorated state with damages to the quay wall, slipway and obsolete vessels obstructing operations. The severity is categorised as low as a private party is interested in acquisition of the property for small ship repairs. The facility should be concessioned with long term lease and proper boundary and utilisation described. Access to the facility by a proper paved road should be guaranteed though by SLPA in case of concessioning the facility.

2.4 Private Facilities

2.4.1 Tokyo Cement Grinding Facility

The Facility

In 1982 a cement manufacturing plant was developed producing cement products like the Nippon brand of Portland cement for the construction markets in Sri Lanka. Today the facility has a production capacity of 1.8 M tons and is owned and operated by Tokyo Cement Group. The country's largest facility is connected by road and rail and is equipped with grinding facilities and bagging plants.

The facility is located in the north of the Trincomalee Bay called Cod Bay with natural water depths up to CD -9.5m. The jetty has modern configurations for discharge of clinker and gypsum by suction and belt systems. In August 2016, Tokyo Cement Company (Lanka) PLC signed a technical cooperation agreement with Ube Industries of Japan. Through this agreement, Tokyo Cement's engineers, technicians and managers will be exposed to modern Japanese production systems, management techniques and new technologies, which will facilitate both technology and knowledge transfer from Japan to Sri Lanka. In 2017 the Group invested more than Rs 7.3 billion to increase domestic production of cement by an additional 1 M tons to 1.8 M tons, using renewable energy.

The group's factories are expected to further increase total annual cement production to 2.8 M tons with an energy self-sufficient 8 MW biomass plant. Other investments include new product lines together with a new laboratory and adding cement storage silos to contain 'Nippon Cement Pro', Tokyo Cement's brand of higher-grade cement specially formulated for high risers and super structures. The jetty in Trincomalee will be expanded to accommodate larger vessels, to transport raw materials to and from the factories. Recently, dredging works were completed to accommodate vessels of up to 30,000 DWT at the jetty.

Figure 2-4: Tokyo Cement Facility

Berth	Length	Water Depth	Cargo / Purpose
Tokyo Cement Jetty	150.0m	CD -9.5m	Clinker and gypsum imports

Observations

The following observations have been made on the Tokyo Cement facility.

Category	Issue	Severity
Tokyo Cement		
Capacity	The facility is expanded with additional cement factories boosting the production capacity from 1.8 M tons today to 2.8 M tons.	Low
Operations	The existing facility is able to handle bulk cement vessels with approx. LOA 156m, around 20,000 DWT at arrival draughts of 8.6m	Low
Operations	The facility is only capable to receive small Handysize cement bulk carriers due to limited water depth but dredging works are underway to increase depths.	Low

Note that the observations are regarded "low" due to the fact that the private company takes lead in the recommendations and SLPA is not involved.

Recommendations and Short-term Priority Projects

The private facility is in the process of lengthening the berth and to increase water depths to accommodate vessels up to 30,000 DWT.

R6. The recommendation for SLPA is to take into account the developments of expansion of Tokyo Cement on expected vessel traffic and ship manoeuvring.

There are no short-term priority projects for SLPA related to Tokyo Cement expansion, other than navigational issues which are addressed under the harbour master.

2.4.2 Prima Flour Milling Complex

The Facility

The Prima Flour facility is a flour milling complex with a production capacity of 3,600 tons per day, and a storage capacity of 200,000 tons. The complex comprises a quay (122m long, with a depth of CD -5.9m) and a jetty (227m long, with a depth of CD -13m), the latter of which is capable of accommodating 100,000 DWT Cape-size bulk vessels to import wheat grain and export flour and by-products. Additionally, the complex is connected to the mainland by both rail and road.

Figure 2-5: Prima Flour Facility

Berth	Length	Water Depth	Cargo / Purpose
Prima Jetty	227.0m	CD -13.0m	Grain imports
Quay	122.0m	CD -5.9m	Multi-purpose / (pellet) export

Observations

The following observations have been made on the Prima Flour facility:

Category	Issue	Severity
Prima Flour		
Operations	The Flour mill is a modern complex with state of the art discharge facilities.	Low
Operations	To widen the access to the flour mill for trucks, land excavation works are under progress	Low

Recommendations and Short-Term Priority Projects

The private facility has a modern discharge facility and deals with own efficiency and improvements. SLPA is not involved hence there are no recommendations or short-term priority projects for SLPA other than navigational issues which are addressed under the harbour master.

2.4.3 SLPA Oil berth

The Oil Facility

The SLPA oil berth is used by Lanka IOC, a Sri Lankan subsidiary of Indian Oil Corporation (IOC), to import refined products and bunker operations. The company owns 16 storage tanks used for the storage of gasoil, furnace oil, gasoline and water. SLPA's Jetty 3, with a 125 m long quay and a water depth of CD -10.5 m is the main jetty used for petroleum products import and for the majority of bunkering operations. SLPA's Jetty 2 is used for bunker operations on very small vessels with limited water depths. Jetty 1 is an old jetty and is used by SLPA for mooring vessels of vessel in lay-up and or under repair.

Of the current 16 owned storage tanks by Lanka IOC on the main terminal terrain:

- 6 are being rehabilitated;
- 1 is used for water
- 3 are used for gas oil
- 2 are used for furnace oil (IFO); and
- 4 for gasoline.

In April 2017, a deal was reached with the Indian government to also exploit 10 tanks of the 99-tank government tank farm located in the woods on the hills. A joint venture will be formed, with the land remaining under governmental control.

Figure 2-6: Lanka IOC Facility and SLPA's jetties

Berth	Length	Water Depth	Cargo / Purpose
Jetty 1	125.0m	CD -10.5m	Not used / occasionally Lay-up vessels
Jetty 2	50.0m	CD -6.9m	Occasionally used for bunkering
Jetty 3	125.0m	CD -11.5m	Main jetty for Petroleum products import, loading bunker barges

Observations

The following observations have been made on Oil facility and SLPA Oil jetties.

The water depth at SLPA jetty three (CD -11.5m) is a constraint to receive larger vessels than 50,000 DWT. In order to gain economies of scale and to cater for 50-80,000 DWT vessels a new jetty or berth is required. It can then optimise the storage capacity and the marine side handling. The facility will need additional pipelines between berths and storage to facilitate further demand growth in fuel handling and bunkering activities. Solutions are sought in a fixed berth or into Continuous Buoy Moorings (CBM) or Single Buoy Mooring (SBM).

Category	Issue	Severity
Oil Berth		
Operations	Deep-water oil jetty or CBM / SBM necessary to handle increasing demand and larger sized vessels	High

Recommendations and Short-term Priority Projects

The recommendation is to create a new jetty or berth to cater for 50-80,000 DWT vessels

R7. Create additional deep-water berthing capacity for 50-80,000 DWT vessels to facilitate Lanka IOC expansion.

This recommendation leads to the following short-term priority project.

Deep-water Oil Jetty – The Oil Facility currently sees a steep increase in demand for bunkering fuels for vessels on the east-west trade. Additionally, the refined oils demand which include fuels are set to increase in Sri Lanka with the tank farm in Trincomalee being a prime distribution location. An additional deep water berthing capacity for 50-80,000 DWT vessels should be created to facilitate the oil facility expansion.

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3 IT in the Port Environment

3.1 Introduction

This chapter aims to provide an overview of the various IT systems used within the port environment of Trincomalee and describes the corresponding procedures.

- Paragraph 3.2 explains IT in Trincomalee in general, describes the current practices and issues related with capturing revenues and expenditures.
- An overview of the existing situation on systems – either IT-based systems or still paper-based systems is provided in section 3.3.
- Paragraph 3.4 describes the IT gaps, key observations and short-term solutions
- In section 3.5, various recommendations are described to transform the port into a more efficient and well performing port and to define the way forward for SLPA with regard to IT-systems, installations and procedures.
- Section 3.6 concludes with the recommendations and short-term priority projects.

3.2 IT in Trincomalee

3.2.1 General introduction

The port operates in two shifts of 12 hours each. The structure of the port with one pier restricts berthing of large vessels. Due to the experienced staff and less involvement by law enforcement security services, after the 30 years of internal conflict, the port is gradually attracting shipping operations. Main focus is break bulk cargo, coal, clinker, gypsum, oil and ship to ship cargo transfers. Occasionally the passenger vessels and luxury cruise vessels call over at the berth. Project cargo carrying vessels also call at the port of Trincomalee. All ship handling work is done using ships cranes or hired for the purpose.

The cargo transporting trucks are private and are registered through the trucking company. There is a Customs office in the port, and since the cargo types are only a few, there is very little customs involvement for inspection. There is an immigration office to support crew changes and passenger embarkation. Health services are provided from the national base hospital in Trincomalee.

All certificates, registrations, cargo approvals have to be obtained from Colombo, thereafter sent to the respective departments as email attachments, and originals submitted when asked for. The distribution of officials and their business performing locations are distributed and are mainly in the City of Trincomalee. Hence if there is a discrepancy, there is a need to obtain signatures from various officers distributed, however, the time spent for travelling is not high as distances are short and light traffic conditions.

3.2.2 Current practices

It is mandatory for shipowners or shipping lines that their ships are registered with SLPA before entering the Port of Trincomalee. The Register is maintained by the Chief Harbour Master in Colombo. If a vessel intends to enter Port of Trincomalee the Line registers with the Harbour Master who will fax a copy of the main information to the Deputy Harbour Master allowing him to serve the vessel intending to enter Port of Trincomalee. He in return maintains a handwritten register to update information leading to invoicing and other related incidents. If the Deputy Harbour Master requires extra information, it has to be collected either

by fax or through a phone call. Images are obtained using WhatsApp from the master file in case it is an emergency.

The register or 'Record File' contains the following information for purpose of reference and manoeuvring of the vessel when she arrives at the pilot boarding station:

- Terminal & Quay vessel can berth;
- Special facilities needed in berthing;
- Number of manoeuvring Tugs;
- Updated Certificates & Documentation;
- Any port limitations or restrictions for the type of vessel.

For billing purposes, SLPA creates a vessel master record in in Navis 3.10 (SPARCS). Simultaneously the master record is created on Navis Express for billing of terminal charges. Following categories of vessels call over at the Port of Trincomalee. On berth availability & after the advance payment is deposited for an estimate SLPA Port of Trincomalee Resident Manager permits the vessel to be handled.

The table below shows the types of vessels and the main type of activities during the call.

Types of Vessels & Purpose of call	Types of Call
Container with Ship Cranes or Derrick Cranes	Discharge & Loading
Passenger	Tourism
General cargo	Distress & Emergency
Project Cargo	Pleasure
Military & Navy	Maintenance, Services, Bunkering
Tugs & Barges	Ship to ship transfer

Considering this, the SLPA has introduced the following:
Some Oracle Financial system modules are implemented to Port of Trincomalee as an extension from the SLPA Head Office in Colombo. The main system is hosted in Colombo and Trincomalee Port access the system through internet. Due to the poor internet connectivity, internet lease line is reset several times in a day to upload and download data transactions.

The Sri Lanka Telecom has installed a microwave link to Siam City Cement operation. SLPA is yet to receive this service for an uninterrupted link to a broadband internet connectivity. Copper wired internet and a leased line is used to transfer transactions, emails, sharing of important photos and images with the main SLPA Head Office Port Finance and Accounting system for data on line update.

Due to the poor internet connections, the Trincomalee Port does not use video conferencing, instead rely on voice calls through fixed lines. Although smartphones are in use, it has not been considered a viable option where images and data can be uploaded or downloaded for quick references. Being a remotely managed port, video conferencing is a vital facility that is not available at present.

3.2.3 Capture of revenues is manually driven

The revenue generating activities remains hand written and subsequently entered to the billing system to generate the invoice to the respective contracting party. This is illustrated by the following points.

- Harbour Masters services - All handwritten paper based and sent to Trincomalee Finance Department to raise the sales invoice to the respective party.

- Special & Extra Services - The requirements are informed by the Shipping Line through their Agents in Colombo. The Terminal Resident Manager with the Operations Department estimates the project and obtains approval from SLPA in Colombo. SLPA Colombo informs the Shipping Line and Agent, after the acceptance by all parties.

- General Cargo - This remains paper driven and all services provided are captured by handwritten records. Subsequently the sales invoices are raised through the billing system to the respective party and is set against the deposit the Ship Agents maintain in their account with SLPA.

- Services for Passenger Vessel - This remains paper driven and all services provided are captured by handwritten records. Subsequently the sales invoices are raised through the billing system to the respective party.

- Request for Data & Information - Other than the standard statistics any other requirement for a report linking other business data for a purpose is done by the Statistics Department based in the Port of Trincomalee.

3.2.4 Capture of expenses is manually driven

Following Expenditures are captured by handwritten paper and later entered to the accounting system to be reflected in the ledgers:

Wireless (Wi-Fi) & Wired - Maintenance and upgrade expenses to respective divisions, service charges, repairs, and related support services is Colombo Head Office Managed and is email and approvals are manual.

Operation Expenses - All operation related expenses are on handwritten vouchers.

Business Support Expenses - Vouchers are handwritten entered to the accounting system.

Shift Planning & Roster System - It is manual, hence the costing and true picture for a vessel operation or any other operation cannot be traced in financial terms.

Infrastructure Maintenance & Management Expenses - This is linked to the Purchase Control System. There are periodical and regular expenses monitoring with no software application but Excel sheet based. There are a few vehicles and Port of Trincomalee own Equipment. Expenses recording of these machinery and ancillary items is manually maintained.

3.3 Existing situation on IT and Communication systems

This paragraph describes the current situation of IT and communication systems at Port of Trincomalee.

3.3.1 Terminal Operations & Management System

There is no computer system for port operations management. Hence berth availability, scheduling, planning, warehouse availability, efficient workforce at a lower cost cannot be announced and publicised. Hence benefits to attract fully laden general cargo ships to be directed to use the Port of Trincomalee are missing.

3.3.2 Terminal Accounting & Finance Management System

The AP, AR, FA, General Ledger are extensions of the main system of the SLPA Oracle Financials. The Cost Centre approach is implemented to the Port of Trincomalee by the SLPA Finance department. There are three senior finance managers based in SLPA Colombo Finance Department supervising the Trincomalee Finance Department's activities. They are in addition to other accountants and finance department staff based in Colombo who does audit, verifications, supervision, on demand spot support.

3.3.3 Terminal Fixed Asset Management System

Fixed Assets recorded are booked in the Financial System. There is an automated Asset Register which produces the listings of Fixed Assets and does the depreciation and updates the Financial Journal for accounting purposes. It lets the assets to be sold or removed from the register passing the Balance Sheet journal vouchers to reflect the transactions in the annual accounts.

3.3.4 Financial Transaction Entries made to the E-Business Suite (Accounting App)

The Accounting Application applies a cash-based system, only financial records and transactions after the bank reconciliation is taken to the P&L. Hence it is a cash-based system instead of an accrual, prepayment-based operation tracking.

3.3.5 Ship Cargo Management & Invoicing

Before the vessel call is over, with the knowledge of the cargo manifest and tonnage to be discharged a proforma invoice is manually created. This is fed to the computer system and an invoice is raised. This is not captured using a computer-based system. The proforma invoice amount is advance paid to the bank account mostly in Colombo and a copy of the payment receipt is sent by Fax. Thereafter the vessel is allowed to berth.

3.3.6 Communication with Shipping Lines & Agents

All shipping agents have their main office in Colombo and advance invoice settlement payments, deposits, fees for miscellaneous services are directly deposited to the SLPA Trincomalee Account with the bank. A copy of the slip as an image is sent for SLPA Accounts Department as confirmation. If the advance payment is less than the final invoice, the agent is given the credit period to settle the bill. If the advanced payment is in excess, the amount is held until the next voyage or ship operation and is set off to the next new invoice raised to the same agent.

3.3.7 Purchasing & Expense Vouchering - updating the Finance System

Supplier invoices are booked into the Oracle Finance System as an approved voucher. The full system implementation is not yet done. From a request being made, booking of Quotation, selecting of supplier, raising of purchase order, receiving of supplies, and all other processes are manually managed. On receipt of the supplier's service or goods, the payment is processed, and a settlement cheque is raised through the computer system. Regular purchasing is done by the Colombo SLPA Central Purchasing Department. Later the

financial transaction is posted to the Trincomalee Cost Centre, and the delivery of goods is arranged by to Trincomalee.

3.3.8 Payment to the Bank and Cash Collection at the Port Cashier's Office

Port charges, navigation fees and other estimated charges are collected in advance made for an estimated invoice, and payment is made to the bank as a transfer. There are cash collections for port permits, vehicle permits, handling fees, etc. A cashier collects cash who is at the Accounts Ashroff's office.

3.3.9 Paper Dependent Transaction Recording System

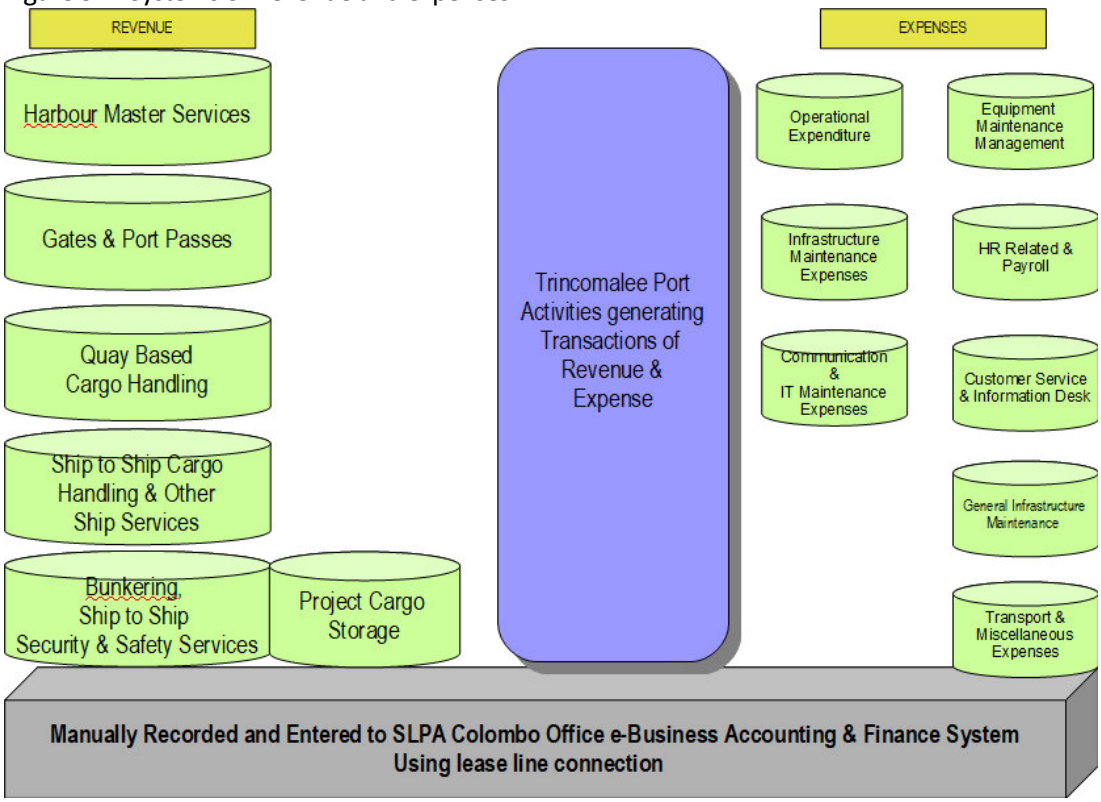
The documents are filled by hand, hard copy based, and require signatures. Practices, procedures, processors are not modern, but lethargic slow and human dependent. If a signature is short or the process stops and it can lead to a long wait before the recommencement of the activity requiring visits to many offices and meeting the responsible officer for the specific signature.

Many business activities and port services are hard to be clearly specified. They differ from project to project, voyage to voyage since it changes. Management decisions are taken job-by-job. Therefore, it cannot be considered as a regular practice. Therefore, approvals are taken a fresh from SLPA Colombo Office through emails and faxes. Use of Modern and latest technologies and electronic data is absent. Even initiations of using WhatsApp images, Smart Phone enabled video calls require hard copy and signature. Due to the wide distances between business locations, there is a loss of time and harmful to improving of efficiencies.

3.3.10 Statistics & Management Information

Statistics, management information and financial information are produced per the standard formats introduced. Any deviations need extra time to produce as the information must be abstracted from hardcopy reports. Schematically, the revenue and expenses systems are displayed in the next diagram.

Figure 3-1: Systems on revenue and expenses



3.4 IT Gaps and short-term solutions

The following IT gaps have been identified.

- The system is not able to produce exception reports and alerts for discrepancies;
- The system is not able to draw the relevant legal contract and does not clearly define the rules and port operations procedures. There is no contract management system with alerts when the expire;
- A Harbour Master Information Management System is not linked with a Marine Traffic application for vessel information;
- The system has limited ability to import information and to have regular update of the Shipping Lines;
- There is no Business Intelligence Dashboard to improve relationship management;
- The booking system is not backed by a Calendar Planning and scheduling system to register berth availability and which can be updated with Shipping Lines schedule information;
- The system cannot produce Information & Publications - Rules and Practices to provide an efficient service;
- The system should be transaction based (voyage based) and auto update the billing system;
- The system has no Finance application system to pick chargeable services and to generate the invoice prior to the ship sails;
- There is no system which tracks; availability, reservations, space, scheduling of pilots, tugs and to publish information on productivity & Performance;
- Consignee has no on-line views on charges and levies to be paid to Shipping Line Agency Office & confirmation to be brought to clear cargo from the port. Online, Consignee pays using e-Banking or internet Banking and submits electronic receipt for the paid charges;
- The system has no ability to capture the operation disputes. Consequently, responses to disputes are cumbersome;
- The system has no Damage Reports and Accidents for insurance claims. The system should be able to get incident report & photos;
- The system should be able to compare Productivity and Performance link to the voyage file to declare turnaround time;
- Availability, reservations, space, scheduling and preventive maintenance can be incorporated in newer systems;

Main observations:

Category	Issue	Severity
Ashroff jetty – IT		
IT	No computer system for port operations management, ship cargo management and invoicing are manual processes	High
IT	The accounting Application applies a cash-based system, no report tracking possible	Low
IT	Manual pro-forma invoices are generated, communication mainly by fax.	High
IT	Purchasing & Expense vouchering is manually based	
IT	Harbour master and pilot reporting and invoicing are manual processes, harbour master ship file is not linked or updated.	
IT	Many items are still cash based such as port permits, vehicle permits, handling fees	

Category	Issue	Severity
IT	Paper Dependent Transaction Recording System (Documents are filled by hand, hard copy based, and require signatures) leading to mistakes, slow decision channels and missing documents.	
IT	Statistical information has to be reproduced onto statistical format templates	
IT	There is no planning system and /or MIS system which tracks; (berth) availability, reservations, space, scheduling of pilots, tugs and to publish information on productivity & performance.	High

3.5 Future Way Forward

SLPA needs to make a transformation in order to safe time, become efficient and pro-active. Currently, SLPA in Trincomalee is in urgent need on requirements related to hardware systems, networks, communication systems as well as on software applications to perform, monitor and report on the operations in the port.

It is recommended that SLPA initiates a project plan on how to install the following:

3.5.1 Fiber Optic Direct Link

This is a replacement to the lease line. An introduction of a Fiber Optic Link assures the rest of the improvements specified above. This will allow transactions and access to SLPA Colombo office much easier. There will be no 'System Hang" situations. The data transfer, VOIP and Video Conferencing can be web based. This also enables all port users and port community system partners to be linked to Port of Trincomalee and utilise the available facilities with ease. This will eventually provide a reliable uninterrupted Wi-Fi with a dedicated data communication link.

3.5.2 Redundancy support Computer Server Room

A dedicated room for IT network hardware, servers and back-ups is to be established to guarantee stable communication and operating systems and to provide back-up facilities.

3.5.3 Introduction and implementation of the Harbour Master Management System

The proposed Harbour Master Information Management System is an important application that is yet to be sourced for Sri Lanka. When securing the Harbour Master Information Management System, since Trincomalee Port currently has no automated application to the supplier it can be another installation with common features and similar characteristics. Hence, for the supplier it will be attractive to replicate the application and benefit on the introduction and implementation. As the SLPA Harbour Master manages all ports in Sri Lanka, a single application will be more ideal, and learning, terms and data interchange will be standard. The Harbour Master Management Information System will be storing information onto a common shared database, a product such as HaMIS, since it is scalable and expandable to meet the demand and can remain as long as SLPA continues to manage the Harbour Master service. The selected application will push and pull information using the web and cloud-based applications. The success of the introduction and implementation will demand a secured and uninterrupted internet connectivity.

3.5.4 Introduce the cargo management application for general cargo after a study of the business model

Currently there is no cargo management system for the Port of Trincomalee. The manual record keeping pushes the entries to be made on the accounting system to raise invoices. Reference based decision making, and reliability accuracy, legitability and disputes of under or over charging is prevented with the introduction of a simplified Cargo Management System. It can be integrated to other related services or be stand alone.

The weight bridge linking to the cargo movement and activities will provide a basis for greater information based on analytics for the management to make their decisions rather intuition driven decisions. Once again, the requirement of a reliable internet connectivity is important considering the geographical distances and distribution. The information collected should generate EDI (Electronic Data Interchange) records to update the national information.

Since the dependency and cargo categories are a few the selection of an application should have the capability to expand. With the introduction, measuring of productivity, performances and statistics and patterns can be clearly seen for better decision making.

As the Trincomalee Port has no automated applications, investments and staff not being exposed to computerised business, processes selection of a proven application is ideal for the business to expand with the business growth. The cargo management application will include online weather forecasts, truck management, gate control and – within the port traffic control – ability for efficient cargo transfer.

3.5.5 Introduce a CCTV system as monitoring platform

Since there is no control room to centrally monitor the activities within the Port of Trincomalee, an introduction of a CCTV system will assist the terminal manager and the operations superintendent to view the port operations remotely. This facilitates to keep incidents, safety and security watched and supervised and stored as digital records. The jetty area and currently used storage area is to be taken as phase 1 with capabilities of expanding. The CCTV system will be wireless hence will be expecting an internet link to be able to monitor from remote.

3.5.6 Automate the gates & introduce a truck management and schedule system

A pre-booking system linked to the truck registration, system that provides management information and projections for best practices to improve. The observations and changes can be recommended for other ports in Sri Lanka. Testing of innovative suggestions and recording of the results can be useful for adoption since it does not interfere with a busy terminal operation. This replaces the present human controlled gates and let the truck flow be managed by the gate control system. The introduction of a system will streamline activities and provide very valuable information to other development agencies like Road and Regional Development Activities.

3.5.7 Introduce a Port Community System

Introduction to the Port Community System can be made with much ease in the Port of Trincomalee. The stakeholders and beneficiaries and actors mostly will be the same partners who are based in Colombo and will be eager to contribute to an integrated solution. With business progressing, and if Port of Trincomalee is promoted as an independent Strategic Business Unit, at which point, the Port of Trincomalee will have a breakaway from the Port of Colombo Port Community System but will share information in the national level.

All financial institutions have a presence in the city of Trincomalee. The document approval is mostly from Colombo and the ship agencies. Some of the ancillary equipment and service providers, port user's main offices are resident in Colombo. As the pilot introduction, Port of Trincomalee is ideal.

Integrate all port users to a single window system and an online approval portal with an electronic procedure and process manual.
With the introduction of the Port Community System document management system, single window to interface with all concerned authorising actors such as Customs, Excise, Inland Revenue, Shipping Agencies and Wharf, Lines and Principals and the Harbour Master together with the Port Operations, will use a common

application and accessing for a speedy processing. As and when SLPA is to be informed and special approval is to be obtained, the Port Community System will flag at the responsible official's computer awaiting instructions. Since the application is internet-based and online access to information mobile enabled and real time. All documentation, practices, procedures, workflow diagrams, approval from relevant authorizing organisation can be captured and made available online. Thereafter, changes to the practices can be announced using the triggering system and online published with detail.

All parties connected to port related activities will use a digitally enabled environment, supported by cloud computing. This reduces the number of in person visits to multiple offices of approving authorities. Linking with Colombo based shipping agencies and booking, payment of port dues and other dues. Confirmation of approvals, system based digital EDI transactions that originates are processes driven and shareable and reusable.

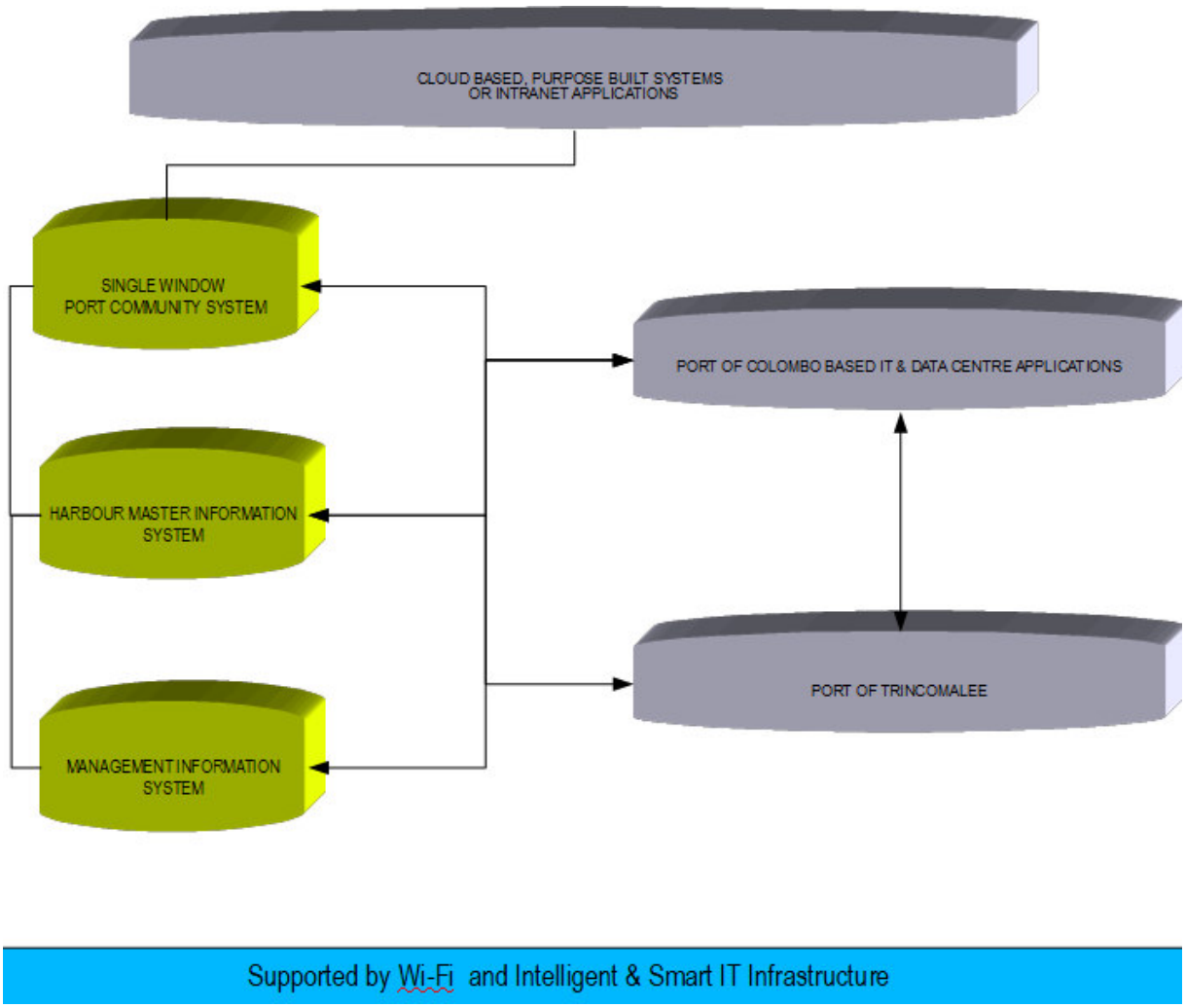
The current activities at the port facility will not be attractive for the introduction of a Port Community System. Nevertheless, this can become the pilot project for an interested port community integrating organisation to make it a reference site and gradually expand, offering the Trincomalee Port facilities to market and attract new business.

3.5.8 Enable e-Commerce ready web portal with information

A strong web portal is a requirement to promote the port of Trincomalee. By making this an independent web portal as a part of the Port Community System will independently promote the port as a regional facility to attract shipping lines. This enables partnering port operators to value the services and facilities in a favourable way.

At present it is diluted in the Port of Colombo and unless directed Port of Trincomalee is not visible as an independent challenger offering attractive opportunities to do business. The web portal will enhance e-Commerce and by linking to social media the objectives of promoting and attracting port users to have a second choice can be published to attract potential shipping lines. This will influence the revenue generation of the Port of Trincomalee.

Figure 3-2: Web-based systems



3.6 Recommendations and Short-Term Priority Projects

With the current business traffic and operations, any IT upgrade is recommended with reservation. The following important functions still needs priority and automated.

The port requires a gate automation, that is linked to a terminal operating system. This is to streamline activities and make functions computer driven. The paperless digitally driven online approval that links with payment gateways contributes to reflect revenue and expenses when it occurs. There procedures are transparent and not human influenced.

Harbour Master Management Information System is required for accurate billing and record keeping.

Management Information Dashboard will give the availability utilization, and productivity and performances visible for decision making and quick responses.

A Single Window Port Community System can be a branch of the Colombo based system. This can be introduced to speed the processing and interfacing with multiple roles and actions where different partners who are distributed, and distant to come into interaction to seek or provide a service to the Port. Later the Trincomalee Port Single Window Community system can become independent but integrated in a national system and collaborate only where transactions need to be updated across platforms to provide information to the respective parties.

Concluding from the abovementioned items, the following recommendations can be made:

R8. Fiber Optic Direct Link to the terminal office building;
R9. A redundancy support Computer Server Room to be established;
R10. Introduce and implement Harbour Master Management System;
R11. Introduce the cargo management application for general cargo after a study of the business model;
R12. Introduce a CCTV linked to performance monitoring platform;
R13. Automate the gates;
R14. Introduce a truck management and schedule system;
R15. Introduce a Port Community System;
R16. Integrate all port users to a single window system and an online approval portal with an electronic procedure and process manual;
R17. Enable e-Commerce ready web portal with information.

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4 Social and Environmental Impact and Policy

4.1 Introduction

This section provides an overview of the legal framework currently in place in Sri Lanka related to the social and environmental issues associated with port development and port modernisation; additionally, an overview of general environmental and climate characteristics of the Trincomalee region are presented. Specifically, section 4 comprises the following sub-sections:

- The first part of section 4.2 focuses on the social issues related to land acquisition: current policies in place, laws and regulations. The second part of the section provides an overview of the current laws and regulations in place regarding environmental impact assessment (EIA) and environmental management. A brief description of an EIA process is provided.
- Section 4.3 provides an overview of the general environmental and climate characteristics of the Trincomalee area.

The specific social and environmental issues concerning the development options or the short-term priority projects are mentioned in the respective sections of each of the pre-feasibility studies.

4.2 Legal Framework in general

4.2.1 Social aspects and social safeguards

There are two important social issues associated with port development and port modernisation. The first issue is the acquisition of land, with involuntary relocation of people as possible consequence. The second issue is the potential retrenchment of staff.

In Sri Lanka, the subject of land acquisition is governed by the following policies, laws and regulations:

- Land Acquisition Act (LAA) No.09 of 1950 as amended and Regulations
- National Involuntary Resettlement Policy (NIRP).

Another document for the protection of women and children in relation to the consequence of land acquisition is the Women's Charter of Sri Lanka.

The potential lay-off of staff in circumstances of privatization of state-run enterprises and modernisation of operations come under the legislation of the Ministry of Labour and Trade Union Relations and are codified in the Labour Termination Act.

For projects with international funding, the relevant guidelines or directives of the financing institution are also to be followed in project implementation (for ADB-financed projects the Social Safeguard Statement of 2009).

Additional information on the social mitigation related to land acquisitions or resettlements is displayed in the annexes.

Technical Assistance Consultant's Report

Project Number: 50184-001
February 2020

Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Trincomalee Port Development Plan – Volume 3 (Part 2)

Prepared by

Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

4.2.2 Environmental management and Environmental assessment

Environmental protection has been given due consideration by the Constitution of the Democratic Socialist Republic of Sri Lanka. Article 27 (14) of the Constitution states that it is the duty of the state to protect, preserve and improve the environment for the benefit of the community. Also, Article 28 (f) of the Constitution states that it is a fundamental duty of every person to protect nature and conserve its riches.

The Sri Lankan Government has enacted several Acts that have a direct bearing on the environment. Of these, the acts, which have a direct bearing on the proposed Master Plan, are:

- National Environmental Act No. 47 of 1980
- Coast Conservation Act No. 57 of 1981
- Mines and Minerals Act No. 33 of 1992
- Marine Pollution Prevention Act No 59 of 1981
- Fauna and Flora Protection ordinance

The EIA process is implemented through designated "Project Approving Agencies (PAA)" led by the Central Environmental Authority (CEA). The PAAs are EIA administrative agencies that are responsible for guiding the EIA for projects and for issuing EIA approval or rejection. A single PAA is appointed as the appropriate PAA for each EIA by the CEA

Any new (commercial) development project requires the permission (clearance) from the CEA. For project without major impacts no further steps may be needed, although the CEA may stipulate specific measures. Projects with intermediate impacts, may require performing an Initial Environmental Examination (IEE). Projects with major impacts require the highest level of safeguard, which would involve the preparation of a full Environmental (and Social) Impact Assessment (E(S)IA. Some projects require an EIA in any way. Those prescribed projects have been listed in the Gazette (Gazette No. 772/22 of 24.06.1993).

A project proponent needs to submit preliminary information about the project to the CEA, in order to initiate the EIA / IEE process. The project proponents are advised to submit preliminary information to the CEA at a very early stage in the project cycle. The project proponent could submit the preliminary information through a Basic Information Questionnaire which could be obtained from the CEA Head Office or Provincial / District Offices or downloaded from the CEA website.

The EIA / IEE process involves 6 major steps; (i) screening (ii) scoping (iii) preparation of the EIA / IEE report (iv) review of the report (by the public and the PAA) (v) approval with terms and conditions or rejection with reasons (vi) post approval monitoring. The step wise process has been defined in the EIA regulations which have been published in the Gazette No. 772/22 of 24.06.1993.

Within the framework of the current National Port Master Plan, preliminary ESIA reports need to be prepared for the priority projects in the ports of Colombo and Trincomalee, as identified in the Master Plan. Such preliminary ESIA reports correspond to the screening and scoping exercises, mentioned in the previous paragraph.

The elements required to prepare the preliminary ESIA reports include:

- First identification and description of the proposed project
- Understanding of the environmental conditions at the proposed project site and its surroundings

Based on these two elements one can identify the most relevant environmental and social impacts. Depending on the nature and the severity of the impacts (and the provisions for prescribed projects) the need for subsequent E(S)IA or IE(S)E can be determined.

The preliminary ESIA reports issued under the current Master Plan, can serve as information for submission to the CEA, as a first step in the EA process.

4.2.3 Recommendations

The following recommendations made in relation with the environmental review.

R18. In view of SLPA's intention to adopt the 'Green Port Concept' in its mode of operations, **it is recommended to start routine monitoring of environmental quality parameters as soon as possible**. In this way, a reference level (existing baseline) of environmental quality can be established. This reference level can be used, in the future when greening concepts have been implemented, to assess the effect and success of the new strategy. Air measurement at two or three points in Trincomalee Port area (For example, one near the city, one near Ashroff and one near China Bay) are recommended to be installed. Media and parameters to be monitored are: Air quality: HC (hydrocarbons), CO (carbon oxide), NOx (nitrogen oxides), PM10 and PM5 (particulate matter) and SO2. Additional information on measurement and boundary limits of air pollution, noise, biodiversity and emission measurement is covered in Appendix VII.

R19. **Clear guidelines to be established for port concessionaires to contribute to a greener port**, including existing companies like Tokyo Cement, Prima Flour and IOC. Guidelines for port greening could include guidelines regarding (i) waste generation and waste management; (ii) compliance with international shipping legislation (e.g., Paris MoU: white, grey, and black flag vessels); (iii) vessel emission reduction requirements; (iv) air pollution; (v) noise pollution; and (vi) biodiversity preservation. Additional information on boundary limits of air pollution, noise and biodiversity and emission measurement is covered in Appendix VII and VIII.

R20. **Establishment of a green policy** and implementation framework including measurement systems, monitoring and controlling emissions.

R21. **Establishment of HSSE department**. Attention for environmental issues within the operation of the port would be greatly served by establishing a dedicated, relatively independent Health, Safety and Environment (HSE) department. Such a department should conduct its task from the perspective of assuring optimum conditions for health, safety and environment. It should not be subordinate to a section with merely economical and efficiency interests.
The role and tasks of such a HSE-department is elaborated in the section on the Green Port Concept.

R22. **Complying to international relevant conventions**.

R23. Set up an **environmental Management System in line with ISO 14001** certification for the different parts of its operations.

4.3 General Environmental and Climate Characteristics

4.3.1 Climate

The Trincomalee area is characterized by the following climate:

- Rainfall – Average annual rainfall in the Trincomalee district is 1,727 mm; however, annual rainfall varies substantially from year to year. Heaviest rainfalls typically occur from October to January, during the North-east monsoon; June is the driest month, on average.
- Temperature – The mean average temperature is approximately 28.5 °C. Monthly mean average temperatures vary approximately 4.5 °C around the overall mean average temperature; the lowest average temperature of 26.0 °C occurs in January due to Northern winds, the highest average temperatur of 30.4 °C occurs in June, during the South-west monsoon.
- Wind – During the Yala season, the wind direction is North-east, whereas the wind direction is South-west in the Maha season. The East coast of Trincomalee is also affected by cyclonic storms formed in the Bay of Bengal; due to the high occurrence of such storms, Trincomalee is considered to be in a high intensity cyclone prone zone. The figures below provide the "wind loading zones" and the dominant wind patterns in the area. The basic wind speed on which buildings and structures are required to remain in operational conditions following the passage of a cyclone or major storm, is expressed the the following table. Since such buildings are normally government owned, determination of whether a particular building is to be designed and built to this standrad will be a matter for the Department concerned.

Figure 4-1 Wind Loading Zones Sri Lanka

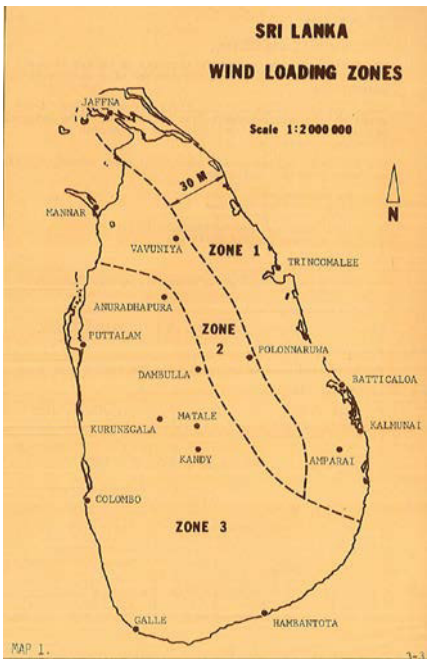


Table 4-1: Basic Wind Speed for calculating wind pressures on structures

Zone in the country	Post-disaster structures	Normal structures
1 (Incl. Trincomalee, KKS and Ouvil)	120 m.p.h. (53.5 m/s)	110 m.p.h. (49.0 m/s)
2 (incl. Mannar)	105 m.p.h. (47.0 m/s)	95 m.p.h. (42.5 m/s)

3 (incl. Colombo, Puttalam, Galle, Hambantota)	85 m.p.h. (38.0 m/s)	75 m.p.h. (33.5 m/s)

In which "Post-disaster" structures typically are:

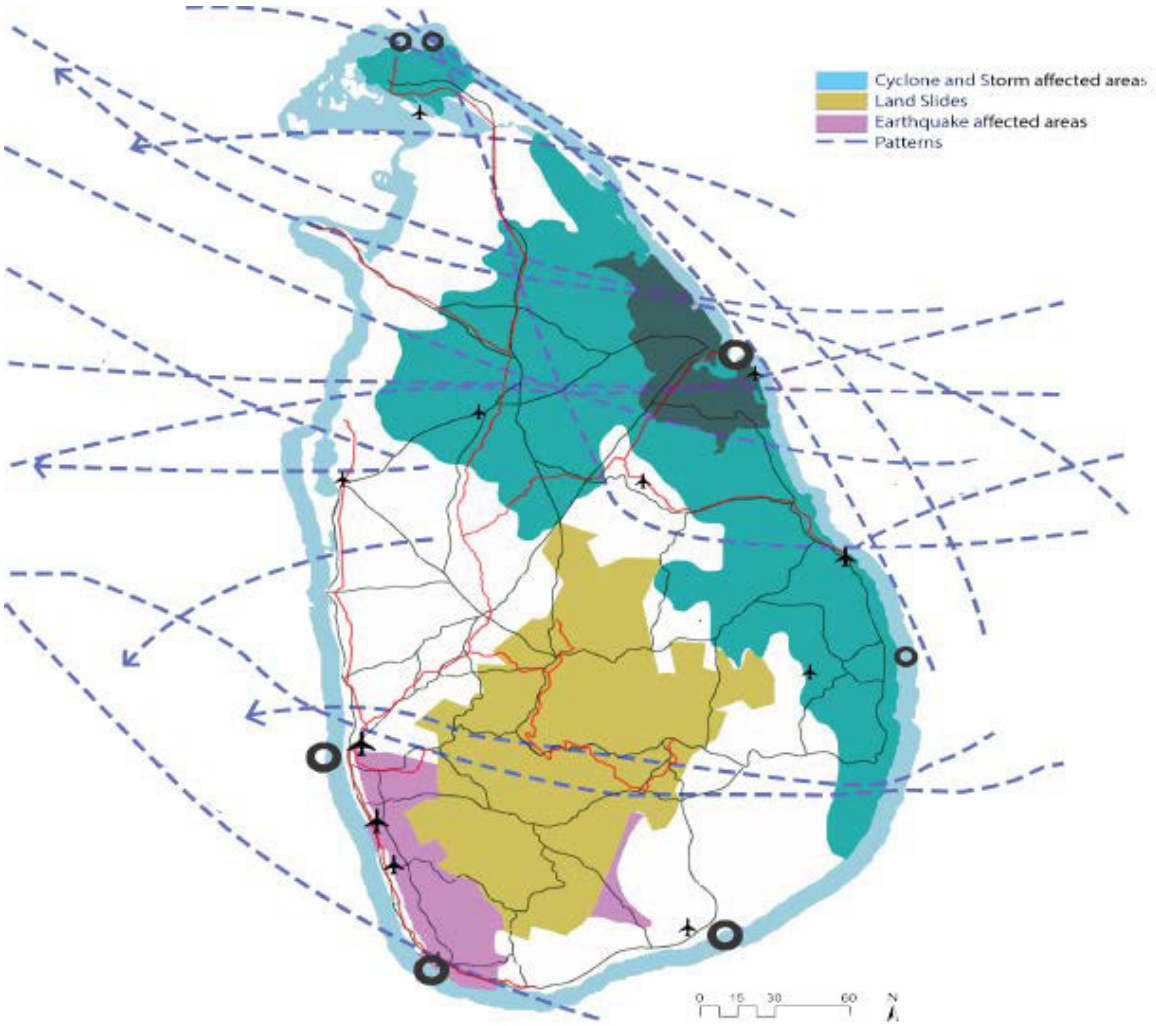
- Power stations;
- Meteorological stations;
- Police stations;
- Telecommunications buildings;
- Air traffic Control buildings;
- Fire stations;
- Hospitals;
- Telephone exchanges;
- Buildings designated as community refuge shelters.

And in which "Normal" structures are:

- All other Government buildings and all private buildings

- Tide and Wave Height – From January to May 2018, average wave height at the measuring station in Port of Trincomalee amounted to 0.03m; maximum wave height amounted to 1.60m. Average tide was measured at 0.59m above Low Water of Ordinary Spring Tide (LWOST); maximum tide was measured at 2.6m above LWOST.

Figure 4-2 Eastern Sri Lanka - Dominant Wind Patterns



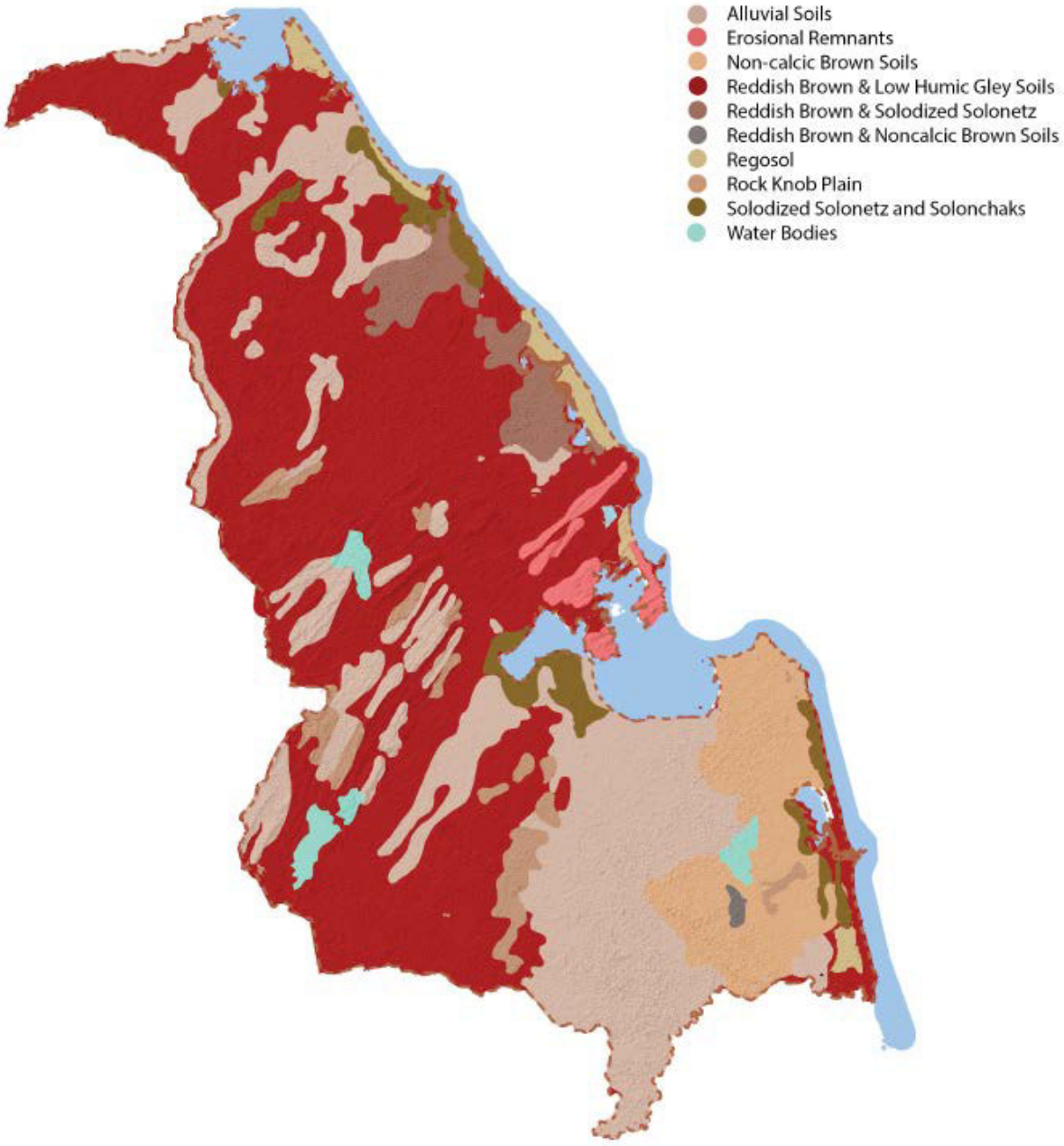
Source: Trincomalee District Master Plan, 2017

4.3.2 Land Features

The Trincomalee area is characterized by the following land features:

- Topography – Dominant topographical features vary between different areas of the Trincomalee region; the Western areas are mainly shaped by hills, whereas the Eastern areas predominantly feature coastal plains and cliffs. Additionally, the region's topography includes dunes, estuaries, beach bars, spits, and beaches.
- Soil – Alluvial soils are the most commonly found soil type in the Trincomalee area, although the China Bay area mainly features erosional remnants and reddish brown low humic gley soils; the division of soil types in the region is presented in Figure 4-3.
- Geology – The majority of the Sri Lankan island is underlain by Precambrian meta-sedimentary rocks that are grouped in two major lithological zones, the Highland Series and the Vijayan Series; the Trincomalee region is situated on the Highland rock group.

Figure 4-3 Trincomalee - Soil Types



Source: Trincomalee District Master Plan, 2017

4.3.3 Environmentally Sensitive Areas and Biodiversity

The Trincomalee area is home to the following environmentally sensitive areas and species:

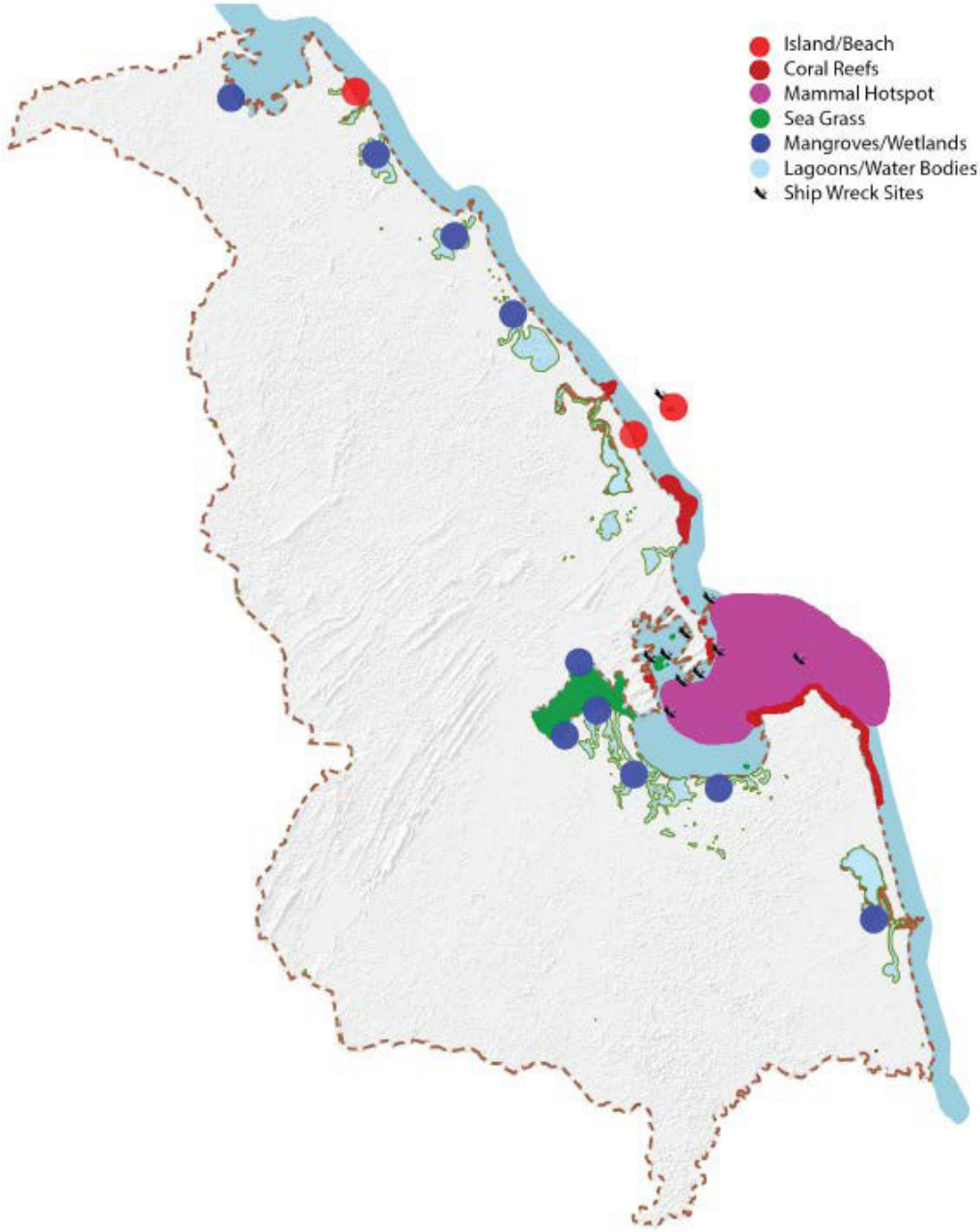
- Environmentally Sensitive Areas – The Trincomalee area is home to several environmentally sensitive areas, such as mammal hot spots, coral reefs, lagoons, bays, sea grass areas, islands, and beaches. These interrelated areas are critical components of the overall ecosystem. The environmentally sensitive areas in the region are visualized in Figure 4-4.
- Biodiversity – The Trincomalee region has a rich biodiversity. Species in the region include aquatic species, such as blue whales, sperm whales, oysters, sea turtles, dolphins; and terrestrial species, such as migratory birds, elephants, and other large mammals.

The Trincomalee area has several specific locations which are considered having high environmental values. These are for example:

- Great- and Small Sober Island and Elephant Island due to the nature reserves for birds.
- The jungle at Elephant ridge
- Beaches like Deadman's Cove, Sweat Bay and Marble bay
- Wetlands at the south part of Tambalagam bay and the south part of Koddiyar bay
- At several locations in Trincomalee Bay coral reefs exists.

For more specific locations and additional information reference is made to the Trincomalee District Master Plan, 2017.

Figure 4-4 Trincomalee - Environmentally Sensitive Areas



Source: Trincomalee District Master Plan, 2017

5 Connectivity and Hinterland

5.1 Introduction

This chapter describes the accessibility of the port of Trincomalee, both from a nautical perspective as well from a hinterland perspective.

- This chapter starts in section with an overview of the current nautical access of the port of Trincomalee and the major recommendations.
- Section 5.3 presents an overview of the current road connectivity to the port, identifies multiple road development requirements and concludes with the major recommendations.
- Paragraph 5.4 describes the connectivity by rail and provides an overview of the development requirements to enhance the rail connectivity of the port. One short-term priority project has been identified: rehabilitation and extension of the rail connection to the Ashroff Jetty.

5.2 Nautical access and navigation

The port of Trincomalee is a large natural harbour with water depths ranging from CD -20 m to CD -40 m. It is the only entirely sheltered harbour in the South Asian sub-continent. Although the current port of Trincomalee has a limited number of berths; however, vessels of any size can still be accommodated in the anchorage. The sheltered bay is ideal for calm water vessel operations such as ship-to-ship transfer, lay-up of vessels, loading and discharging submersible structures and other shipping related services.

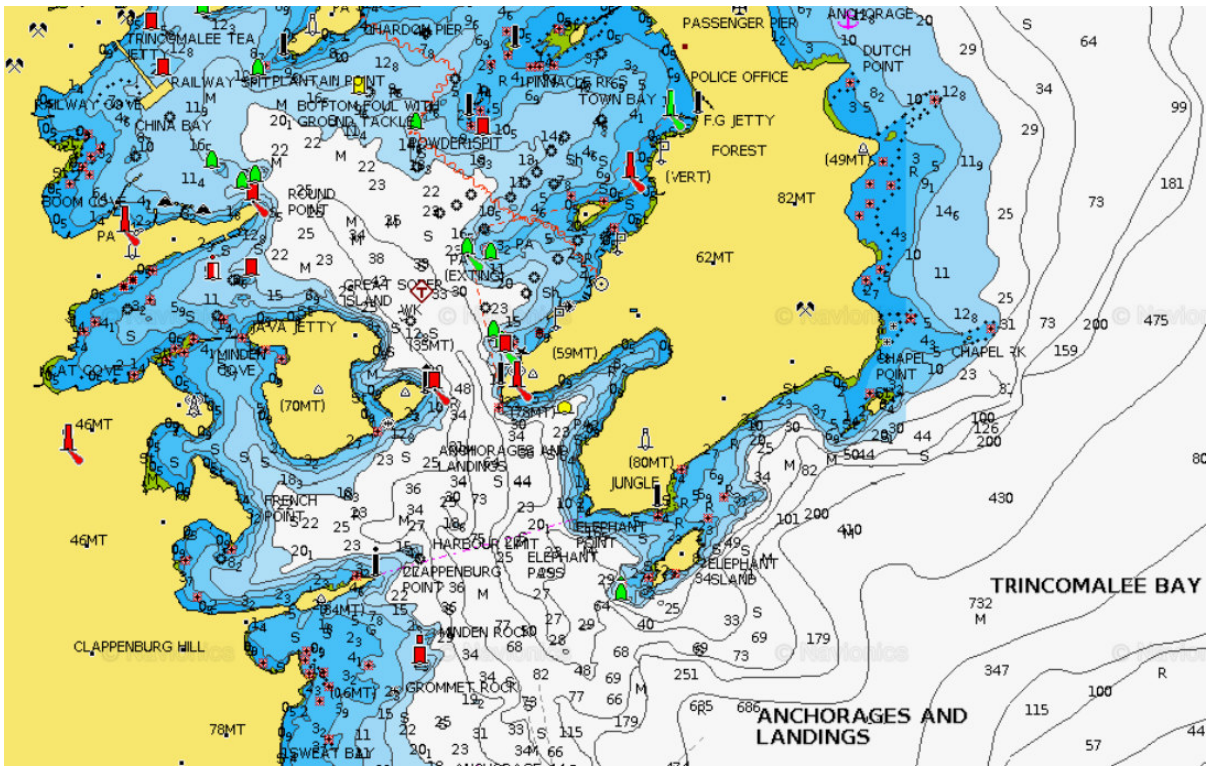
5.2.1 Current situation

Port limits - The port of Trincomalee consists of 2,023 hectares at low water. The harbour limit is a line joining Clappenburg and Elephant Points, 0.8 nm ENE.

Approaches – Trincomalee port is approached through Trincomalee Bay and entered through a channel, 500 metres wide between Clappenburg Point and Elephant Point.

Main entrance – The entrance channel has a width of 1,554 m and a natural depth of at least 22.0 m. The remainder of the navigable waters within the harbour varies between 11.0 and 30.0 m.

Figure 5-1: Bathymetric Chart of Trincomalee Port Area



The table below provides a more detailed overview of navigational data and restrictions in and around the port of Trincomalee.

Figure 5-2: Nautical Information Port of Trincomalee

Nautical information	Description
Tidal range and flow:	Range: Springs 0.6 m, Neaps 0.2 m.
Dock density:	1012, 1023
Weather	Prevailing winds: SW'ly and NE'ly monsoon.
Swell	Heavy swell on outer beaches during the NE monsoon.
Current	The tides-current approaching Trincomalee is usually setting South from October to February with a rate of up to 3 knots and setting N with a rate up to 1.3 knots during the months of March, April and August; irregular currents set strongly North and sometimes South during the other months of the year may be experienced off the harbour.
Principal navigation aids:	Bare slope on the SE shore of Great Sober Island. Water tower, from which a red fixed obstruction light is exhibited, 0.35nm WSW of Southampton Hill Silos SW of Round Point. Buildings, 0.075nm W of Ostengurg Point Round Island Light 08°31.9'N 081°12.7'E
Restrictions	• Vessels may enter the port of Trincomalee **during daytime only**.

Nautical information	Description
	• There are a number of prohibited areas, some onshore, some within the port; basically, related to the Sri Lankan Naval Yard area.
Tugs	2 tugs available at the port.

5.2.2 Development requirements on port access and turning basins

The navigational channel towards the port has a width of 1,554 m, which is largely sufficient for two-way traffic. According to PIANC guidelines, the following formula should be applied to calculate the required channel width:

- One-lane channel: $W = W_{BM} + \Sigma W_i + 2W_B$
- Two-lane channel: $W = 2 * (W_{BM} + W_B + \Sigma W_i) + W_P$
  in which: WBM = basic width (1.5-1.7 * ship's beam)
  W_i = width additions (depending on winds, currents, waves, etc.)
  W_B = bank clearance
  W_P = distance between two lanes
- In the case of Ultra Large Container Vessels with a beam of 60 m, W_{BM} = 102 m

For turning basins, the following formula is used:

- Rule of thumb: D = 2 * Length of design vessel (normal tug assistance)
- In case of high freeboard and wind/current: more
- In case of calm waters and extra tug assistance: less
- Limited space available: less, subject to simulations

5.2.3 Recommendations and short-term priority projects

The following recommendations are made:

R24. Night time navigation should be made available as soon as possible.
R25. Ashroff development: two-phased jetty expansion suitable for larger bulk vessels (Capesize, max. 300 m long).
R26. New deep-water oil jetty or CBM/SPM to accommodate larger mainline vessels up to 80,000 DWT with a maximum draught of 13.0 m.
R27. New 350 m long jetty with a draught of 12.0 m for a LNG floating storage hub at Clappenburg Island.
R28. Long term: marina and dedicated cruise berth in front of the city; 360 m long berth dredged at CD -11.0 m to allow for the largest cruise vessels with a maximum draft of 10 m currently in service.
R29. Sampur: in case coal or gas fire powered project will emerge, nautical mooring facilities will be required.
R30. Ship lay-up locations identified within Trincomalee Bay. The locations need fixed mooring buoys.
R31. Longer term future: options for potential container terminal development.

The following short-term priority project related to nautical accessibility has been identified:

SP2. **Navigation Aids** - For night time navigation the ports needs lights, buoys and lighthouses to ensure safety. Maintenance can be outsourced to private parties. SLPA will be remunerated for these costs by increased traffic to the port for which it will receive port dues.

5.3 Roads

5.3.1 Current Situation

The figure below presents the road connectivity of the Ashroff facility, SLPA's main facility in Trincomalee. The following observations can be made:

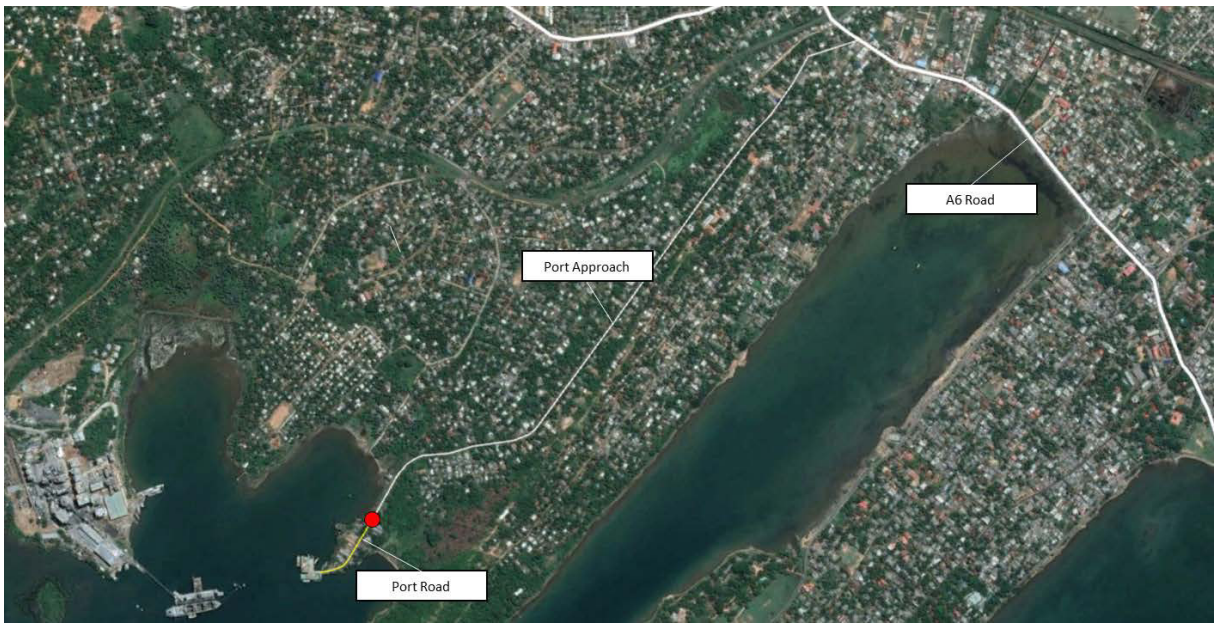
- The facility has one manually operated gate, which is marked by a red circle on the map.
- Within the port area, the road splits into two main roads; one road connects to the TTA facility, the other road connects to the Ashroff jetty. All main roads in the port are paved. The Ashroff road approach is hilly.
- From the gate, a 400m road connects the port facility to the A15 main road, which connects the facility to east coast destinations in Sri Lanka. The A15 also connects to the A6 main road, which connects to the central and western regions.

Figure 5-3: Current Road Connection to Ashroff Facility

Similarly, the figure below presents the current road connectivity of SLPA's Mud Cove facility. The following can be observed:

- The port approach is an unpaved road of approximately 2km.
- The internal port road is unpaved.
- There is one entrance to the port, which is marked red on the map.
- The port approach connects to the national A6 road, which heads towards Colombo in the West.

Figure 5-4: Current Road Connection to Mud Cove Facility



5.3.2 Development Requirements

In order to develop the accessibility to the port area, the following requirements have been identified:

- The internal port road of the Ashroff facility needs to be upgraded in order to accommodate more truck traffic efficiently.
- An improved gate system needs to be introduced at the Ashroff facility.
- Additional dedicated port traffic road connections from the port to the A6 are required to enable truck traffic to bypass city traffic. Potential road connections are presented in the figure below.

Figure 5-5: Proposed Additional Road Connections

5.3.3 Recommendations and Short-term Priority Projects

From the development requirements, the following recommendations have been derived:

R32. Upgrade the internal port road of the Ashroff facility.

R33. Introduce an improved gate system at the Ashroff facility.

R34. Develop additional road connections from the port to the A6. This is split between a road directly moving north and a new road connection along the airbase heading north west following the boundary of SLPA's land (as shown in picture) or the rail track.

The following short-term priority project related to road connectivity has been identified:

SP3. **Port Access Road Development** - A road connection starting from A15 near Lanka IOC heading North West will make it possible for port traffic to bypass the city traffic to A6.

5.4 Rail

5.4.1 Current Situation

The nation's rail network runs directly adjacent to the Trincomalee port area, as can be observed from the figure below. The following observations can further be made:

- The private Tokyo Cement and Prima Flour facilities have rail connections.
- The Ashroff facility currently has no direct rail connections. The China Bay Station is the nearest train station; the station is approximately 1km from the Ashroff facility premises and approximately 2km from the Ashroff quay.

Figure 5-6: Current Rail Connectivity to Trincomalee Port

Current Use of Rail Transport for Ashroff Bulk Commodities

It is noted that, despite the lack of a direct rail connection to the Ashroff facility, several clients and logistics services providers use rail to transport bulk cargoes (mainly coal destined for cement producers near Puttalam). Currently, these cargoes are transferred from vessels to trucks at the Ashroff facility, after which they are trucked to the China Bay station. There, the cargoes are transferred to trains.

The fact that this practice is preferred over an all-trucking option indicates the competitiveness of rail transport for bulk cargoes, and thus the importance of a rail connection to the Ashroff facility.

5.4.2 Development Requirements

The extension of the railway to the Ashroff jetty is essential for efficient bulk cargo operations. Current operations, where cargo is loaded from vessels onto trucks, are highly inefficient and time consuming; additionally, long distance transport of dry bulk commodities by truck is very cost-inefficient. Hence, the extension of the rail should be realised as soon as possible.

5.4.3 Recommendations and Short-term Priority Projects.

Considering the current situation and identified development requirements, the following recommendation is proposed:

R35. Extension of rail to Ashroff Jetty

This recommendation translates into the following short-term priority project:

SP4. Rehabilitation and Extension of the Rail Connection to the Ashroff Jetty

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6 Opportunities for Trincomalee

6.1 Introduction

This section chapter explains the potential opportunities for the Port of Trincomalee.

- Section 6.2 describes the ideal location of the port with natural deep waters which is a key strength to handle bulk commodities.
- Paragraph 6.3 describes the opportunities related to India, Bangladesh and Myanmar.
- Various other opportunities for the port of Trincomalee could be sought in the international trends in ports. Paragraph 0 provides a section on opportunities related to other sectors like energy, chemicals, light manufacturing, logistics and ship repair.
- Paragraph 6.5 concludes with the recommended short-term priority projects.

6.2 Trincomalee Port Directions

Trincomalee has development potential due to its key strength of a protected natural bay with deep waters. It is the place of choice for bulk goods servicing the energy and production sector in Sri Lanka and offers opportunities with a focus on the Bay of Bengal.

Trincomalee is well positioned to handle dry bulk cargoes for the country. Especially in connection to the planned corridor development and rail connections the port can emerge as important dry bulk, liquid bulk/gas and general cargo port. The establishment of a refinery, fertiliser plant, power stations or processing zone would create an additional node in Sri Lankan industrial development. The Trincomalee port is well positioned to serve industry opportunities focussed on import/export and processing of products with destinations in the Bay of Bengal.

Several key developments impact the success of the port of Trincomalee; among the most important is the development of the Colombo – Trincomalee corridor to ensure hinterland access to the port. Linked to that is the railway connection to the hinterland to ensure access and distribution of bulk goods to country. For Trincomalee, to attract industries of its own, substantial effort should be placed in targeting investors in specific markets.

Trincomalee is strategically positioned to serve markets in East India, Bangladesh and Myanmar. A prerequisite for the development is the establishment of the right business climate. Several factors affect a successful port business climate:

- Set up of industrial development policy, including marketing efforts;
- Create land areas for industrial development;
- Create free trade zones;
- Create land and sea accessibility;
- Trade facilitation measurements like (attractive settlement tariffs and (corporate) tax regimes);
- Create free trade zones.

6.3 Opportunities related to India, Bangladesh and Myanmar

This paragraph describes the opportunities for the Port of Trincomalee based on a high level analysis of the main import and exports markets in the Bay of Bengal (East India, Myanmar and Bangladesh). The opportunities related to general trends in ports and shipping are described in next paragraph.

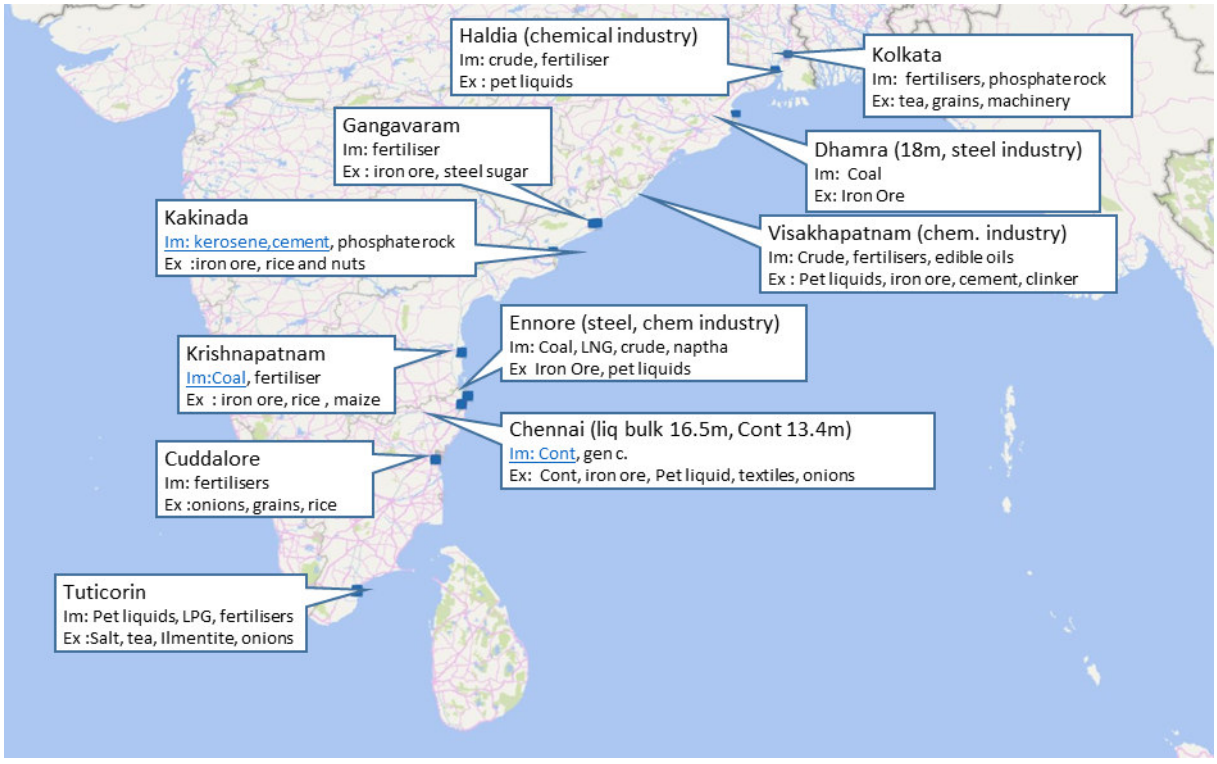
6.3.1 India

In this paragraph an overview and analysis of the main import and exports in the Bay of Bengal with focus on India is provided. From this graphic and the related tables, an opportunity matrix is made to illustrate the opportunities the central position of port of Trincomalee has in this market. Opportunities arise for Trincomalee to play a role in the supply to and from small ports on the East coast of India with specific commodities. The deregulation of the cabotage legislation in India adds to the opportunities of foreign vessel operators seeking new optimal distribution patterns. In the traditional markets of Sri Lanka, namely tea garments and rubber it should be remarked that these commodities are high containerized and benefit from the sea distribution networks of the port of Colombo. It is therefore that Trincomalee should foremost focus on new concepts aligning to the strategic location of Trincomalee towards the Bay of Bengal. This section and the opportunities mentioned should therefore be read as out-of-the-box thinking.

For many of the ideas the supporting elements of port developments should be:

- The dry ports / free trade zone establishments;
- The development of the Trincomalee – Colombo Economic corridor.

Figure 6-1: Indian Ports Main Trades



The table below gives an overview of the main East-Indian ports with their main traded commodities.

Table 6-1: East India Ports

Port	Max Vessel draughts	Imports	Exports
Chennai	Liquid Bulk: 16.5m Container: 13.4m Iron Ore: 16.2m Developments: LPG terminal Container terminal	Containers, coal, general cargo Crude oil, mineral oils, vehicles, project cargoes, machinery, food, grains, coal and chemicals	Iron ore, granite, mineral oils, petroleum fuel, textiles, onions, tobacco, leather goods, bone and bone meal, sugar, food grains, quartz, barytes, feldspar, and general cargo
Cuddalore	Port works with lighters at anchorage max 25,000 DWT	Fertilisers	Onions, Grain, rice wheat & general cargo
Dhamra	JV between Larsen Toubro and Tata Steel (steel port) Dry Bulk vessels: 18m Developments: new general cargo berth (export steel products) Liquid Hub incl. LNG	Coal	Iron ore
Ennore	Dry bulk: 13.5m (77-150,000 DWT) Liquid Bulk: 13.5m new general cargo berth RoRo facilities Marine Fuels Liquid Hub incl. LNG	Coal (thermal)	Iron Ore
Gangavaram	Max vessel 200,000 DWT Bulk vessels: 21m	Coal, project cargo, fertiliser	Iron Ore, bauxite, limestone, steel, raw sugar
Haldia	Vessel draught: 13.4m Max LOA 250m Congested Port Refinery port	Containers, Coal, Crude oil, Fuel Oil, fertiliser, chemicals molasses, edible oil, general cargo	Fuel oil, LPG, naphtha, benzene, butadiene, pygas, mogas, bitumen
Kakinada	Vessel draught 11.5m LOA max 190m	Fish, timber, kerosene, wheat, cement, magnesia clinker, rock phosphate, urea	Iron ore, rice, tobacco, Palmrya fibre, castor oil, crushed bones, sugar, ground nuts.
Kolkata (riverport)	Under port Trust Harbour draft 8.5m Max LOA 172m Developments Sagar Island project (draught 11m)	General cargo, Grain, Fuel oil, iron & steel, grain, cement, machinery, fertiliser, rock phosphate, sulphur, vegetable oil, timber,	Coal, scrap, tea, grain, linseed, seeds, hides, castor oil, mica, cotton yarn, machinery and sugar.

Krishnapatnam	Private port Vessel draught Dry bulk: 16m LOA 250m, 170,000 DWT Container: 13.5m	Coal, fertiliser LNG, Liquid Bulk, General cargo and containers	Iron ore, barite, rice and maize
Visakhapatnam	Trust port Draught 17m Max LOA 280m Refinery port	Crude, petroleum products, LPG, coking coal, limestone, fertilisers (urea, di-ammonium phosphate, potash, fertilisers, raw materials such as rock phosphate, sulphur, magnesite, liquid ammonia, phosphoric acid, caustic soda, edible oils, fish, General cargo	Iron ore, alumina, steel, pig iron, Petroleum products, thermal coal, cement, clinker, general cargo container cargo.
Tuticorin	Draught 12.8m Max LOA 330m 75,000 DWT	Dry Bulk (coal), Fuel Oils, finished fertilisers, raw materials for fertilisers, sugar, food grains, dun peas, vinyl chloride monomer, ethylene dichloride, raw bauxite, timber logs, iron scrap, pulp wood, Petroleum products, naphtha, furnace oil, LPG and RoRo	Salt, tea, ilmenite sand, garnet sand, cement, cotton piece goods, geomyid stones, sugar, molasses, cotton yarn, coffee, cashew kernels, construction materials, onions, dry chillies, palmyrah fibre, sanna leaves, hoofs, and horns

Following the review of the main ports of East India and their main import and export profiles the following opportunity matrix for Port of Trincomalee emerge:

Table 6-2: Observations and opportunity matrix

Observation	Description of related opportunity
High demand for fertilisers in East India	Demand for fertiliser factory with supply from local sources.
High iron ore exports and coal exports in region	A steel manufactory would have short logistics chains and could provide quality steel products for the development of Sri Lanka but also for steel exports.
Exports of Onions, rice and grains and other agriproducts	Option to develop foodstuff cluster for exports of food products and supply to Sri Lanka.
Demand for vegetable oils and ethanol in blended fuels in region. Demand for edible oils in the region.	Possibility to develop liquid bulk opportunities for the import, storage and supply (export) of (blended) fuels and edible oils for industry. Especially the trend for more bio-fuels requires an adjustment in the supply chain to supply vegetable oils, storage and blending. Ethanol is often used in the blending of

	gasoline, gasoil and bio fuels. A useful strategy can be made based on the supply of ethanol in the Middle East and the demand in the Bay of Bengal.
India car industry will also increase its share of electrical cars and trishaws.	Opportunity to specialise in the manufacturing of batteries to supply to local and export markets.
Demand for solar panels	Industry and households in the Bay of Bengal have demands for solar panels. The production of these panels can be taken-up by Sri Lanka.
Fish processing demand	Fish can be processed in Trincomalee for import and export markets.
The Indian East coast has several chemical industries	At Trincomalee product development is possible on the basis of the chemical cluster in the region. Although high investments in green field chemicals industry is not very likely when there is no local refinery.

These opportunities are further detailed here below.

- **Liquid bulk opportunities.** Sectors of interest are for example the supply of (blended) (bio-) fuels, edible oils, palm oil and special chemicals towards draft limited ports by coastal vessels. Especially ethanol is often blended with bio-fuels and is a possible new commodity. Trincomalee can act as storage, blending and trading hub of these commodities and has the advantage that supply towards Trincomalee can be done with deep drafted vessels.
- **Dry Bulk – Fertilisers**. Another opportunity is the demand for fertilisers in nearly all East Indian ports. Trincomalee can act as port of supply once a fertilisers factory is developed.
- **Added values on exports** of the East Indian ports and to create additional value on exports from this region. For example, in the food chain (sugar, flour and onions). In this respect food processing industries combined with cold storage near the port is regarded as opportunity.
- **Fish processing and re-exports.** By using cold storage and fish processing industries, Trincomalee can act in the cold-chain. Deepsea fish trawlers can discharge their ocean catch and it can be processed at Trincomalee industrial areas.
- Another opportunity would be using the exports from Indian refineries to create additional industries such as a **chemical industry** with crackers. This would require intensive capital investments of chemical producers; hence this opportunity should be explored by marketing people for this industry.
- **Steel manufacturing / Steel industry**. Sri Lanka is fully dependent on steel through imports of products thereof. Having main resources (iron ore, coal) in nearby countries like India and located near the sea, the opportunity would be to start a high-tech steel factory. A small Electric Arc facility should create the ability to create products which are today mainly imported. This should also be in view of the building, construction and car industry which is being developed in the nation. Power for the Electric Arc factory can be provided through LNG at the port. The port can act as import facility for the raw materials and the export facility for finished products.
- **Car/vehicle (battery) manufacturing**. Sri Lanka is about to lift off with a car manufacturing industry. Also, Tri-shaws are expected to be electrified. These developments may require production areas near ports and Trincomalee is one of them. Once only looked at the manufacturing of batteries again new opportunities arise for a high-tech industry which develops the batteries for the future. The world demand

for such devices is expected to become enormous since all traditional manufactures move away from fuel-based engines to electrified engines.

6.3.2 Bangladesh and Myanmar

The following table illustrates the imports and exports of main ports in Bangladesh and Myanmar. These countries are heavily reliant on the import of nearly all products and are characterised by strong export markets on textiles and garments which are similar market segments already offered by Sri Lanka.

Table 6-3: Ports in Bangladesh and Myanmar

Port	Max Vessel draughts	Imports	Exports
Chittagong	Draught 9.5m Max LOA 190m	Textiles, raw cotton, food stuff, chemicals, paper and wood pulp, machinery, steel/iron products, grain, cement, oil products, crude oil, fertilizer, vehicles (RoRo)	Ready-made garments, jute, tea, leather, frozen fish, shrimp, urea, ammonia
Mongla	Draught 7.5m (jetties) – 8.5m (anchorage) Max LOA 225m		

6.4 Opportunities related to port trends

Other opportunities for Trincomalee could be sought in the international trends in ports, which are mentioned the following table.

Table 6-4: Opportunities arising from port trends

Sector	Existing	Opportunities
Energy	Liquid bulks	• Bio-mass pellets export to coal fired power stations • Set up of coal or gas fired power station in region • Strategic storage of fuels • Trading storage of fuels and edible oils & chemicals • Bio-fuels (Blended fuels with vegetable oil and or ethanol) • Waste to energy • Bio-mass to energy • Solar panel production • LNG Imports for nation
Chemicals	No	• A chemical pant depends on imported fuels and naphtha (most logical location is near a refinery) but naphtha and LPG and other base products can also be sourced from Indian refineries at the East Coast.

Sector	Existing	Opportunities
Light Manufacturing & Assembly	No	• Assembly parks for windmills and rotor blades • Manufacturing/assembly of car parts for the (India) car industry • High tech industries (3d printing; data centres; electronics manufacturing)
Heavy Industry	No	• No
Logistics & value added	No	• Development area for 3rd party logistics providers to optimize hinterland transport (domestic cargo) • Area for storage and repackaging and other value added activities for transhipment cargo
Ship repair	Limited and old	• Set up of ship repair
Shipping	Yes	• Lay-up of vessels in sheltered waters • Performing ship-to-ship transfer • Performing maritime activities such as loading structures onto submersible vessels
Bunkering		• LNG Bunkering to vessels.

Especially in the energy sector the following may be of interest:

- Waste to energy - Waste is a national and international issue. Ports are ideal locations to handle waste efficiently and effectively and modern waste-to-energy plants can contribute to the energy supply of the nation. The disadvantage for Trincomalee is the processing of waste.
- H2 and Syngas energy plants create energy from renewable (wind mills and solar) sources and create gas to store the energy. For example, an H2 and Syngas energy plant is under development in the Port of Delfzijl, The Netherlands, to support the local chemical industry and the local energy grid. Noteworthy are the components in the Power-to-Gas solutions in this project. This system creates gas from renewable energy so that generated energy is stored in gas which can be consumed at a later stage than it is produced.
- Bio-mass to energy - Sri Lanka will start with the exports of biomass. This product can also be used by national power plants instead of exporting it to other nations.
- Solar panels and wind mills – The energy production with solar power and or windmills have potential in the Trincomalee area. However also the production of solar panels and wind mills has become a new industry which seeks port assembly areas for easy exports. Whereas the solar panels exports are containerised, the wind mill components would be exported by multi-purpose vessels.
- LNG Import gasification station – Possible gas fired power plants will require a gasification plant on the waterside. Trincomalee is well suited for this.

6.5 Recommendations and Short-term Priority Projects

The following recommendations are made:

R36. Carry out detailed commercial studies for (a selection of) the opportunities to ascertain the demand and viability for Trincomalee to capture part of the demand.

R37. Promote Trincomalee as deep-water port having ample land development areas for industries and logistics.

R38. Create promotional plan for land use and assign land plot specifications for future usage. Make difference between quay-connected activities and dry port related activities and distinguish between port related and non-port related business.
R39. Create roll-out plan for land development and prepare the first land plots for logistics and new industrial settlement areas
R40. Create road connectivity between newly developed areas, port and the A6.
R41. Integrate the land use planning with the plan from urban planning
R42. Set-up commercial taskforce to promote and lease-out the land plot(s) for port related industrial and logistics developments in Trincomalee. Create roadshows and promote business.

The following short-term projects are defined:

SP5. Make promotional plan on land and connectivity for newly assigned industrial and logistics.

7 Trincomalee Port Zoning

7.1 Introduction

This chapter describes the Trincomalee port zoning in the following manner:

- Paragraph 7.2 presents the draft zoning map of Trincomalee port. The zoning map describes areas identified based on characteristics of the land and proximity and utility to the port of Trincomalee. Optional areas are to be secured for potential future use.
- An overview of the current SLPA owned lands with a detailed description is presented in section 7.3.
- Paragraph 7.3.1 provides an overview of the potential lands to be released, subject to SLPA considerations.
- Subsequently, section 7.3.2 shows an overview of land plots possibly to be added to the Trincomalee port area.
- Paragraph 7.4 concludes with the recommended short-term priority projects.

7.2 Zoning Map Trincomalee

Figure 7-1 presents the current zoning map, as prepared by the UDA. When compared to the envisioned SLPA developments in the area, the following can be observed:

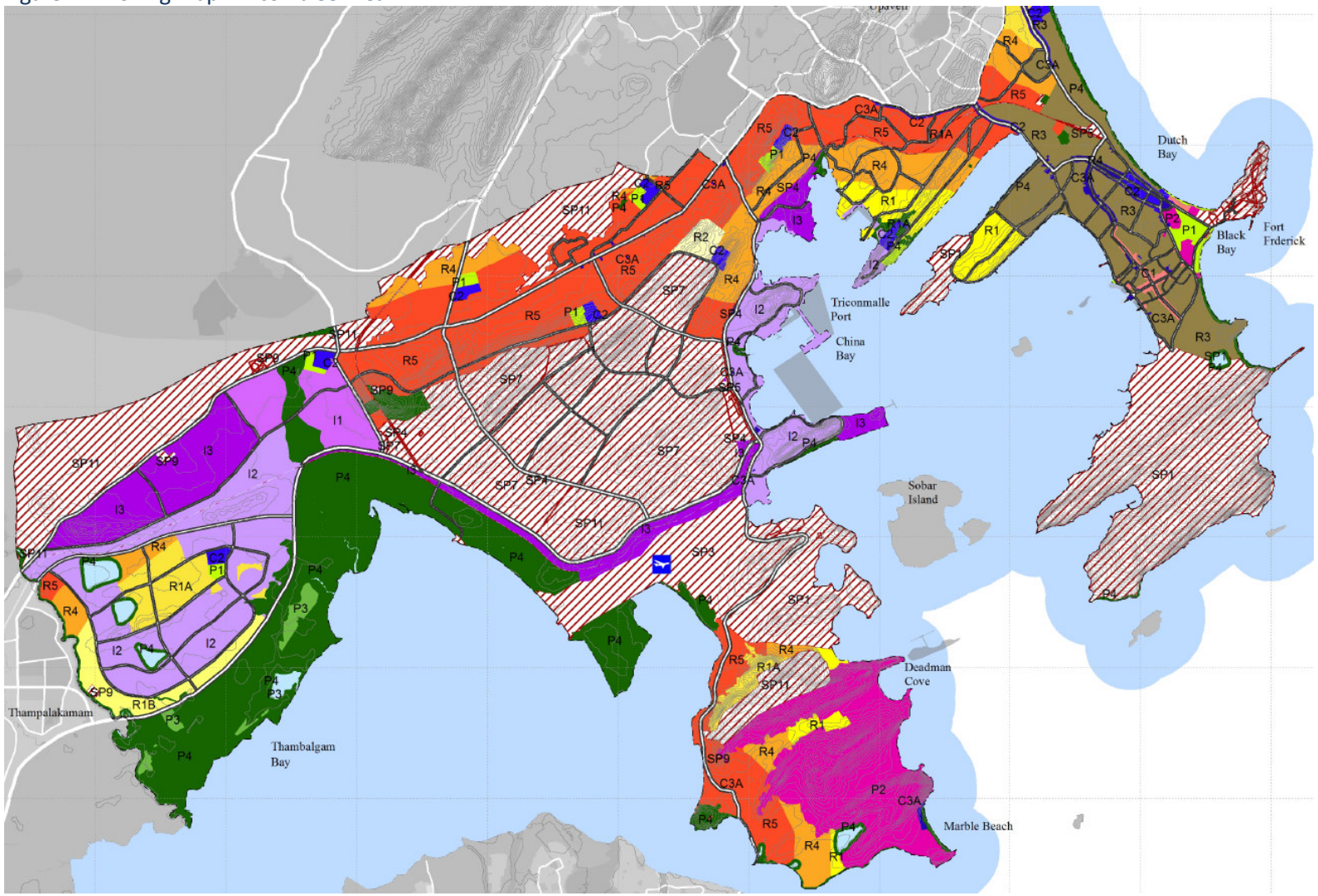
- Ashroff Jetty expansion (see section 9.3) – The envisaged space for the Ashroff Jetty expansion has been incorporated in the plan.
- LNG Terminal (see section 9.10) - The potential LNG jetty near deadman cove has been incorporated in the plan; however, no bridge to the mainland has been planned for.
- Container Terminal (see section 9.13) - The primary container terminal option at Sobar Island has not been incorporated, likely due to environmental issues. The secondary container terminal development option near the Ashroff Jetty has been incorporated in the plan.
- Deepwater Oil Jetty (see section 0) - The deepwater oil jetty has been incorporated in the plan.
- Ship Lay-Up (see section 9.5) - The lay-up areas have not been incorporated in the plan.
- Dock Yard expansion (see section 9.12) – The dock yard expansion area has been incorporated in the plan.
- Cruise / Marina (see section 9.6) – The cruise and marina development area has not been incorporated in the plan.
- Water and non-water based Industrial Development (see section 9.9 and 9.14) – The areas for industrial development have been partially incorporated; several areas near Tambalagam Bay have been classified as “protected areas”.

Several relevant colour codes for the zoning map are presented in the table below

Table 7-1: Description Zoning Map

Colour	Zone	
	I1	Light Industrial
	I2	Logistics / Warehousing
	I3	General Industry
	SP4	Transport Terminals / Depots
	SP7	Export Processing Zone
		Future (Port) Development

Figure 7-1: Zoning Map Trincomalee Area



7.3 SLPA Lands

SLPA owns several plots of land around the port as displayed in Figure 7-2. The table below the figure indicates the extent of each plot; the percentage of land encroached by housing and the percentage of land unusable due to forestation, elevation or otherwise.

It is noteworthy that the private facilities in Trincomalee are not under control through a concession fee agreement nor are they on official SLPA land. SLPA does incur port dues from vessels mooring at the facilities.

The SLPA plots provide ample space for expansion of port activities although some are encroached by civilians. The prime port development plots are FVP 17, FVP 18 and parts of FVP 15. Plot FTP 5A lies furthest away from the port. The plots FVP 22, FVP 23, FVP 24 and FVP 26 around Clappenburg are hilly, but Clappenburg Island does offer access to deep water. FVP 21 and the southern part FTP 5B contain jungle with only a railroad crossing through it. The most part of FVP 15 has merged into the city with a small hill adjacent to FVP 16 and Mud Cove facility and surroundings areas still available for port related activities.

Figure 7-2: SLPA Owned Lands Trincomalee

SLPA Plot	Plots owned (ha)	Encroachment (%)	Unusable (%)	Usable for dev. (Ha)	Current Use by SLPA	Description
FTP 5A	1,327	19.2%	30%	674	None	The plot is further away from the port around Tambalagam bay. It currently lacks connectivity except for rail passing by and the A6 highway up north. This makes future connectivity easy. The flat land and large extent, covering about 50% of the plot (or 674 ha) makes it very usable for (industrial) development.
FTP 5B					None	The plot contains encroached residences along the Kandy Road (A6). The village of Sardhapura is partly located on the plot. A large portion of the plot is hilly and therefore not suitable for development.
FVP 15	141	64.0%	20%	22	Mud Cove	The plot contains residences for 64%, but also contains the SLPA Mud Cove facility. The area south of Mud Cove is not encroached but is hilly. Only about 16% (22ha) is useful for development.
FVP 16	132	56.6%	5%	51	None	The plot contains residences with Sardhapura in the western part and Ganeshapuram in the eastern part. Part of the land is uninhabited. About 38% or 51 ha is useful land.
FVP 17A*	61	19.2%	50%	19	None	The village of Kavaddikudah is in the plot limits. The land bordering plot 16 is uninhabited, but hilly. About 38% or 19 ha would be useful for development.
FVP 17B*					TTA & Ashroff	This plot contains the SLPA administration buildings and the TTA. It is the access to the Ashroff Jetty.
FVP 18	7	100.0%	-	-	None	This plot is ideally located at the port and along the A15 road. Unfortunately, the plot is fully encroached.
FVP 21	154	5.0%	10%	131	None	This plot is located along the rail next to Tambalagam bay. It is vacant and not connected by road. The location makes its suitable for development covering about 131 ha. The area west of the rail line contains mangrove and is not suitable for development.
FVP 22, 23,24	175	15.0%	80%	9	None	This is an empty plot at Clappenburg bay including Clappenburg island. The land is

SLPA Plot	Plots owned (ha)	Encroachment (%)	Unusable (%)	Usable for dev. (Ha)	Current Use by SLPA	Description
						significantly hilly (80%) leaving only 9ha for suitable development land. The area is important to safeguard a safe and secure port development area near Clappenburg bay.
FVP 26	217	7.4%	90%	6	None	This plot is a vacant and hilly piece of land with the "diamond hill" reaching 79m. The area is adjacent to the touristic beaches on the east part. Due to the hilly surroundings the area is less suited for industrial development but facilitating the tourism industry with adjacent nature is an option.
Totals	**2,214 ha**	**488 ha****	**815 ha****	**911 ha**		

*Please note that plot suffixes such as A, B are added for ease of reference; they do not reflect the legal plot nomenclature.

**The percentages are multiplied with to plot extent to arrive at the total hectares.

The encroachment displayed in Figure 7-3 is a challenge for port development as port activities and urban development do not go hand in hand. Some areas are designated as tsunami relief after 2004 and as such are inhabited by displaced people.

Figure 7-3: Encroached Lands SLPA

7.3.1 Lands to be Released

Figure 7-4 presents the potential areas for release of land indicated with dotted lines. The yellow represents SLPA land plots and in red the encroached areas. The lands to be released are subject to SLPA considerations; no precise indications have been reached by the consultant for that reason. The reasoning for releasing the land might be:

- **FVP 21 West of the rail** – this land is wet due to mangrove forest. There is no use in in industrial development.
- **FT5B and FVP16 along the A6 road** – these lands are heavily encroached.
- **FVP15** – This plot is heavily encroached due to the expansion of the city.

Figure 7-4: Implication Port Zoning Map – Lands to be released

SLPA Plot	Designation Zoning	Implication Zoning Plan
FTP 5A	Optional non-water-based industries	To be retained for optional future (industrial) development.
FTP 5B	(Optional) non-water-based industries / Urban area	Area along A6 road is heavily encroached and non-essential for direct port operations though the land could have value for small industries along the main road.
FVP 15	Partly port dev. area	The area along the waterline is to be retained for future development.
FVP 16	Urban area and water-based industries	Area along A6 road is non-essential.
FVP 17A*	Water based industries	Essential area adjacent to port.

FVP 17B*	Port development area	Essential port area.
FVP 18	Port development area	Essential port area.
FVP 21	Non-water-based industries	To be retained for optional future development. Land to south west of the rail line is not suited for development and might potentially be released
FVP 22, 23,24	Optional water-based industries	To be retained for optional future development. Especially the area near Clappenburg should be remain secured in order to create safe areas for port development.
FVP 26	Touristic and recreational	Non-essential plot for port development.

*Please note that plot suffixes such as A, B are added for ease of reference; they do not reflect the legal plot nomenclature

7.3.2 Lands to be Acquired

Figure 7-5 shows 10 land plots for a total of 242 hectares possibly to be added to the port area. The naming of the plots (A1, A2 etc.) does not reflect legal plot nomenclature.

Figure 7-5: Implication Port Zoning Map – Lands to be acquired

Plot	Extent (ha)	Reason for Acquirement
A1	33.5	This plot has access to deep water and is located in the prime development area. Necessary for connection to Sobar Island in case of port development.
A2	20.6	Sobar island has access deep water. The northern part can be considered prime port development area[2]
A3	14.9	Optional port development area close to deep water.
A4	50.0	The lands between the road and water should be designated as port area.
A5	17.7	The lands between the road and water should be designated as port area. This secures the northern entrance of the port
A6	2.3	This small strip of land is uninhabited and close to the road. Useful for port related businesses and offices.
A7	31.9	This plot of land is an extension of the adjacent SLPA lands and designated for non-water-based industries. The plot is essential to create a west connection road to have a dedicated port access road in future.

[2] Development on Sobar island maybe subject to environmental constraints

A8	8.8	This plot of land is an extension of the adjacent SLPA lands and designated for non-water-based industries. The plot would secure a logical corridor along a new port access road.
A9	30.9	A possible location for port expansion. The land is albeit rather hilly
A10	31.5	A possible location for port / cruise development.
Total	**242.1**	

7.4 Recommendations and Short-term Priority Projects

SP6. **SLPA Land Use Plan** - The Trincomalee Port Zoning Report is a step in identifying the ports future needs to continue to think about which lands are lands need to be uninhabited for port development. A displacement plan, set-up years in advance will ensure a smooth process.

8 Forecasts & Capacities

8.1 Introduction

This chapter describes the volume forecast projections and corresponding capacity requirements for the port.

- Paragraph 8.2 presents the forecast approach and details explanations on the chapter.
- An overview of the various commodities currently handled at Trincomalee is presented in section 8.3.
- Paragraph 8.4 presents the volume forecasts of the current commodities as well as the new commodities expected to be handled by SLPA such as biomass, ilmenite, LNG, containers and fertilisers.

8.2 Forecast approach

The forecasts below are split in forecasts of current commodities handled at Trincomalee and forecasts of new commodities expected to be handled in the future. For current commodities, a capacity analysis is given. The colours in the capacity analysis indicate:

- Red – facility is at full capacity
- Yellow – facility is near full capacity
- Green – facility has ample capacity

For an explanation of methodology of the forecast we refer the reader to the National Port Directions Plan. Below the table displays the base case forecasts made for Trincomalee.[3]

Table 8-1: Summary Forecasts

Commodity	Unit	2016	2025	2030	2050
Coal	'000 Tons	103	120	120	120
Grains	'000 Tons	867	1,457	1,509	1,709
Clinker	'000 Tons	1,712	2,297	2,560	3,113
Refined Oils	'000 Tons	238	1,064	507	1,358
Cruise	Vessels	4	7	12	21
Containers	'000 TEU	-	-	26	112
Fertilisers	'000 Tons	-	1,536	1,536	1,536
Biomass	'000 Tons	-	325	500	500
Ilmenite	'000 Tons	-	700	700	700
LNG	'000 Tons	-	-	-	-

[3] The Final Development Plan will contain the forecast boundaries.

8.3 Cargo

Below the table outlines the throughput per commodity. The main driver for growth in cargo handled can be attributed to the increased demand in clinker for both the Tokyo Cement facility and the Siam Cement facility in Galle (through mid-stream operations).

Table 8-2: Trincomalee Throughput 2010-2017 per Commodity

'000 Tons	2010	2011	2012	2013	2014	2015	2016	2017
Discharged								
Wheat in bulk	911	1,090	901	676	825	868	714	760
Clinker in bulk	738	985	1,369	1,244	1,383	1,419	1,593	1,678
Gypsum in bulk	12	43	107	80	114	86	112	166
Coal in bulk	106	105	89	99	113	93	103	90
Other (slag)	-	-	-	10	14	-	22	-
Liquid bulk (fuel)	191	113	179	166	173	182	281	417
Total Discharged	**1,960**	**2,337**	**2,646**	**2,276**	**2,621**	**2,649**	**2,825**	**3,120**
Loaded								
Wheat bran pallets	139	-	-	140	127	162	153	122
Clinker	-	-	-	-	-	217	536	619
Other	55	237	213	20	-	-	-	37
Total Loaded	**194**	**237**	**213**	**159**	**127**	**379**	**689**	**778**
Cargo Handled	**2,154**	**2,574**	**2,859**	**2,435**	**2,748**	**3,027**	**3,514**	**3,897**

Source: SLPA

Cargo ships remain the main category of ships calling at Trincomalee port. Although the port today is limitedly called for repair or bunkering, the amount of vessels is increasing supported by higher throughputs and more lay-up/service vessels.

Table 8-3: Trincomalee Throughput 2010-2017 Ship Arrivals

	2010	2011	2012	2013	2014	2015	2016	2017
Cargo ships	97	116	139	113	120	158	207	224
Ships for repairs	8	2	3	3	1	1	1	2
Ships-bunkering	0	2	6	6	1	2	4	0
Passenger Vessels	1	2	8	4	2	3	4	5
Other ships	3	4	5	8	3	-	-	2
Total ships arrived	**109**	**126**	**161**	**134**	**127**	**164**	**216**	**233**

Source: SLPA

8.4 Forecasts of Current Commodities Handled

8.4.1 Coal

Current operations

Coal is a dry bulk commodity shipped in bulk carriers. Currently, the handling of coal through the Ashroff Jetty is limited to around 100,000 tons per annum and mainly destined for the Siam Cement plant in Puttalam. This coal is discharged from small bulk carriers and transported by rail through the use of containers loaded near the Ashroff jetty. This type of operation is regarded suboptimal as coal handling is normally characterized by dedicated cranes and belt systems connecting a loading station which is able to load rail wagons for bulk transportation. Coal is also currently handled for the cement factory in Galle. This coal is transferred from ship to ship, a so-called midstream operation. The mid-stream operation is handled through ship's gear.

Current berth capacity

The existing berth of 250m in length and a water depth of CD -12.5m was designed for Panamax vessels. However, this vessel class segment has deeper drafts today. Moreover, coal is often shipped into Capesize vessels and this illustrates a suboptimal quay dimension and water depths of the existing Ashroff quay.

Table 8-4: Dimensions overview dry bulk vessels

Dry bulk vessels	DWT (tons)	LOA (m)	Beam (m)	Draught (m)	2015 (Vessels)	2016 (Vessels)	2017 (Vessels)
Handysize	10,000 - 40,000	140 - 180	22 - 28	8.0 - 10.5	7	10	10
Handymax (supramax)	40,000 - 65,000	169 - 200	31 - 32.4	9.8 - 12.3	6	14	16
Panamax (incl. new)	67,000 - 99,000	223 - 233	32 - 48	13.2 - 14.1	-	-	-
Capesize	100,000 - 200,000	250 - 300	43 - 50	14.2 - 18.5	-	-	-
Ultra Large Cape	250,000 - 320,000+	300 - 360	50 - 64	18.0 - 24.0	-	-	-

Future developments

Two main developments affect the significant increase for the demand of coal in the future:

- **Rail transport of Coal to power plant Puttalam**[4] – As soon as the Ashroff Jetty is upgraded and having an efficient rail connection, Trincomalee could not only play a role in the supply to the cement plants in Puttalam. The current supply to the power station is done through barges and a midstream operation west of Puttalam. This operation is subject to stoppage due to monsoon weather conditions leading to high storage pilling. During these months a supply through rail from Trincomalee becomes attractive. The demand when the plant operates at full capacity is estimated at 2,2 MTA. This reduces the need for costly maintenance of the Puttalam coal stock pile.
- **Future Coal Fired Power Plants** – As indicated in the preface, the demand for coal fired power plants still highly uncertain in Sri Lanka. Under current forecast based on CEB projections, coal demand is set to

[4] This development is currently incorporated in the forecast, though it is still under debate. Pending the decision of SLPA the forecast shall be adjusted accordingly.

increase significantly with Trincomalee being a prime port for coal imports for further hinterland distribution by rail. This is mainly destined for coal demand from Northern part of Sri Lanka including the potential development in Sampur.

Table 8-5: Coal Forecast

	2016	2025	2030	2050
Share Trincomalee (%)	5%	5%	5%	5%
Forecast Coal ('000 Tons)	103	120	120	120

The current facility at Ashroff simply lacks the capacity and the equipment to handle the increase in demand expected. A comprehensive upgrade plan of the Ashroff plan is needed, not only to create a more efficient operation, economies of scale and also a more environmental friendly solution. In international trading of coal, the most common bulk carriers are larger than the Panamax sized vessel (70-99,000 DWT) which can berth at the Ashroff quay. To reach economies of scale Capesize vessel of around 120-140,000 DWT vessels are very common in the coal trades and berth expansion is required to cater for them.

Table 8-6: Coal Handling Capacity

Terminal		Technical Characteristics		Capacity		
Name	Port	Berth	Terminal Area	Estimated Capacity ('000 Tons)	2016 Throughput ('000 Tons)	Free Capacity ('000 Tons)
TTA & Ashroff	Trincomalee	250 m -12.50 CD	0.30 ha	450	103	347
					Total	347

Assumptions Estimated Capacity

TTA & Ashroff Trincomalee

- Shiploads of 15,000 tons
- Discharge of 150 t/hr
- Berth occupancy of 41%
- Based on small bulk carriers of 20,000 DWT
- Coal hopper discharge rate through ships gear
- Berth occupancy to allow common berthing

8.4.2 Grains

Current operations

Grain is a bulk commodity carried in bulk carriers. Prima Flour uses suction pipes to discharge the grain from bulk carriers directly into the 200,000-ton storage facilities adjacent to the quay.

Berth capacity

The Prima Flour facility has a dedicated berth of 240 m to discharge bulk carriers with a maximum draught of 12 m. This corresponds to bulk carriers up to 70-99,000 DWT, commonly known as Panamax vessels. See also the table on Dry Bulk Vessels in the coal section. It should be noted that the Panamax type vessel is indeed the

most common bulk carrier for grain. In this respect the facility is aligned with the international trend on vessel used.

Future developments

The national demand for grains is expected to increase as Sri Lanka develops. The majority of the imports is expected to keep flowing to Trincomalee in the form of bulk imports. This forecast foresees an approximate doubling of demand by 2030, but of course the business reality of Prima Flour will dictate the exact number. Several factors affect their business as indicated by Prima Flour management:

- Faster and cheaper logistics to Colombo for export boxes will increase international competitiveness of their products.
- A possible rail connection will ease transport.
- International demand might change or shift.
- National demand might change or shift.

Table 8-7: Grains Forecast

	2016	2025	2030	2050
Share Trincomalee (%)	82%	85%	75%	75%
Forecast Grains ('000 Tons)	867	1,457	1,509	1,709
Forecast High	867	1,457	1,574	1,899
Forecast Low	867	1,457	1,443	1,519

The Prima Flour facility is expected to have ample capacity to handle demand in the foreseeable future. In the grain trades to most common vessel type is the Panamax vessel which can berth at the Prima Flour facility.

Table 8-8: Grains Handling Capacity

Terminal		Technical Characteristics		Capacity		
Name	Port	Berth	Storage Area	Estimated Capacity ('000 Tons)	2016 Throughput ('000 Tons)	Free Capacity ('000 Tons)
Prima Flour	Trincomalee	240 m -13.00 CD	350,000 tons	1,875	714	1,161
					Total	**1,871**

Assumptions Estimated Capacity

Prima Flour Trincomalee:

- Shiploads of 75,000 tons
- Discharge of 375 t/hr
- Berth occupancy of 57%[5]
- Panamax vessel of 90,000 DWT
- Common discharge rate for grain suction
- High berthing occupancy in a dedicated industrial environment is common.

[5] A high berth occupancy can be expected as the facility is dedicated single user and privately operated.

8.4.3 Clinker

Current operations

Clinker is a dusty bulky material used for the manufacturing of cement. Clinker is often transported in Handysize bulk carriers (10,000 - 35,000 DWT). The grinding plant of Tokyo Cement handles most of clinker imports in Trincomalee. The Ashroff jetty also handles clinker imports and these are destined for the Siam Cement grinding plant in Puttalam. Once the berth is occupied or because of depth constraints, a mid-stream ship-to-ship operation is performed to supply Galle with clinker. The mother vessel cannot reach Galle because of depth restrictions in the port of Galle. The new proposed cement development in Galle will potentially enhance the mid-stream operations in Trincomalee.

Berth capacity

The Ashroff jetty with a length of 250m and a depth of CD - 12.5m is sufficient to handle the Handysize or even the Handymax sized vessels which are commonly used in the clinker trades. Because the Ashroff jetty is a common berth, the number of berths shall become an issue in view of the increased clinker trades and increased maritime traffic.

Table 8-9: Clinker Forecast

	2016	2025	2030	2050
Share Trincomalee (%)	44%	40%	40%	40%
Forecast Clinker ('000 Tons)	1,712	2,297	2,560	3,113
Forecast High	1,712	2,623	3,070	3,957
Forecast Low	1,712	1,971	2,049	2,268

Table 8-10: Clinker Handling Capacity

Terminal		Technical Characteristics		Capacity		
Name	Port	Berth	Terminal Area	Estimated Capacity ('000 Tons)	2016 Throughput ('000 Tons)	Free Capacity ('000 Tons)
Tokyo Cement	Trincomalee	150 m -9.50 CD	1.50 ha	1,750	1,270	480
TTA & Ashroff	Trincomalee	250 m -12.50 CD	0.30 ha	450	330	120
					Total	**600**

Assumptions Estimated Capacity

Tokyo Cement Trincomalee:

- Shiploads of 35,000 tons
- Discharge at 500 t/hr
- Berth occupancy of 40%
- Common shipload for Tokyo Cement
- Common discharge rate for clinker
- Occupancy rates at Tokyo Cement facility

TTA & Ashroff Trincomalee:

- Shiploads of 15,000 tons
- Common shipload at Ashroff quay

- Discharge at 150 t/hr
- Berth occupancy of 41%
- Discharge rate for clinker
- Occupancy for common berths

8.4.4 Refined Oils

Current operations

Refined oils consist of refinery products such as Gasoil, Diesel, MDO, IFO. The IOC facility plays a crucial role in the supply of fuels to the northern part of Sri Lanka. Further the facility supplies fuels to vessels, the so-called bunkering operations. Lanka IOC operates 16 fuel storage tanks for Gasoil, Diesel, IFO and water. It handles the imports and exports through one jetty owned and operated by SLPA and is facing marine loading/discharging constraints with high berth occupancy rates.

Berth capacity

The existing jetty 3 has a water depth of CD -11.5m and a berth length of 125m. This is a set-up to accommodate mainly small tankers up to about 35,000 DWT. The facility not equipped to handle the medium range tankers up to 65,000 DWT as water depth and proper loading arms are lacking. Lanka IOC wants to further optimise the storage tanks opportunities and upgrade the marine side handlings in order to gain economies of scale, to cater for larger sized vessels such as the Medium and Long-range vessels commonly used in the refined oil trades whilst at the same time diversify into more bunker supply operations.

Table 8-11: Product tanker dimensions

Product tankers	DWT (tons)	LOA (m)	Beam (m)	Draught (m)
Small tankers	10,000 - 45,000	135- 185m	22 - 28m	8 – 11.2m
Medium range (MR)	45,000 - 65,000	183 - 207m	31 - 32.2m	12 – 13.5m
Long Range (LR1)	65,000 - 80,000	200 - 228m	32m	13.0 - 14.5m
Long Range (LR2) (aframax)	80,000 - 120,000	228 - 250m	34 - 45m	13.0 – 14.5m

The refined oils forecast shows an increase of fuels and other oils with a majority of the increase in fuel demand is expected to be handled in Trincomalee. Lanka IOC currently services fuel to a range of 150 km of Trincomalee. The forecast does not include bunkering or other commercial ship supply activities. Lanka IOC does have bunkering operations in MGO, MDO and IFO and it expects this business to increase in the future.

Table 8-12: Refined Oils Forecast

	2016	2025	2030	2050
Share Trincomalee (%)	9%	20%	30%	30%
Forecast Refined Oils ('000 Tons)	238	1,064	507	1,358
Forecast High ('000 Tons)	260	1,322	1,047	2,304
Forecast Low ('000 Tons) *	216	807	-	412

*The zero imports in 2030 can be attributed to opening of a refinery in Hambantota.

The tank farm in Trincomalee comprises of 99 tanks in reasonable condition. The potential storage capacity is therefore high. Meanwhile, the loading at the jetty is subject to improvements. The current operations are through connecting hoses and a loading arm is lacking. Furthermore, the loading of bunker barges is slow leading to high occupancy rates of the berth. To utilise more of the existing storage capacities, the jetty needs expansion, also to accommodate larger vessels.

Table 8-13: Refined Oil Capacity

Terminal		Technical Characteristics		Capacity		
Name	Port	Jetty	Terminal Area	Estimated Capacity ('000 Tons)	2016 Throughput ('000 Tons)	Free Capacity ('000 Tons)
Oil Berth	Trincomalee	2,500 ton/hr.	1,069,200 tons	10,692	103	10,589
					Total	**10,589**

Assumptions Estimated Capacity

Oil facility:

- 99 tanks with 10,800 tons of oil storage
- 12 refreshes per year
- 80 % utilisation
- Tanks are subject to refurbishments
- Common turnaround time for tanks
- Limited berth and low discharge rates lead to high occupancies

8.4.5 Cruise

Currently, the handful of cruise vessels destined for Trincomalee dock at the Ashroff Jetty. This is not optimal as increased traffic to Ashroff jetty and the distance to other amenities might constrain cruise vessels coming to Trincomalee. The forecast shown below is based on an increased traffic to Colombo, which could lead to more cruise demand for the other ports in Sri Lanka if capacity is available. A dedicated cruise berth in Trincomalee could boost this demand.

Table 8-14: Cruise Vessels Forecast

	2016	2025	2030	2050
Forecast Cruise (Vessels)	4	7	12	21

8.5 Forecasts of New Commodities

8.5.1 Gateway Containers

With increased economic activity in Trincomalee it is likely that demand for containers also arises as new business settle in the region. The current forecasts estimate that a limited percentage of national traffic is serviced through Trincomalee, leading to 112,000 TEU in 2050. This number might have a significant upswing depending on the exact industrial development of the region especially in comparison to Hambantota. The market capture might even be larger if a highway to the Western region is established. Several development options for a container terminal in Trincomalee are presented in this regard.

Table 8-15: Gateway Containers Forecast

	2016	2025	2030	2050
Share Trincomalee (%)	-	-	1%	3%
Forecast Containers ('000 TEU)	-	-	26	112

Forecast High	-	-	29	136
Forecast Low	-	-	24	88

8.5.2 Fertilisers

The forecast of fertilisers is based on a private initiative to produce SSP fertiliser for the domestic and international market. The production process requires phosphate which is available in Sri Lanka, though it is not certain whether these will be used for production. Some sulfuric acids need to be imported and the production in excess of domestic demand can flow external to markets. It is noted that expected volumes remain constant over time, in line with the vision of the relevant market parties in the market-driven forecast. Due to the production-driven nature of the commodity, and the fact that it is a new commodity for the port, such a market-driven approach is considered the most appropriate forecasting methodology.

Table 8-16: Fertiliser Production Forecast

('000 Tons)	2016	2025	2030	2050
Imports Sulfuric Acids	-	432	432	432
Export Excess Production	-	1,104	1,104	1,104
Total	**-**	**1,536**	**1,536**	**1,536**

8.5.3 Biomass

Biomass is being produced by a private company for which a bulk export location is needed. Trincomalee is opted due to the possibility to load into bulk carriers and the availability of land near the Ashroff quay. Regarding Biomass demand, international power facilities are interested to burn biomass at their coal-fired power stations. The forecast is based on the predictions of the private party involved. Biomass exports are 150,000 tons in 2020 increasing to 500,000 tons in 2030. It is noted that expected volumes remain constant after 2030, in line with the vision of the relevant market parties in the market-driven forecast. Due to the production-driven nature of the commodity, and the fact that it is a new commodity for the port, such a market-driven approach is considered the most appropriate forecasting methodology.

Table 8-17: Export Forecast Biomass

'000 Tons	2020	2025	2030	2035	2040	2045	2050
Share Trincomalee (%)	100%	100%	100%	100%	100%	100%	100%
Biomass	150	290	500	500	500	500	500

8.5.4 Ilmenite

Sri Lanka has pockets of ilmenite which is used as a metal in titanium production. Currently, they are already exporting in smaller vessels north of Trincomalee. The private party request 1 ha. of land for their export set-up. Ilmenite will be exported with 29 ships annually of 30,000 DWT filled at 80% capacity starting when bulk export capacity is available at Ashroff jetty (possibly 2023). It is noted that expected volumes remain constant over time, in line with the vision of the relevant market parties in the market-driven forecast. Due to the production-driven nature of the commodity, and the fact that it is a new commodity for the port, such a market-driven approach is considered the most appropriate forecasting methodology.

Table 8-18: Export Forecast Ilmenite

'000 Tons	2020	2025	2030	2035	2040	2045	2050
Share Trincomalee (%)	-	100%	100%	100%	100%	100%	100%
Ilmenite	-	700	700	700	700	700	700

8.5.5 LNG

In the current forecast, no LNG demand is assigned to Trincomalee, but given the nature of the changes in energy supply for the country this might happen in the future. As of 2017, the government of Sri Lanka is investing in an LNG power plant in Colombo region. If LNG energy generation is deemed successful by the government subsequent power plants might arise elsewhere in the country, with the Trincomalee / Sampur area as one of those.

Another trend boosting LNG demand is use of the commodity as bunkering fuel as a clean alternative to MGO. Trincomalee could be well suited to supply LNG bunking demand for vessels along the international shipping routes.

9 Development Options

9.1 Introduction

The development options presented in this chapter are preliminary designs, based on discussion and possible future needs for Trincomalee. A further detailing of the Ashroff Jetty upgrade and the construction of the deep-water oil jetty will follow in chapters 11 Ashroff Jetty Expansion and 12 Deep-water Oil Jetty.

As such, this chapter has the following approach:

- Paragraph 9.2 presents the connectivity developments for the port and focuses also on the corresponding social and environmental aspects.
- The proposed expansion of the Ashroff Jetty follows is presented in section 9.3.
- Paragraph 0 presents the deep-water Oil Jetty developments.
- Potential development options related to ship lay-up opportunities and related services are discussed in paragraph 9.5.
- Paragraph 9.14 discusses the Tambalagam Bay Development.
- A possible design for a marina and cruise berth is discussed in section 9.6, focussing as well on the social and environmental aspects.
- Paragraph 9.9 presents the options for industrial development and logistics near the port.
- Section 9.10 presents the options for a future floating LNG hub terminal.
- Several options for development of energy plants for the Sampur Area are discussed in paragraph 9.11.
- Paragraph 9.12 discusses the future dock yard possibilities.
- Finally, the options for the potential development of a container terminal in the port area is presented in paragraph 9.13.

Note: appendix II describes an assessment on SLPA initial development plans for Trincomalee. Expansion plans and private initiatives are addressed in this annex as well.

In the Annex V, an implementation plan is provided for the recommendations, the short term priority projects and the long term priority projects.

9.2 Connectivity

The existing railway line currently reaches the private facilities of Prima Flour and Tokyo Cement heading west. The expansion of the railway to Ashroff Jetty is essential for smooth operations at the jetty. The shunting yard next to the port needs expansion space as well, if possible.

The port is connected by road to the east coast of Sri Lanka through the A15 and heart of the country in the direction of Colombo through the A6. Currently, the area west of the port lacks sufficient connection for it to be developed. A connection starting from A15 near Lanka IOC heading north west will make it possible for port traffic to bypass the city traffic to A6. The land between road and rail can be used for industrial development.

Figure 9-1: Connectivity Trincomalee Port

Environmental and Social Aspects

The various sections of the port of Trincomalee are generally situated at considerable distance from the town. The activity nearest to the town is the Mitsui Cement Factory, with its own berth and storage silos, at 600 to 700 m from the nearest residential areas. The Ashroff jetty, with potential dust problems due to handling of coal and clinker, is situated at about 500 m from dwellings along the A15. The same is true for the Prima Ceylon Flour Mill Complex.

Transport of goods from and towards the port (Ashroff Jetty) occasionally affect the traffic on the A15, connecting Trincomalee via the A6 with Damballa and the centre of the country. There is limited parking space for lorries on the premises of Ashroff Jetty. During peak hours this parking space may not be enough, causing lorries to que along the main road. Of course, the traffic generated by the port adds up to the traffic along the A15 and A6 and to some extent on the A12 leading from Trincomalee to Anuradhapura

The proposed rail link, between Ashroff Jetty and China Bay railway station will reduce to some extent the need for vehicle transport, also alleviating occasional traffic congestions along the A15. The rail link will also render redundant the transhipment (of coal and clinker) from the port to China Bay station.

A new road parallel to the railway, connecting Ashroff Jetty directly to the A6 will reduce vehicular port traffic along the A15 considerably. The two interventions combined will adequately address the traffic congestion problem for the foreseeable future, while contributing to the reduction of gaseous emissions, noise production and traffic risks.

9.3 Ashroff Jetty

SLPA land plot FVP 17 which currently includes the TTA warehouses is ideally located near the Ashroff Jetty, making it suitable for storage and terminal area. The railway expansion from China Bay station is a necessity in order accommodate dry bulk transport to the Sri Lankan hinterland.

The proposed expansion of the Ashroff Jetty follows twee phases, adding two berths. The proposed shape is different from the SLPA development plans as it follows the natural depth of the water on the eastern side and tries to limit quay construction in shallow waters on the western side.

The following main activities are planned to take place at the Ashroff Jetty:

- Coal storage (import);
- Clinker (imports and ship-to-ship transfer);
- Ilmenite & Biomass export processing;
- General cargo handling;
- Container handling in limited volumes;

The one of the commodities handled at the Ashroff Jetty is coal, initially coal is destined to the cement manufacturers in Puttalam and those in the northern section of the country. A conveyor belt system to the stock pile is needed, after which coal is loaded on train wagons.

The current hilly road to the Ashroff jetty is being replaced by SLPA. Some land reclamation will increase the area available for cargo activities. The current TTA facility is in bad shape and should be replaced. Any office should preferably be centralised in a high rise building to maximise land use as it is prime port development area.

Figure 9-2: Expansion Ashroff, Railway and TTA

A	Phase 1 Ashroff Jetty expansion	F	Possible location coal stock pile
B	Phase 2 Ashroff Jetty expansion	G	SLPA land plot FVP 17
C	100m service jetty for tug boats	H	Rail expansion from China Bay station to Ashroff
D	Land reclamation	I	New road development
E	Service pier (-3m CD)		

To support auxiliary functions a service pier is projected at the back of the TTA facility for workboats and crew tenders at limited depth of CD -3.0m.
Tug boats and pilot boats do not have a dedicated berth and a new tug boat mooring pier of 100m is projected on the west side of the Ashroff jetty at CD -6.0m.

9.4 Deep-water Oil Jetty

Lanka IOC operates 16 fuel storage tanks for Gasoil, Diesel, IFO and water. It handles the imports and exports through one jetty and is facing marine loading/discharging constraints with high berth occupancy rates.

The company currently sees a steep increase in demand for bunkering fuels for vessels on the east-west trade. Additionally, the refined oils demand which include fuels are set to increase in Sri Lanka with the tank farm in Trincomalee being a prime distribution location. The government designated 10 extra tanks to Lanka IOC, and 10 to a JV set to develop in the future. These tanks are assigned from the 99 storage tanks available. Reportedly, the majority of the storage tanks are in reasonable condition. The current bottlenecks are in the pipelines to connect them.

Due to the water depth constraint at Trincomalee jetty 3 (CD -11.5 m) the facility can handle small tankers up to 45,000 DWT. Larger vessels are currently sailing to Colombo and Trincomalee is then opted as secondary discharge port. A new deep-water jetty could accommodate large mainline vessels of 50,000 to 80,000 DWT. This would enhance the economies of scale and have a positive effect on the purchase price of fuels in the nation.

The Jetty

Characteristics of the new jetty:

- Deep-water jetty of CD -18 m[6];
- Able to handle 80,000 DWT mainline vessels, and small tankers at the inner side;
- Open jetty construction with service people walking about the jetty;
- Location at the end of prima flour;
- Maybe emergency response vehicles should be able to cross the jetty; then a regular steel construction is not sufficient;
- Pipelines exposed above ground to enable regular environmental checks and maintenance.

Figure 9-3: Deep-water Oil Jetty

As alternative for the jetty for refined products, a SBM could be constructed. The latter feature will however not have the ability to load bunker fuel oil.

[6] It should be noted that in the proposed location about CD -18m water depth is available. The water depth required for a 80,000 DWT vessels would be around 15m.

9.5 Ship Lay-up

The deep-water Trincomalee bay offers enough area for ship lay-up and related services. SLPA already accommodates this activity but it can be marketed more.

Lay-up Activities

The term 'ships laid-up' means ships which are temporarily idle due to lack of cargo or which are temporarily phased out of commercial operations. Ships are laid-up when freight rates are not sufficient to cover the running costs. During times of economic crisis, laying-up is often preferred to the sale of the ship. Within the vessel operating market, we can distinguish two types of lay-up:

- Hot laying up
- Cold laying up

During 'hot laying-up' a ship is idle but can be brought back into service at short notice. 'Cold laying-up' means that the ship is taken out of service due to lack of business and is moored or anchored at a safe place waiting for new business. Cold lay-up periods typically range from 3 to 12 months.

In lay-up the shipowner removes the normal crew and the ship is only manned by safety guards. In this way, the shipowner is able to reduce its cost and waits till market demand picks up again. The above description indicates that the lay-up business is cyclical and also marginal in terms for what a port authority can ask for sheltering the ship at its anchor grounds. However, besides revenues from accommodating the laid-up vessels, the port authority accommodating the vessel can also charge the vessel owners for other activities, such as:

- crew changes, as the regular crew leaves the vessel and is replaced by safety guards; and
- supply of provisions to the laid-up ships.

There are also other lay-up reasons, different than low freight rates. Ships can be put into laid-up in case major repairs have to be carried out or that the ship is "arrested by law" or is under sale or waited to be scrapped.

In any case the shipowner remains responsible for safe manning of his laid-up ship. During laying up of a ship the shipowner must man the ship such that:

- Safe watchkeeping is guaranteed;
- It can respond effectively in case of emergency;
- The watertight integrity according to fire protection and buoyancy is maintained;
- The ISM- and the ISPS-code are complied with;
- At anchor a safe anchor watches according to STCW code section A-VII/2, part 4.1 is guaranteed.

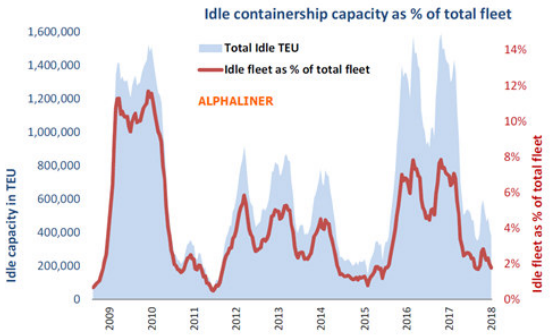
A special 'safe manning certificate' can be issued for the exemption that a laid-up ship must be relocated under hot lay-up. In that case, limited crew is allowed during the relocation of the ship.

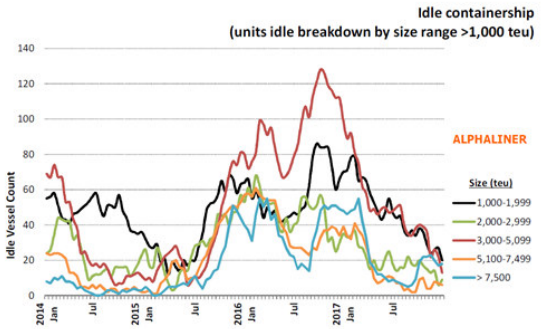
Market for lay-up ships

To lay-up ships, a port should have ample berthing space at anchorage. Further, the anchorage position should be in sheltered waters protected against winds and waves. Trincomalee has these conditions and is therefore able to increase services into this marginal business segment. In terms of location, Trincomalee is not as well positioned as Singapore where the majority of lay-up occurs. However, Trincomalee can attack a minor part of the market. The disadvantage for Trincomalee is the more difficult access through the lack of a commercial airport which may hamper this ambition.

The market for lay-up ships as mentioned is cyclical. During the period of the global financial crisis, 2009-2010, was a typical market in which shipowners wanted to lay-up their ships. Another period was 2016 and 2017 when global demand for shipping did not materialize and shipowners deployed their newly ordered ships and

laid-up less economical ships (ships with high running costs). On average about 5% of the container fleet has been in laid-up during the last decade ranging between 100 and 350 units. Early 2018 this percentage was around 1.8% or about 100 vessels.





Source: Alphaliner

In general, the design of an anchorage mainly depends on the following factors;

- Size, dimensions and characteristics of the vessel;
- Type of operations expected to be undertaken;
- Duration for which the vessel(s) will stay at anchor;
- Site's general configuration and availability of space for manoeuvring;
- Arrangements as a general anchorage area or have defined anchorage position;
- Number of defined anchoring points to be provided at the site
- Marine environment in the area and operational limiting conditions
- Site's physical characteristics and, in particular, depth and shape of the seabed and the ability of the bed material for anchor holding
- Availability of pollution combating resources.

Anchorage capacity

An anchorage must be of a sufficient size to allow a vessel or vessels to move unhindered with a suitable safety margin. Consideration should be given to likely time that vessels will need to stay at anchorage, design vessel length, length of anchor chain expected to be used and the clearance from nearby hazards or vessels should anchors drag.

Depth

The bathymetry of the anchorage should be relatively flat and clear of any obstructions which may foul an anchor. Due to the vessel's weather-vaning around its anchor, the vessel would experience vertical wave-induced motions which are less severe than in the channel, and no squat, except that which might be generated by a strong current. Anchorage areas may be protected from waves so wave motions can be relatively small. This means the under keel clearance at anchorage does not have to be more than in an all-weather and tide navigation channel. Generally speaking this is at 1.1*T (T=draught of the vessel).

Quality of holding ground.

The geographical location of the port will generally dictate the anchorage area and thus the nature of the seabed holding ground. Sailing directions usually give the type of seabed and quality of the holding ground, information that is important for assessing the suitability of an anchorage.

Protection from wind and sea.
Where possible, the anchorage should be chosen regarding prevailing winds and currents, so it provides the greatest natural shelter possible, whilst also endeavouring to achieve sufficient protection from wave effects.

Maritime traffic in the area.
Preferable anchorages should not be located near busy shipping lanes to minimise the risk of a collision, especially regarding the effects of fog and other phenomena which may reduce visibility.

Nautical facilities for taking and leaving the anchorage.
As far as possible, an anchorage should be chosen which has suitable natural or artificial marking enabling the vessel to be accurately and safely positioned when approaching and whilst remaining at anchor.

The bay of Trincomalee has sufficient water areas which are suited for anchoring, although at several locations the depth is very large. The following indicative locations are identified where ships may be laid-up. These areas are further to be analysed in detailed, to assign a formal anchor location. The area's are characterized by calm waters at sufficient water depths, protected from the prevailing winds and ocean waves, located away from passing traffic lanes, and not in use for other purposes such as marine cables. Depending on the size of the ship, wind directions and the duration of the stay, vessels will be directed to these areas.

To accommodate laid-up ships it is advised to cater for mooring buoys instead of using ship's anchors. The advantage is that bottom sea-life is not disturbed as mooring buoys are permanently fixed to the seabed. This is also an advantage at large water depths. In that case the mooring buoy should be specify the maximum size of vessels and vessel types allowed to moor.

In case the ship anchor solution is chosen the following would apply. For a free weather-vaning anchorage (Ra) (ship's anchor only), the minimum radius is Ra = Loa +5h + 30m according to PIANC guidelines. In this formula h is the water depth. The general rule in shipping is that the vessel has to have an anchor chain length of at least five times the water depth to ensure a horizontal pull at the anchor with an assumption that anchor may drag for 30m before holding ground.

Figure 9-4: Locations for Ship Lay-up

Indicative areas in the picture from left to right-above:
Area 1: Near Clappenburg, large 13 ha[7].
Area 2: Between Clappenburg bay and Sobar island, large 10.4 ha.
Area 3: Opposite Clappenburg bay, large 10.5 ha.
Area 4: Town bay, large 31.3 ha.
Area 5: Powder bay, large 25.9ha.

Environmental and Social Aspects

Provided ships laid-up in the port are in good, operational condition, no major impacts are foreseen. However, regular checking for leaks or spills is warranted. No ships should be allowed to disintegrate within the port zone.

[7] In case a LNG terminal is constructed this site will no longer be suited for anchorage

9.6 Auxiliary functions

9.6.1 Introduction

Auxiliary functions in this report can be defined as: "All activities taking place which are stand-alone functions and activities taking place to support the primary commercial port operations." This boils down to the definition being all functions except for the commercial port operations. Sometimes auxiliary port functions can be a commercial activity on itself like, bunkering services or the crew change service.

Auxiliary functions in ports can be split into direct services required to perform the port activities and indirect services which are supportive to the port.

Direct Supportive Functions:	Indirect Supportive Functions:
Tugs and Pilotage	Ship repair yards
Linesman & mooring	Ships Chandlery
Bunkering	Fire department
Water supply	Medical services
Weighing and scanning facilities	Marinas
Ballast water treatment	Seamen club

9.6.2 Direct Supportive Functions

Tugs and Pilotage

In Trincomalee there are two tugs available in the port as detailed below. The tugs are needed to support the vessels to in approaching the berth and for mooring and unmooring.

Description	GT	Length (m)	Beam (m)	Draught	Horse power
CEB-PCPP T-1 (2010)	268	29.9	9.0	3.7	2,122
PYAREY LAL (2006)	255	28.8	8.4	3.5	2,432

Source: SLPA

The station for the tugs today is adequately addressed today and due to the limited depth at the TTA jetty tugs are often moored at the Ashroff jetty or at other places in the bay. With the modernisation of the Ashroff jetty a new service jetty is projected for mooring tug and pilot boats. The new set up will also concentrate the activities of the marine department near the Ashroff quay rather than being scattered around the bay.

The bollard pull power for handling small cape size vessels (Loa 240-300m) would be in the order of 45 tons. This is the required minimum. Existing tugs have bollard pull powers of approximately between 25 tons and 30 tons. This is insufficient for handling the expected larger vessels in the future. It is therefore recommended that the tugs are replaced whilst the Ashroff jetty is modernized.

Pilotage, which is carried out by the deputy harbour master, is compulsory for vessels over 200t. Pilot will board vessel (during daylight hours only 0600-1800hrs) 0.2nm North of Round Island. Vessels arriving between

1800-2100hrs may be brought in at the harbour master's discretion. With the modernisation of the Ashroff jetty a new service jetty is projected for the pilot boats.

Linesman & mooring

The linesman supports the crew of the vessel with mooring the ship. The linesman act from the quay in Trincomalee. They use workboats to position them at the oil jetties when required. These workboats are today located near the TTA facility and serviced from poor infrastructure. With the modernisation of the Ashroff jetty a new service pier for workboats is projected at the back of the TTA jetty.

Bunkering

At Trincomalee today, the bunker activities are limited. Ships can be supplied with bunkers ex-quay with marine diesel oil, Gasoil and furnace oil. Supply of bunkers through bunker barges is projected to increase in future. Especially the types of fuels may increase due to new marine fuel legislations. Low sulphur fuels are required under the new IMO rules to limit to 3.5% sulphur content from 2020 onwards (this was 4.5% since 2012). Additional emission control zones (ECAs) could be implemented along the coast of the Indian sub-continent including Sri Lanka in the future. However specific international agreements on this have not been made sofar. This in contradiction to the European union where coastal zones upto 200nm are assigned for using only very low sulphur fuels (<0.5%) as from 1st January 2020. Similar legislation is opted and rumoured for the Asia marine waters stretching from Singapore to the coast of Japan with indicative timing of 2030. Should this legislation also be introduced in the Bay of Bengal then the marine fuel demand is expected to change drastically which will also apply for supplies from the Port of Trincomalee.

It is the ambition of Lanka IOC to supply more frequently to vessels in the future. Steps have been taken to cater for larger volumes through investments on storage tanks. Meanwhile the speed of loading bunkering at the jetty is slow leading to long berthing hours and occupation of the berth for the main import volumes of gasoil and gasoline.

The deep-sea jetty envisaged for the Port of Trincomalee would enact an increasing capacity to off load large quantities of gasoil and gasoline for the import market, whilst at the same time would provide capacity to load bunker vessel or supply bunkers to vessels directly.

Water supply

Fresh water by barge is available subject of 24 notice. The barge facility can supply water to vessels at anchorage and whilst at berth. The facility for water is planned at the service jetty near the TTA.

Weighing and scanning facilities

The Ashroff jetty has one weighing bridge at the entrance of the Ashroff jetty. New regulation of IMO of the VgM (verified gross mass) as per 1st July 2016[8] of each container and shipment loaded on board of vessels requires a properly functioning weighbridge. The weigh bridge at Trincomalee is dated and requires replacement under the modernisation project of the Ashroff facility. In that case it can also be placed in a good logistical position.

Ballast water treatment

The port has no facilities for ballast water treatments. The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) (2004) is implemented by 8th September 2017. Sri Lanka has not yet ratified this convention whilst countries as Singapore, Japan, South Korea, most European countries but also Maldives and Seychelles have ratified this convention.

[8] On 1 July 2016, new requirements to verify the gross mass of a packed container enter into force under the International Convention for the Safety of Life at Sea (SOLAS).

For Trincomalee it is important to prepare for the new convention with facilities especially as new facilities are planned.

9.7 Indirect Supportive Functions

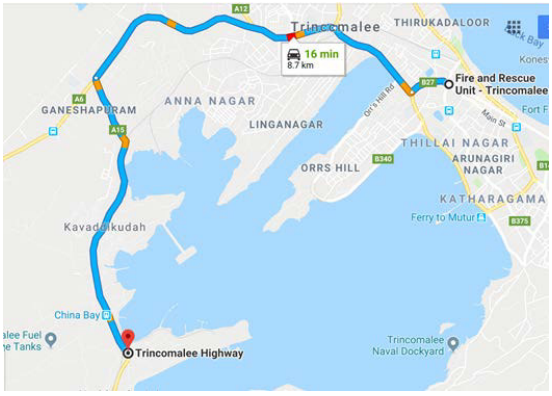
Ship repair yards
Trincomalee has one slipway located at Mudcove. The slipway is in a depilated stage since the tsunami of 2014. It is recommended to dispose the shipyard activities in Trincomalee to the private sector. SLPA vessels and workboats can be maintained at Colombo facilities. Small workboats can be repaired at the fishery harbour when relevant.

It is important to note that a new shipyard or related activities at Mud cove should not harm the environmental sea-life in the Bay and should be subject to clear and good environmental guidelines.

Ships Chandlery
The ship chandlery in Trincomalee is not a large market as of yet. With increased vessel traffic it is expected that ship chandlery is also improving. This will be driven by private initiatives.

Fire department
The fire department of Trincomalee which is also acting as the fire and rescue department for the port, is located at the main street of Trincomalee. This is at a distance of about 9km away from, for example the oil facility. Whilst driving distance maybe as short as 16 minutes, often traffic in town is hindering the service to act quickly. The international norm to reach industry, for example in Europe is 10 minutes. Therefore, the location of the fire department as well as the large area for which this department is responsible makes it clear that the service needs to be adapted in future, especially in view of the enlarged port industrial terrains west of China bay. Once the port is expanded a new (port-) fire department on the west side of the bay is required.

Figure 9-5: Fire department Trincomalee



General emergency and oil pollution.
The harbour master should be in control of an emergency situation providing directions to other services such as the firemen or the ambulance. For the case of oil pollution at sea an oil-boom is present in the port but respective parties should drill and simulate such events in order to be prepared for action.

Medical services
The medical services in Trincomalee are provided by the Hospital located in Town at a distance of 10 km.

Marinas

The bay of Trincomalee is ideal for boating. The surrounding beaches have touristic value and leisure sports can be expected once Trincomalee develops as touristic location. A marina for small boats upto around 50m is projected in the Bay in front of the city. This project can be developed through private-public partnership or through private initiatives only. It is envisioned that the marine will host local boats, coastal sailors and features clubhouses, restaurants, small craft workshops and small craft ship-lifts. The facility is expected to be combined with a planned cruise terminal.

Seamen club

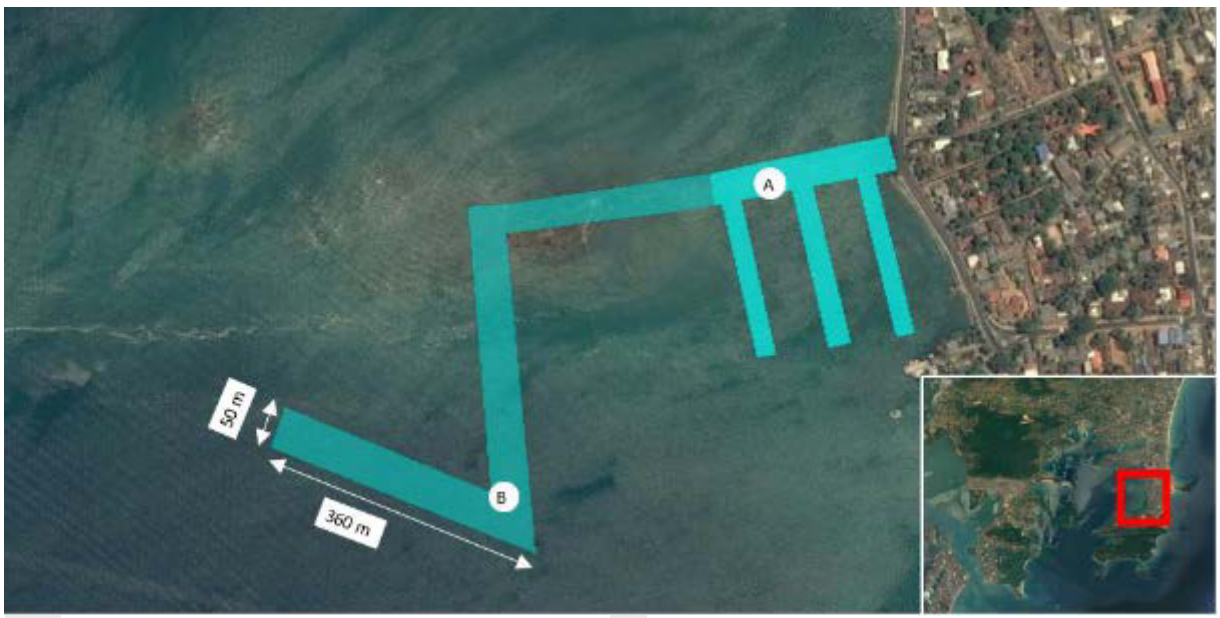
There is no seamen club or mission to seafarers in the port. Once the port expands and the number of vessels increases accommodation for seafarers should be planned for.

9.8 Cruise Berth & Marina

The image below provides a possible design for a marina and cruise berth at the city of Trincomalee. The marina would be developed as phase 1 of the design. If enough demand arises based on market interest, the cruise berth could follow.

The cruise berth provides will provide enough space for busses to pass and to turn. The shape is designed to locate the 360-m south berth along a stretch of a natural 10 m deep water spot. Further, the shape depends on the shallow waters towards powder island. Dredging it to 11 metres would allow the accommodation of the largest cruise ships currently in operation (as these vessels have a LOA of 360m and a draught of approximately 10m). Smaller vessels can be accommodated on the East side. The area northeast along the connectivity pier would be suitable for a marina to concentrate touristic development.

Figure 9-6: Cruise Berth & Marina Concept



A	Phase 1 Marina	B	Phase 2 Cruise Berth

Environmental and Social Aspects

The plan to construct a cruise berth with marina at the town part of the port basin will carry with it some developments and opportunities, most of which beneficial:

- Construction of Terminal/Reception Building;
- Upgrade/embellishment of current untidy water front;
- Provision of waste receiving facilities and bunkering / supply of provisions;
- Boost to tourism, commercial activities;
- Additional incentive to conserve ecological resources in the vicinity.

9.9 Industrial Development & Logistics

Currently, BOI has designated land for the development of logistics in Trincomalee. Some local companies have settled at this area. SLPA has two potential areas in this picture of about 160 ha each, to be designated to either logistics and or more probably large-scale industries. The road connectivity will ensure good access to the areas.

A prime user might be the fertiliser industry. The fertiliser manufacturer needs the port in its proximity to minimise transportation costs to produce the 1.8 M tons of fertiliser when fully operational. The facility is expected to import phosphate and sulphur.

Figure 9-7: Options Accommodation Phosphate Industry

Environmental and Social Aspects

The area designated for industrial development and logistics is situated on the north side of the Trincomalee airport. The area is now covered under bush and jungle. The jungle has no protection status. The development of this area would lead to the removal of a considerable stretch of natural land. Although the land has no protection status, it has some ecological value as habitat for birds, reptiles and small mammals, as well as for

carbon sequestration and oxygen production, water shed protection. Therefore, its occupation should be a well-considered decision.

In between the zone of Tambalagam Bay (item 2) and the area described above (item 4) there is the valley of a small stream entering Tambalagam Bay. This valley with bordering land functions as a corridor for elephants moving towards and from the Bay. This function should not be put in jeopardy by developing the two areas for industrial / commercial development.

9.10 LNG Hub Terminal Floating Storage

Floating storage and regassification of LNG can be realised on a jetty near Clappenburg Island. This design minimises the cost, as no land development for tanks are needed. The facility can supply a power station and industry by gas pipelines. Ships of LOA up to 350 m with draught of 12 m need to discharge and load at the hub terminal. This often reaches depths up to 16 metres. The floating storage can be specifically used for the gas supply to a power station and for bunkering services to vessels and or for supplying industries with energy through gas. LNG has an important safety aspect and hence the region should stay clear of housing and other human activities.
The LNG terminal could also have a land-based storage area for gas tanks to match the storage supply with the power station demands in case this is beyond the vessel capacity. A common LNG land-based terminal which has for example three tanks (full containment tanks) with a net useable capacity of 180,000m³ each would require a terrain of approximately 42 hectares[9]. This is based on the LNG Gate terminal in the Port of Rotterdam which acts as supplier for the local gas networks, the LNG supply from/to seagoing ships, the LNG supply to inland vessels and bunkering, and the supply of LNG to road trucks.

Figure 9-8: Options Accommodation LNG Hub Terminal

The LNG bunkering market is growing substantially; the map below provides an overview of current LNG bunkering facilities (indicated by the flags, with yellow flags indicating the major bunkering facilities).

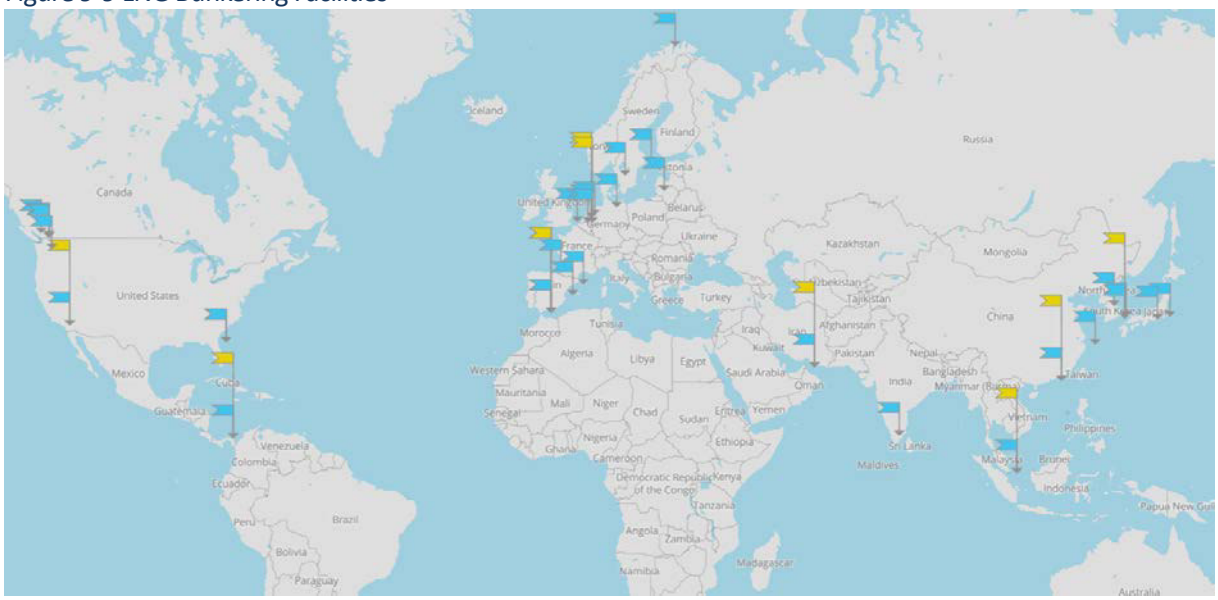
[9] Based on the example of Rotterdam LNG Gate terminal of which specifications are provided in the annex

It can be observed that the majority of facilities are located in North Western Europe, due to the recently introduced strict emission requirements. Current EU policy requires at least one LNG bunkering port in each member state. Approximately 10% of European coastal and inland ports will be included, a total of 139 ports. Coastal port LNG infrastructure will be completed by 2020; inland port infrastructure will follow by 2025.

Additionally, there are several ports under development in North America, mostly in the south east, the Gulf of Mexico and around the Great Lakes, but also for ferry and deep-sea operations in the Pacific Northwest. China is extending LNG bunkering infrastructure from inland waterways to coastal areas and is expected to be able to service the LNG demand of all vessel types. South Korea offers LNG bunkering in the port of Incheon and is considering a second facility in Busan. Elsewhere in Asia, in addition to Singapore, Japan and Australia are also working to develop LNG bunkering facilities.[10]

It is noted that the LNG bunkering market has not yet developed to a similar degree in the South Asia region, despite the bunkering potential resulting from the strategic position near the main trade routes. It is expected that in the future this market may further develop, triggered by stricter regulations on emissions in this region. Currently, the demand for LNG bunkering among vessels in the Bay of Bengal area, which could be a key target market for Trincomalee, is considered insufficient for the envisaged development.

Figure 9-9 LNG Bunkering Facilities



Source: https://sea-lng.org/bunker-navigator/

Environmental and Social Aspects

If it is deemed necessary to develop a floating storage LNG terminal in Trincomalee Port, the Clappenburg peninsula has been selected as the most suitable location. The construction of a LNG facility is a 'prescribed project' requiring conducting a full Environmental Impact Assessment (EIA).

The area has touristic value. No information is available on its ecological resources. It is imperative that the area be investigated for the presence of corals along its shore and/or other ecologically sensitive habitats.

[10] https://sea-lng.org/lng-as-a-marine-fuel/bunkering-infrastructure/

9.11 Sampur Area Energy Development

Several plans for development of energy plants for the Sampur area have been considered by the government. The two proposed coal plants have been cancelled by the government. No definitive decision has been taken yet as the energy development at Sampur. The possibilities include but are not limited to:

- An LPG fired power plant;
- A coal fired power plant;
- Solar panels.

Obviously, in case of a solar farm no marine side facilities are required, but in the former two cases, SLPA can provide facilities.

LPG (Option A)

To supply LPG the gas powered station an LNG jetty can is projected in the bay close to the power plant. The jetty should have a length of 280 m and a depth of CD -14 m. This is sufficient to handle an 80,000 cbm design vessels. The connection to the power plants would be through pipelines. A jetty in Sampur area will however be prone to possibly high swells from the north easterly monsoon. Alternatively, a jetty can be constructed in the port of Trincomalee and then connected by pipeline. This would provide sheltered mooring. It can also be supplied by a FPSO, a floating storage unit for LNG with a re-gasification unit onboard. The later is described under a separate paragraph. The location and type of the jetty (Gas or LNG) and the pipeline connection paths are fundamental issues which shall be assessed when the location of the gas power station has been appointed.

Coal (Option B)

Figure 9-10 depicts possible locations of the plant and the jetty necessary to accommodate the dry bulk vessels. The location has been chosen based on the natural water depth in the region. The jetty has a length of 400 m with a depth of CD -20m. to accommodate large capesize vessels of approximately 180,000 DWT. Despite that fact that these large ships can have considerable waves at berth, it is to be noted that probably for 4 to 5 months a year the jetty cannot be used due to the Monsoon. This can be overcome through supply by a new rail from the Trincomalee port during that period. The most efficient option would however be to ship the approximate 2 M tons of coal annually needed for a 1000 MW energy plant directly to Sampur outside the Monsoon season.

Figure 9-10: Sampur Coal Plant & Jetty

Environmental and Social Aspects

Sampur is situated on the opposite (southeast) side of Koddiyar Bay. The development of a new power plant would be subject to conducting a full Environmental Impact Assessment study.

Recent plans for a Sampur coal-fired power plant have been cancelled. It however should be noted that the required EIA for the coal-fired power-plant had been approved by the CEA (in 2016).

With the LNG (re-gasification) facility at Clappenburg Island, there would also be a possibility to construct a gas-fired power station in the area connected by gas pipeline from the facility. A new EIA for the gas-fired power-plant, jetty and pipeline will have to be made once the location for the power plant is firm.

Technical Assistance Consultant's Report

Project Number: 50184-001
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Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Trincomalee Port Development Plan – Volume 3 (Part 3)

Prepared by

Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

9.12 Dock Yard

The dock yard in Mud Cove can be expanded as presented in Figure 9-11. These options can only be developed if private initiatives see market potential. SLPA would then be responsible for the road connection to the facility. SLPA service vessels are to remain at the Ashroff jetty due to the distance between these facilities.

Figure 9-11: Options Accommodation Dock Yard

Environmental and Social Aspects

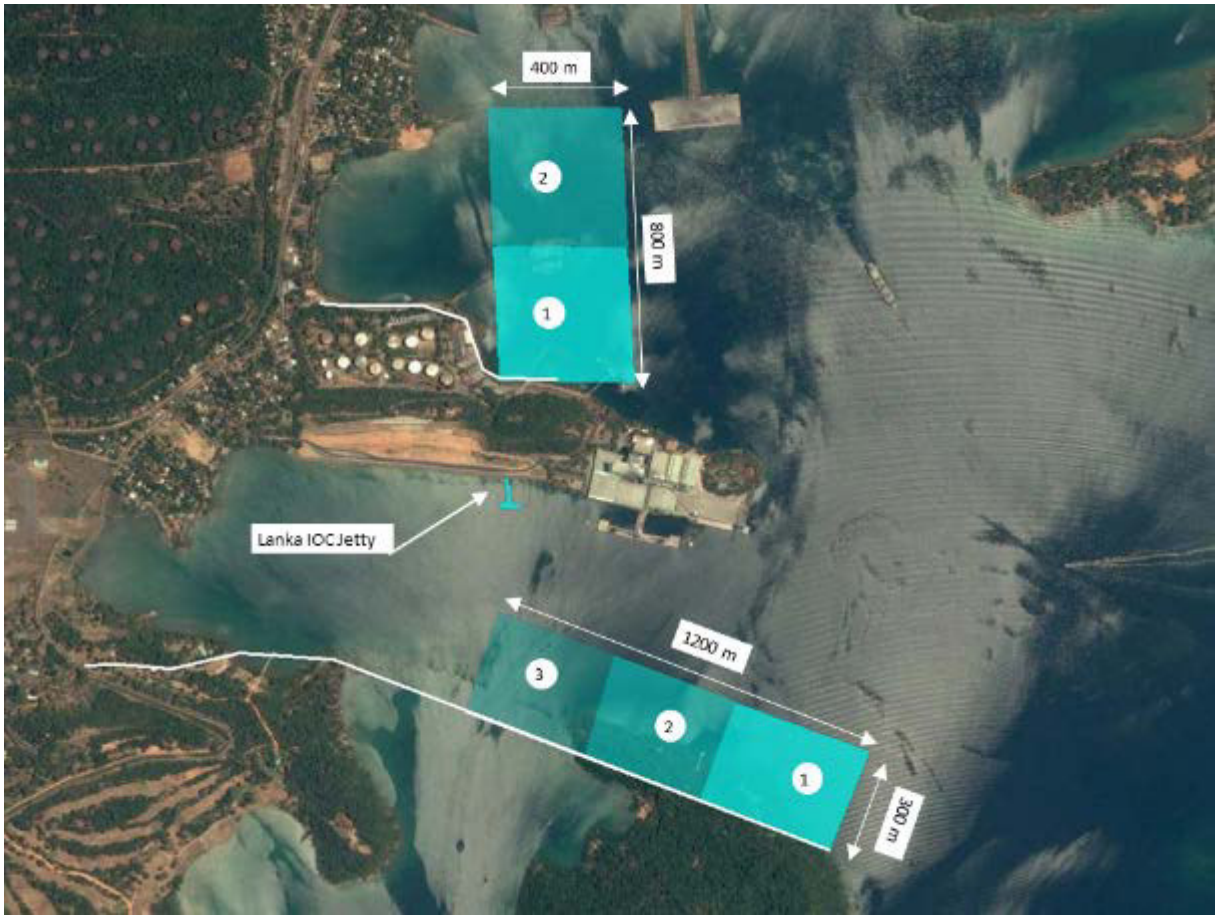
In this proposed development, the natural coast line is severely affected as the hill will need to be partly removed. This is a serious concern for the ESIA of such a project.

9.13 Container Terminal

The demand for containers in Trincomalee is still highly uncertain; the initial demand can be handled at Ashroff Jetty. In case a dedicated terminal is needed, the first option would be to construct it in three phases on Sobar Island. This design will need a bridge to cross to the island for connectivity.

In case the Sobar Island option is deemed unfeasible due to environmental issues, a second option would be to construct a terminal in two phases between Lanka IOC and the Ashroff Jetty. The SLPA Oil berth should then be replaced.

Figure 9-12: Two Options Accommodation Container Terminal



Environmental and Social Aspects

The preliminary container terminal at Sobar Island is expected to encounter environmental constraints because of the ecological value of the island. An ESIA should therefore be carried out to ascertain the feasibility of constructing a container terminal at the Sobar Island site.

The secondary option, next to the Ashroff Jetty, has significant dredging and reclamation requirements along the quay; however, construction in this area is less likely to result in environmental issues.

9.14 Tambalagam Bay Development

SLPA owns several plots of land adjacent to Tambalagam bay. The potential for large scale port water side development is deemed low by the consultant because of its (nautical) characteristics:

- It is shallow with deepest point at CD -3 m. Dredging is costly and needs to be frequent as it is in a river delta area which requires constant dredging. Also, the stretch to be dredged is approximately 5 km from the access bridge to the corner near SLPA plot 21;
- Access is blocked with a low bridge which could be turned into a tunnel with accompanying costs of development;
- The airport fly route inhibits ships passing close to it.

It is possible though to develop the area for small scale development like fish farming or fishery as such[11]. The plots are thus not ideally suited for water-based development, but they are strategically located for non-water-based industries.

Figure 9-13: Chart Tambalagam Bay

Environmental and Social Aspects

Tambalagam Bay is an ecologically sensitive area. Development of the bordering land (now in use mainly for extensive paddy cultivation) for industry or commercial services should be well planned and managed to prevent:

- any discharge of waste water or drainage water into Tambalagam Bay;
- disposal of solid waste into Tambalagam Bay; and

[11] Water depth and water quality may cause constraints in the development of a fish farming in Tambalagam Bay

- spills of liquid chemicals or fuel.

Of course, development of the land along Tambalagam Bay will provide economic opportunities and increased employment opportunities. However, commercial fish farming in the Bay should be prohibited. It might help to give the Tambalagam Bay a protected status.

10 Project Identification and Selection

10.1 Introduction

This chapter outlines the selection of the short-term priority projects to the pre-feasibility phase. For pre-feasibility, three high level studies are performed:

- Financial feasibility;
- Economic feasibility; and
- Environmental and social impact analysis.

The 2 projects selected for pre-feasibility for the port for Trincomalee are:

1. Ashroff Jetty Phase 1 Upgrade Plan
2. Deep-water Oil Jetty Construction

Reading Guide

- The selection process is done through an analysis method outlined in 10.2.
- A description of the identified short-term priority projects is provided in section 10.3.
- Section 10.4 presents the selection results for the short-term priority projects which will be studied in more detail in the pre-feasibility phase.
- Paragraph 10.5 explains the methodology applied to the Financial and Economic Pre-Feasibility Analysis.
- The results of Pre-Feasibility projects are presented in section 10.6.

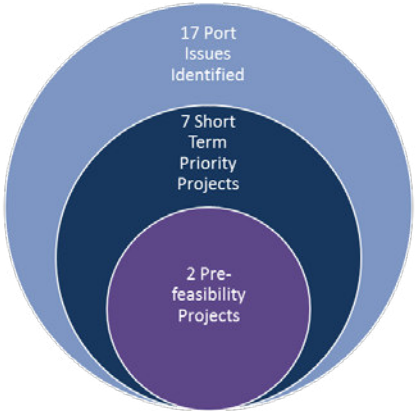
Please note that the short-term priority projects concern pressing matters on itself which SLPA should solve in the coming years. Thus, the fact that projects are not selected for pre-feasibility, does not mean that they should not be prioritised.

10.2 Selection Methodology

In the figure below an overview is given of the numbers involved in the selection process. The port issues are identified on the basis of:

- Site visits and observations;
- Desk Research;
- Stakeholder consultations.

Figure 10-1: Overview Project Numbers



Source: MTBS

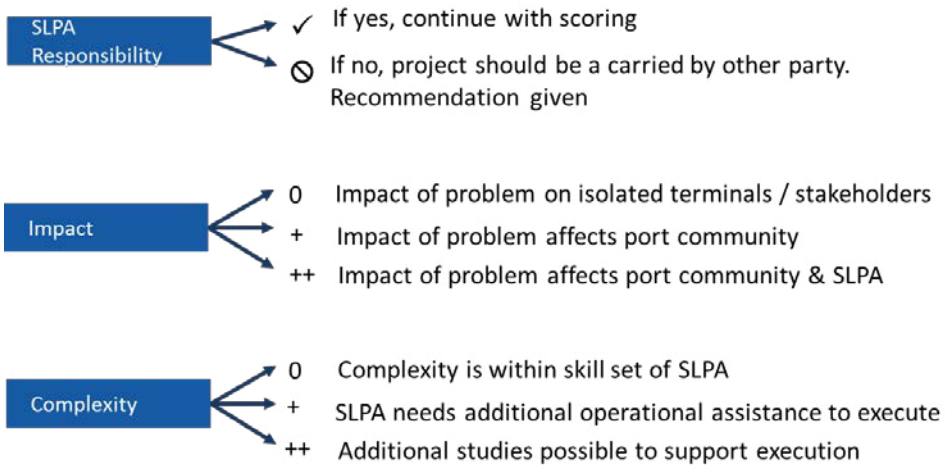
The short-term priority projects are identified then based on:

- The severity of the issue;
- Low / Medium / High ;
- Short-term means <10 years.

These 7 projects are then scored on the basis of:

- Whether or not it is a SLPA responsibility;
- The complexity;
- The impact.

Figure 10-2: Explanation scoring



Source: MTBS

A minimum score of three is needed to be selected. As displayed in diagram below.

Figure 10-3: Selection Threshold

Source: MTBS

10.3 Short-term Priority Projects Description

The table below describes the short-term priority projects identified.

Table 10-1: Trincomalee - Short-Term Priority Projects

Category	Priority Project	SLPA Responsibility
Mud Cove Rehabilitation / Access road development		
Infrastructure	Mud Cove is in a deteriorated state with damages to the quay wall, slipway and obsolete vessels obstructing operations. The severity is categorised as low as a private party is interested in acquisition of the property for which it could handle the repairs. In this case, the private party would want a longer lease. Access to the facility should be guaranteed though by SLPA in case of leasing of land. One can think of paving of the access way.	Partly
Rehabilitation and Extension of the Rail Connection to the Ashroff Jetty		
Infrastructure	The extension of the railway project is essential for the functioning of the Ashroff Jetty as the location for bulk throughput. Current operations with cargo being loaded on trucks from vessels is highly inefficient and time consuming. The transfer of dry bulk by trucks to the hinterland can be categorised the same. The expansion of the railway is key for current operations and future operations of TTA and the Ashroff Jetty, thus the expansion should be realised as soon as possible.	Yes
Port Access Road Development		
Infrastructure	A connection starting from A15 near Lanka IOC heading North West will make it possible for port traffic to bypass the city traffic to A6. The land between road and rail can be used for industrial development.	Yes
SLPA Land Use Plan		
Zoning	The Trincomalee Port Zoning Report is a step in identifying the ports future needs to continue to think about which lands are lands needed to be uninhabited for port development. A displacement plan, set-up years in advance will ensure a smooth process.	Yes, in co-operation with government
Ashroff Jetty Upgrade Phase 1		
	A belt system is needed to reduce inefficiencies of trucking to the Ashroff Jetty and to accommodate future cargoes. Land reclamation, the extension of the quay, new road development, new equipment amongst other should be included in the plans.	Yes
Navigations Aids		
Safety	For night time navigation the port needs lights, buoys and lighthouses to ensure safety. Maintenance can be outsourced to private parties. SLPA will be remunerated for these costs by increased traffic to the port for which it will receive port dues.	Yes

Category	Priority Project	SLPA Responsibility
Deep-water Oil Jetty		
Operations	Lanka IOC currently sees a steep increase in demand for bunkering fuels for vessels on the east-west trade. Additionally, the refined oils demand which include fuels are set to increase in Sri Lanka with the tank farm in Trincomalee being a prime distribution location	Yes

Source: MTBS

10.4 Selection Results Short-Term Priority Projects

The table below displays the selection results for the short-term priority projects which will be studied in more detail in the pre-feasibility phase.

- Mud cove rehabilitation is in principle to be outsourced to a private party if a deal can be reached;
- The rail connection on itself does have a significant impact on port operations, but the project can be considered a straight forward infrastructure development project;
- The same reasoning for the port access road development can be applied;
- The SLPA land use plan is an important document for SLPA. This report has the components of that plan, detailing should be done by SLPA. For this project, no financial calculations are needed;
- The Ashroff jetty upgrade will encompass many elements from land reclamation to warehousing location;
- Navigational aids deployment is a straight forward project with a big impact on port operations as it allows for night time navigation of vessels;
- The deep-water oil jetty will allow for the growth of the current Lanka IOC facility and will significantly increase handling capacity of the port.

Table 10-2: Scoring Short-Term Priority Projects

Short-Term Priority Projects	SLPA Responsibility	Impact	Complexity	Score
Mud Cove Rehabilitation / Access road development	✓ ⊘ Private Parties	**0**	**0**	**0**
Rehabilitation and Extension of the Rail Connection to the Ashroff Jetty	✓	**++**	**0**	**++**
Port Access Road Development	✓	++	0	++
SLPA Land Use Plan	✓	+	+	++
Ashroff Jetty Upgrade Phase 1	✓	**++**	**+**	**+++**
Navigation Aids	✓	++	0	**++**
Deep-water oil jetty.	✓	**+**	**++**	**+++**

Source: MTBS

10.5 Methodology Financial and Economic Pre-Feasibility Analysis

10.5.1 Objective

The objective is to indicate whether or not the identified projects are viable from a financial, economic, social and environmental perspective. As a rule, it is recommended to implement a project, if it is economically viable. The financial viability determines whether or not government and/or public funding will be required. In case it is also financially viable, then there is no need for government subsidy.

Table 10-3: Methodology Pre-feasibility Projects

Economically viable	Financially Viable	Recommendation
✓	✓	• Implement the project • Project generates sufficient return to recover the investments
✓	✗	• Implement the project • Government/SLPA subsidy is needed or the tariffs should be redefined to make the project financially feasible as well
✗	✗	• Don't implement the project • It is very unlikely that a project is feasible
✗	✓	• Don't implement the project • This is a very unlikely scenario[1)]

1) It could be financially viable and economically not, if developing a project leads to a shift in volumes. In that case the project generates revenues that are a loss for a different project within the same economy. Another possibility for this scenario could be severe negative environmental or social impacts.

10.5.2 Framework for the Studies

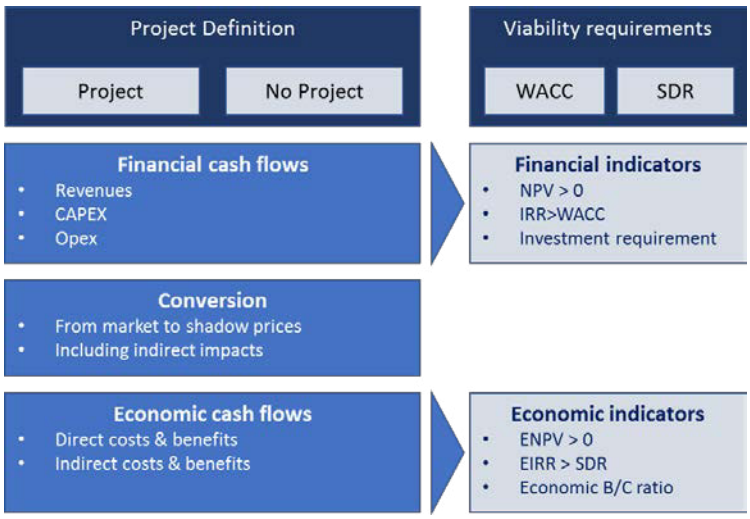
The basic set-up or framework for the studies is as follows.

1. **Background to the Project** – A description of the priority project in general, initial observations and the problem and bottlenecks to be solved.
2. **Supporting Analyses** – This analysis differs per pre-feasibility. The JCT modernisation plan will need a thorough operational analysis whereas the BQ warehousing relocation plan needs a location analysis.
3. **Project Scope -** A clear and concise definition of project scope as input for the financial, economic and environmental analyses
4. **Financial Pre-Feasibility** – A high-level financial pre-feasibility assessment resulting in project NPV and IRR.
5. **Economic Cost-Benefit Analysis** – A high-level economic benefit analysis resulting in economic NPV and IRR.
6. **Environmental and Social Impact Analysis** – A high-level ESIA resulting in mitigation measures for the environmental and social impact of the project.

10.5.3 Approach to Prefeasibility

The general approach to the financial and economic prefeasibility is visualised in the following figure.

Table 10-4: Methodology Pre-feasibility Projects



- Starting point is the **definition of the project**. Since SLPA has the choice to implement a project or not, the project case should be compared with the "non- project case".
- Secondly, one should understand, when a project is deemed to be viable. For the financial pre-feasibility, the weighted average costs of capital (WACC) is relevant as hurdle rate. For the economic pre-feasibility, the social discount rate (SDR) is considered as hurdle rate.
- Then, the **financial cash flows** like investments (capex), revenues and operational expenditures (opex) are defined to arrive at a project free cash flow.
- This project free cash flow is used to calculate the **financial indicators**. The project is considered to be financially viable, in case the internal rate of return (IRR) exceeds the WACC. In that case the net present value (NPV), the sum of the discounted expected free cash flows, is positive. If the project is financially feasible, it is recommended to implement the project. The funding requirement is added to indicate the budget that is needed to implement the project.
- The financial cash flows, which are based on market prices, are **converted** into economic cash flows, based on shadow prices.
- The conversion results in **economic cash flows**. Indirect costs and benefits are added. Those can include quantified social and environmental impacts.
- These **economic indicators**, based on the economic free cash flows eventually indicate whether the project is considered viable from an economic point of view. This is the case if the economic internal rate of return (eIRR) exceeds the SDR. In that case, the economic net present value (ENPV) is larger than zero and the economic benefit-cost ratio exceeds one.

10.5.4 Basic Assumptions

Considering the pre-feasibility character of the analyses, some basis assumptions are applied to all analyses. The following table summarises some key assumptions applied here.

Item	Value	Comment
FINANCIAL		
Perspective	SLPA	The port projects are typically part of broader project plans. For the financial analysis, SLPA's perspective is taken as a basis.
WACC SLPA	10%	No official WACC or hurdle rate for financial viability is known.
Inflation	-	As a pre-feasibility analysis, the model is in real terms
Currency	USD	
Sri Lanka Rupee exchange rate / USD	153.4	Per 1st of December 2017
Tax Rate	10%	According to the SLPA's Financial statements: • Operational profits from port operations are exempt (Inland Revenue Act) • The subsidiary company is liable for the tax at 10% • For other sources of income, the tax rate is 28%.
Modelling period	2018-2050	
Basis for revenues	SLPA tariff book SLPA financial report Interviews with SLPA	Tariffs are elaborated on in the individual pre-feasibility study sections
ECONOMIC		
Perspective	Sri Lanka	
Social Discount Rate	7.8%	Based on calculation: r = e*g + p • e: elasticity of marginal social welfare with respect to public expenditure: 1.5 (estimate, typically between 1 and 2) • g: expected per capita consumption growth: 4.35% (IMF projection real GDP per capita growth) • p: pure tie preference: 1.3 (empirical studies)
Conversion factor CAPEX:	1.0	No evidence for market distortions. It is likely that an important part is to be imported. In that case, the "border prices are to be applied.
Conversion factor OPEX: • Fuel, maintenance, insurance	1.0 0.85	No evidence for market distortions. Based on an average income tax of 15%

- Labour

Conversion factor Revenues:	> tariff WTP	"Willingness to Pay" The applied tariffs are based on the tariff book and not on market efficiency. For the ECBA, the "Willingness to Pay" (WTP) is relevant as revenues. The applicable official tariff is a lower limit of this WTP (else the volumes wouldn't come with these tariffs). If the project – with the official tariffs is already economically viable, then it is not needed to estimate the higher WTP. Else, an estimate will be made on a case-by-case basis.
Allocation factor	1.0	All economic costs and benefits are in principle allocated to Sri Lanka. Only for external impacts, with foreign businesses, the allocation factor may become less than one (between 1 and 0)

10.6 Results Pre-Feasibility Projects

SLPA Deep-water Oil Jetty

The below shows the results of the economic and financial feasibility analysis for the deep-water oil jetty. The Project is **not financially feasible** due to the high CAPEX investments in the superstructure required. The business case did not include the investments necessary by Lanka IOC which includes piping infrastructure.

The project **is economically feasible** because of high potential transport costs savings which Trincomalee imports provide. These can be attributed to Lanka IOC; thus, the recommendation is to further negotiate funding with the parties involved.

An alternative would be the construction of a CBM instead of a jetty. The investments for such a project are much lower, but the new arrangement does not allow for expansion of bunkering operations sought after by Lanka IOC.

Table 10-5: Results Financial and Economic Pre-Feasibility Analysis

Project	Financial Feasibility		Economic Feasibility		Recommendation
Deep-water Oil Jetty / CBM	✗	NPV -8.1 M USD IRR: 4.2%	✓	ENPV: USD 85.1 M USD ERR: 29.11%	Implement Project with additional funding, possibly by LANKA IOC

Ashroff Jetty Upgrade

The below shows the results of the economic and financial feasibility analysis for the Ashroff Jetty expansion. The first phase of the Ashroff Jetty expansion project is **financially feasible**. Additionally, the project is **economically feasible**.

Table 10-6: Results Financial and Economic Pre-Feasibility Analysis

Project	Financial Feasibility		Economic Feasibility		Recommendation
Ashroff Jetty Upgrade	✓	NPV 3.9 M USD IRR: 10.98%	✓	ENPV 19.8 M USD ERR: 11.75%	Implement Project

11 Ashroff Jetty Expansion

11.1 Background to the Project

Increased demand and operational bottlenecks for the Ashroff Jetty multi-purpose terminal operated by SLPA in Trincomalee creates the need for expansion of the current quay structure. Currently the following activities take place on the Jetty:

- Coal handling, ship-to-shore operations;
- Clinker handling, ship-to-shore operations;
- Occasional handling of general cargo vessels;
- Occasional handling of cruise vessels.

The current berth is overutilized and the storage area on SLPA lands is not sufficient to cater to future growth. This expansion plan will entail:

- The first phase of expansion of the jetty indicated (label A) on the map;
- The landfill for upgraded storage area (label D);
- Storage sheds to rail connection (F);
- Service jetties (E &C);
- The expansion of the rail to the storage area.

Figure 11-1: Expansion Ashroff, Railway and TTA

A	Phase 1 Ashroff Jetty expansion	F	Possible location coal stock pile
B	Phase 2 Ashroff Jetty expansion	G	SLPA land plot FVP 17
C	100m service jetty for tug boats	H	Rail expansion from China Bay station to Ashroff

D	Land reclamation	I	New road development
E	Service pier (CD -3m)		

11.2 Supporting Analyses

11.2.1 Infrastructure Development

Existing Infrastructure

The Ashroff Jetty is T-shaped with a jetty head of dimensions 257 x 91 m. The main quay is 257m long with a corresponding water depth of CD -12.5m. (initial design depth: CD -13.0 m).

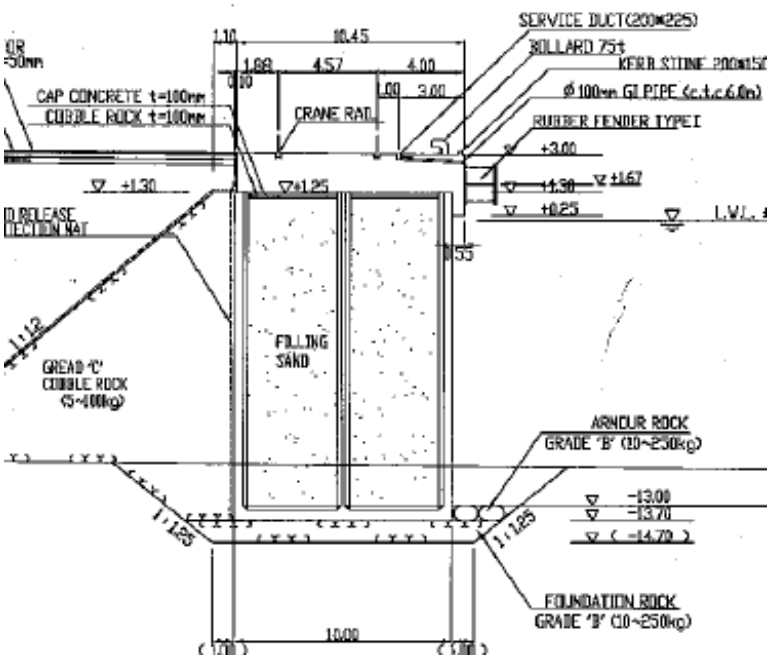
Secondary berths are available along the two short ends of the jetty head with water depths of approximately CD -9.0 m.

Figure 11-2: Apron Jetty

The quay is designed as a gravity structure based on RC caissons of dimension 10.0m perpendicular to the quay alignment. The base of the caisson is at CD -13.7 m

The caissons are founded on a bedding layer of rock with thickness of 1.0 m.

Figure 11-3: Main Quay Cross Section



According to available soil information the natural soil underneath the caisson bedding is termed 'rock'. Caissons are ballasted with sand fill. There is a shoulder embankment on the land side termed 'cobble rock'. The rock is separated from the general sand fill of the reclamation by a geotextile filter.

Caissons are topped with a cap of in-situ RC concrete above the low water level. The crest level is CD +3.0 m.

The jetty head is fully paved with a pavement of asphalt concrete. The surface was designed to be uniformly sloping from the rear of the jetty head towards the quay front with run-off of rainwater into the sea.

The jetty-head is connected to the shore with a causeway which is basically a sand embankment with rock protection towards the sea at the two sides. The crest width is 23 m of which the central 10.0 m are paved and constitute the access road.

Observations

Based on visual observations during a brief visit to the site, jetty structures appeared to be in a good condition with no apparent malfunctions.

The only comment relates to a general, uniform settlement at the interior of the jetty which is assumed to be due to some densification of the sand fill over time. This has resulted in a local depression in the full length of the quay some 10-15 m behind the quay front to a level lower than the quay front. At the time of the site visit the depression zone was filled with 5-10 cm of standing water.

Figure 11-4: Quay Alignment and Water Accumulation

Proposed Development

The proposed development includes the following components as shown in the figure below:

- An extension of the existing quay with 50m (from 250 m to 300 m) with a water depth of CD -12.5 m;
- A new quay of 300 m length with a water depth of CD -14.0 m[12];
- An extension of the jetty head area (A) with approximately 5.5 ha;
- A service jetty (C) of approximately 100 m for tugs etc.

The alignments of the quay extension and of the new quay are in accordance with existing seabed contour lines (CD -10.0 m to CD -11.0 m) to minimise the amount of dredging works.

The different dry bulk vessel classes, including the number of vessel calls in Trincomalee over the last 3 years for each of the classes, are presented in the table below.

Table 11-1: Dimensions overview dry bulk vessels

Dry bulk vessels	DWT (tons)	LOA (m)	Beam (m)	Draught (m)	2015 (Vessels)	2016 (Vessels)	2017 (Vessels)
Handysize	10,000 - 40,000	140 - 180	22 - 28	8.0 - 10.5	7	10	10
Handymax (supramax)	40,000 - 65,000	169 - 200	31 - 32.4	9.8 - 12.3	6	14	16
Panamax (incl. new)	67,000 - 99,000	223 - 233	32 - 48	13.2 - 14.1	-	-	-
Capesize	100,000 - 200,000	250 - 300	43 - 50	14.2 - 18.5	-	-	-

[12] During detailed design phase it should be investigated whether it is feasible to construct the quay at CD -16m or -17m to create options for future deeper draft vessels through additional dredging.

Ultra Large Cape	250,000 - 320,000+	300 - 360	50 - 64	18.0 - 24.0	-	-	-

Expected dry bulk at the Ashroff Jetty will be dominantly 'Handymax' and occasionally 'Panamax'. Judging from the soil investigations carried out in connection with the construction of the jetty (investigations do not cover the extension) there is an apparent risk that dredging to -14m may involve hard materials (described as 'weathered rock' or 'rock'). The soil conditions are estimated to be suitable for a gravity quay wall solution.

The existing water depths in the area of the reclamation can be assumed at CD -6.0 m to CD -9.0 m approximately. From a rough calculation, the following volumes are estimated:

- Dredging: 100,000 m^3
- Reclamation: 550,000 m^3

Additional Works

Additional works considered in Trincomalee near the Ashroff Jetty development project include:

- Extension of storage area by nearshore land reclamation: (≈ 2.5 ha);
- Extension of rail track to storage area: (≈ 1,000 m);
- Service pier for small boats.

Storage area works will include shore protection and pavement.

Cost Estimates

Preliminary cost estimates have been prepared for the proposed Ashroff Jetty extension and for the following development projects with the aim to assess capital cost requirements.

The cost estimates are based on an actual cost level in the international market and on several assumptions regarding the physical conditions at the sites and regarding the nature of the works, matters to be clarified in future stages of project development.

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
01			Ashroff Quay				
	01		**Dredging & Reclamation**				
		01	Platform piles	m^3	100,000	18.00	1,800,000.00
		02	Platform piles	m^3	550,000	6.00	3,300,000.00
	02		**Quay Works**				
		01	Extension of existing quay (-12.5m)	m	50	24,000.00	1,200,000.00
		02	New quay (-14m)	m	315	29,000.00	9,135,000.00
		03	Quay equipment	m	350	1,800.00	630,000.00
		04	Revetment	m	270	3,000.00	810,000.00
	03		**Pavement**				**0.00**
		01	New pavement	m^2	55,000	65.00	3,575,000.00
		02	Utilities	Sum	1	1,000,000.00	1,000,000.00
	04		**Miscellaneous Works**				
		01	Rail extension (≈1km)	Sum	1	1,000,000.00	1,000,000.00
		02	Service jetty	m	100	12,000.00	1,200,000.00
		03	Service Pier	Sum	1	500,000.00	500,000.00
		04	Land reclamation	m^2	25,000	30.00	750,000.00
		05	Pavement	m^2	25,000	50.00	1,250,000.00
		06	Shore protection	m	250	500.00	125,000.00
	05		Subtotal				26,275,000.00
	06		Site installation costs	10%			2,627,500.00
	07		Planning and design	5%			1,313,750.00
	08		Contingencies	15%			5,255,000.00

35,471,250.00

11.2.2 Operational Analysis

Dedicated equipment – International Best Practices

- Mobile Harbour Cranes (MHC)
  The current use of ship's gear for vessel unloading activities results in very low productivity levels. Typically, on general cargo berths or dry bulk terminals, the terminal operator installs mobile harbour cranes to operate the vessels. This type of equipment is very flexible and can be used for various types of cargo/commodities. Crane manufacturers offer a range of standard ('off the shelf') mobile harbour cranes with varying sizes and load capacity, depending on the specific requirements.
- Hoppers
  On top of the use of ship's cranes, direct vessel unloading into trucks slows down the process even more. From operational point of view, the vessel unloading process and the subsequent horizontal transport need to be disconnected. Therefore, hoppers are used on most terminals where dry bulk products are discharged. The crane unloads the vessels, drops the cargo into the hopper and can immediately return to the vessel side for the next unloading cycle without waiting for a truck and without time consuming manoeuvring above the truck. Similar to mobile harbour cranes, hoppers can be found in different sizes and functionalities for each specific commodity.
- Conveyor belt system(s) and storage silos
  To develop an export trade of biomass products in the future, dedicated storage facilities will be required as well as environmental friendly transportation systems between the storage area and the quay side. Typically, for grain, wheat and other types of biomass products, silos are used to store the products. This allows efficient use of required storage area in an all-weather environment. Modern dry bulk grain terminals are equipped with a (covered) conveyor belt system between the quay side and the landside storage area. This improves loading and discharging productivity rates and reduces the impact on the environment.

Observations

The following observations can be made regarding the current operations at the Ashroff jetty:

- Currently coal handled by ship gear, towards stockyard and moved into containers and then moved onto rail;
- Discharging with ship's gear directly on berth: Considered to be time consuming and inefficient due to double handling;
- Transport to Port storage area: Creates inefficiency due to double handling, also extra road movements within port area;
- Clinker is discharged to trucks half of which drive directly to the facilities in Puttalam delaying unloading of vessels as they have to wait for the trucks to return from the trip;
- Current storage area is not design for coal storage: Causing both a loss in quality and a loss in volume of the stored coal;
- Dust at storage area is poorly controlled: Only using a few people with water hoses is not sufficient to control the dust;
- High dwell times cause relatively low capacity of storage area: Obviously, when heaps of coal remain in the yard too long, this limits storage capacity.

To mitigate the time-consuming handling with ship's gear, the dusty operations of coal and inefficient storage methods, three options are considered in discussions with SLPA.

Options for Future Operations

Option 1 – Coal discharge directly in rail wagon on quay

This option is a clean option as dust from operations is minimised, however there are several downsides of this option:

- The proposed first phase development of the jetty does not offer enough room for the train rails to make the bend towards the jetty;
- The large investments are not justified with Ashroff jetty volumes.

Figure 11-5: Visualization Option 1

Option 2 – Discharge via hoppers into truck, truck into stock pile and or directly into rail wagon
The option of loading coal and clinker with ship's gear or quay cranes into hoppers and trucks is feasible with lower volumes. This is the preferred options for the Ashroff Jetty, though trucks add to operational expenses. For operational efficiency, a decision must be made whether to use ship's gear or quay cranes.

A major current bottleneck is berth utilisation. Vessels take time a long time to unload as often ship's gear differs in productivity and accuracy causing delays and spills. Two grabs on quay would mitigate this issue.

Figure 11-6: Ship's Gear vs Quay Cranes

Option 3 – Belt system and bucket reclaimer

The belt system and bucket reclaimer offer a quick discharge of vessels and quick transfer of the products to the storage. Again, this investment can only be justified with large volumes. A single belt system should be cleaned when switching between coal and clinker, making this operationally challenging.

Figure 11-7: Visualisation Belt System

Required Equipment and Cost Estimates – Option 2

Due to the expected volumes, the most financially suitable option is option 2. The proposed approach of unloading dry bulk vessels at Ashroff jetty will be:

- Ship to truck with mobile harbour cranes;
- Quay to stack with trucks;
- Loading to stack with mobile belt equipment;
- Loading from stack to container;
- Loading container onto rail.

The table below displays the costs overview for the necessary equipment requiring an investment of 9.3 M USD.

Table 11-2: Cost Estimates Ashroff Jetty Equipment

Item	Quantity	Rate (USD)	Cost (USD)
Ashroff Quay Equipment			
Discharging			
Quay Cranes	2	3,500,000.00	7,000,000.00
Hopper	2	40,000.00	80,000.00
Loading to Stack			

Item	Quantity	Rate (USD)	Cost (USD)
Mobile Belt Conveyor	1	15,000.00	15,000.00
Low Hopper	1	20,000.00	20,000.00
Payloader	1	50,000.00	50,000.00
Loading from stack to container			
Mobile Belt Conveyor	1	15,000.00	15,000.00
Low Hopper	1	20,000.00	20,000.00
Loading Hopper	1	10,000.00	10,000.00
Bobcat	1	50,000.00	50,000.00
Loading Container on Rail			
Reach stacker	1	450,000.00	450,000.00
Subtotal			*7,690,000*
Contingencies	15%		1,153,500
Total			**9,252,000.00**

11.3 Pre-Feasibility Ashroff Jetty Expansion

11.3.1 Results Pre-Feasibility

Ashroff Jetty Upgrade

The below shows the results of the economic and financial feasibility analysis for the Ashroff Jetty expansion. The first phase of the Ashroff Jetty expansion project is **financially feasible**. Additionally, the project is **economically feasible**.

Table 11-3: Results Financial and Economic Pre-Feasibility Analysis

Project	Financial Feasibility	Economic Feasibility	Recommendation
Ashroff Jetty Upgrade	✓ NPV 3.9 M USD IRR: 10.98%	✓ ENPV 19.8 M USD ERR: 11.75%	Implement Project

11.3.2 Project Scope

To assess and present the financial and economic impact of the envisaged project, a project case and non-project case are defined:

- **Project Case** – SLPA invests in: (i) extension of quay (ii) operational upgrade (iii) rail line to Ashroff jetty (iv) resettlement of people for rail line.
- **Non-project Case** – No additional investments, Ashroff jetty operations continue as they were.

Revenue estimations for the storage sheds / to be constructed warehouses are not considered in hit analysis. It is expected that SLPA will offer these at cost to parties interested in using these.

The table below describes the elements of the cases further:

Table 11-4 Ashroff Jetty Expansion - Project Scope

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Operations at current quay until 2019; operations at renewed quay commence in 2020.	Continuous
Service Level	Panamax vessels, with capacities between 50,000 and 80,000 DWT, can be accommodated at the port. *	50,000 tons vessel remain the maximum.
Business Case Scope	Until 2050	Until 2050
Throughputs	Additional throughputs can be accommodated at the jetty.	Dry bulk throughputs at the Ashroff Jetty are capped at the estimated current capacity of 450,000 tons per annum.

**Water depth of CD -14m enables berthing of medium-sized or not fully loaded Panamax vessels.*

11.3.3 Capacity Berths & Forecasts

Capacity Berths

The table below first indicates the berth capacities for the project case and the non-project case. Currently, operations at Ashroff jetty are conducted with ship's gear. The vessels often have to wait for trucks headed to Puttalam to return for the operations to continue. In the project case this situation should be resolved by directly trucking to the stack, which increases berth productivity significantly.

Table 11-5 Berth Capacities

Item	Project Case	Non-project Case
Number of Berths	2	1
Number of cranes per berths	2	1
Operational Hours per Year	7,200 hrs	7,200 hrs
Berth Utilisation	41%	41%
Type of Crane	Mobile harbour crane, two per berth	Quay crane, one per berth
Crane Productivity	1000 ton/hr	150 ton/hr
Capacity Jetty	**5,900,000 tons**	**450,000 tons**

Forecasts

Table 11-6 shows the difference between the two forecasts in the project case and non-project case. Subsequently, Table 11-7 and Table 11-8 detail the forecasts for the project case and non-project case, respectively. In the non-project case, volumes are expected to only grow slightly, due to the capacity restriction. The operational and infrastructure upgrade in the project case allows for more business to the jetty, specifically:

- Additional estimated coal for smaller manufacturers (other than the cement companies) estimated at 80,000 tons per annum. In the non-project case, 10,000 tons per annum of this additional coal throughput can be accommodated.
- Ilmenite and biomass exports can take place.

Table 11-6: Total Project Case and Non-project case

'000 Tons	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Demand Project Case	440	670	705	1,440	1,475	1,510	1,545	1,720	1,720	1,720
Demand Non-Project Case	440	450	450	450	450	450	450	450	450	450
Difference	**-**	**230**	**265**	**1,000**	**1,035**	**1,070**	**1,105**	**1,280**	**1,280**	**1,280**

Table 11-7: Project Case – Forecast

'000 Tons	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Cargo Discharged										
Coal Puttalam	120	120	120	120	120	120	120	120	120	120
Coal Other	-	80	80	80	80	80	80	80	80	80
Clinker Puttalam	220	220	220	220	220	220	220	220	220	220
Gypsum Puttalam	100	100	100	100	100	100	100	100	100	100
Total Discharged	*440*	*520*	*520*	*520*	*520*	*520*	*520*	*520*	*520*	*520*
Cargo Loaded										
Biomass	-	-	-	700	700	700	700	700	700	700
Ilmenite	-	150	185	220	255	290	325	500	500	500
Total Loaded	*-*	*150*	*185*	*920*	*955*	*990*	*1,025*	*1,200*	*1,200*	*1,200*
Total Demand	**440**	**670**	**705**	**1,440**	**1,475**	**1,510**	**1,545**	**1,720**	**1,720**	**1,720**
Berth Capacity	5,900	5,900	5,900	5,900	5,900	5,900	5,900	5,900	5,900	5,900

Table 11-8: Non-project Case – Forecast

'000 Tons	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Coal Puttalam	120	120	120	120	120	120	120	120	120	120
Coal Other	-	10	10	10	10	10	10	10	10	10
Clinker Puttalam	220	220	220	220	220	220	220	220	220	220
Gypsum Puttalam	100	100	100	100	100	100	100	100	100	100
Total Discharged	440	450	450	450	450	450	450	450	450	450
Total Loaded	-	-	-	-	-	-	-	-	-	-
Total Demand	**440**	**450**	**450**	**450**	**450**	**450**	**450**	**450**	**450**	**450**
Berth Capacity	450	450	450	450	450	450	450	450	450	450

11.3.4 Financial Pre-feasibility

Revenues

For the calculations for revenues for the jetty, a revenue per ton rate is calculated based on currently applied tariffs for (i) dirty bulk cargo (coal) and (ii) other bulk cargo (tariffs used in the revenue per ton calculation are presented in Table 11-10). The revenue per ton calculation was based on the *current* design vessel for coal for the project case and non-project case, because the results were roughly equal for both vessels. The applied tariff is 9.26 USD per ton for coal and 7.51 USD per ton for the other dry bulk commodities.

Table 11-9 Ashroff - Design Vessels Coal

Item	Current Design Vessel	Future Design Vessel
		
Name	Grace Ocean	Amami
Vessel Class	-	-
Gross Tonnage (GT)	21,220	52,186
Deadweight Tonnage (DWT)	33,296	98,681
Estimated Call Size (Tons)	25,000 tons	35,000 tons*
Vessel Class	Handysize	Mini-Cape
LOA (m)	180	240
Beam (m)	28.2	38.0
Draught (m)	10.1	14.5

*Coal demand is coming from manufacturers in limited call sizes of 25,000 to 35,000 tons. Other commodities like biomass will frequently require Panamax class vessel up to mini-cape vessels for export. In view of this and possible new commodities the future design vessel is mini-cape.

Table 11-10 Ashroff Jetty - Marine Services and Handling Tariffs

Tariff Item	Unit	Value	Tariff Item	Unit	Value
Light Dues	USD / 100 GT	4.00	Tug Service Fee	USD / Tug / Hour	350.00
Entering Dues	USD / 100 GT	5.00	Dockage Fee	USD / 100 GT / Hour	0.22
Pilotage Fee	USD / 100 GT	5.00	Landing & Delivery Fee	USD / Ton	2.00 / 1.50*
Pilot Fee	USD / Movement	32.00	Cargo Handling Dry Bulk	USD / Ton	6.25 / 5.00**

*USD 2.00 per ton for coal (delivered to yard / warehouse); USD 1.50 per ton for other commodities (direct delivery)
**USD 6.25 per ton for coal; USD 5.00 per ton for other commodities

OPEX

Based on previous MTBS benchmarks for dry bulk terminals, the OPEX per ton rate varies between 0.5 USD per ton to 1.5 USD per ton depending on the level of capital intensity. For the project case the capital intensity of operations is increased due to the purchase of several quay cranes and other handling equipment. In the non-project case the operations would be relatively labour intensive as is the case right now. The OPEX per ton rates used are:

- Project case: USD 1.30 per ton
- Non-project case: USD 0.80 per ton

CAPEX

The CAPEX investments are expected in 2019, whilst operations start for the project case start in 2020. The total investment for the Ashroff Jetty upgrade is estimated at USD 47.0 M and consist of:

- Equipment - USD 8.8 M
- Jetty Expansion - USD 35.5 M including rail
- Costs of resettlement - USD 2.7 M (the resettlement costs are included because they can be directly attributed to the expansion)

The asset lifetime of the infrastructure is assumed to last throughout the full operational period. For equipment, the following asset lifetimes are assumed:

- Quay cranes – 15 years (reinvestment in 2034; no reinvestment in 2049 because it is close to the end of the business case scope)
- Other equipment – 10 years (reinvestment in 2029 and 2039; no reinvestment in 2049 because it is close to the end of the business case scope)

Results Financial Feasibility

The feasibility is based on the incremental cash flows, to provide insight in the value that is created by developing the Ashroff Jetty. The table below summarizes the financial results. The presented cash flows result in the following financial performance indicators:

- NPV (10% WACC): USD 3.9 M
- Payback period: 10 years (from the start of operations in 2020)
- IRR: 10.98%

Hence, it is concluded that the project is financially feasible.

Table 11-11 Ashroff Jetty – Financial Feasibility

'000 USD	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Incremental Revenues	-	1,776	2,039	7,562	7,825	8,088	8,351	9,666	9,666	9,666
Incremental OPEX	-	(511)	(557)	(1,512)	(1,558)	(1,603)	(1,649)	(1,876)	(1,876)	(1,876)
Incremental CAPEX	(46,993)	-	-	-	-	-	-	-	-	-
Incremental Tax	-	(77)	(55)	402	423	445	467	576	576	576
Free Cash Flow	(46,993)	1,342	1,537	5,648	5,844	6,040	6,236	7,215	7,215	7,215

11.3.5 Economic Pre-Feasibility

For the Ashroff Jetty expansion, economically the upgrade will bring some efficiency benefits to the imports. Possibly, additional import capacity of dry bulk to the region; however, the impact of these is limited. The main difference between the financial and economic cash flows is the omission of taxes in the economic cash flows.

The table below summarizes the converted economic cash flows. To calculate the Economic NPV (ENPV), a social discount rate of 7.83% is applied. This results in the following economic viability indicators:

- ENPV (@ 7.83%): USD 19.8 M
- ERR: 11.75%

Hence, it is concluded that the project is economically viable.

Table 11-12 Ashroff Jetty – Economic Feasibility

	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Benefits										
Incremental Revenues	-	2,702	2,829	5,513	5,640	5,768	5,896	6,535	6,535	6,535
Costs										
Incremental CAPEX	(46,993)	-	-	-	-	-	-		-	-
Incremental OPEX	-	(592)	(620)	(1,208)	(1,236)	(1,264)	(1,292)	(1,432)	(1,432)	(1,432)
Economic Cash Flow	**(44,315)**	**2,110**	**2,209**	**4,305**	**4,404**	**4,504**	**4,604**	**5,103**	**5,103**	**5,103**

11.4 Environmental and Social Impact Assessment

11.4.1 Environmental Aspects

- Archaeological Impact Assessment to be done with AD. The historical nature of this harbour buildings is important to be highlighted and the proposed development needs the archaeological study to be undertaken to find out whether any archaeological important artefacts or building be affected with the proposed activities.
- A plan for dredging and dredge spoil disposal is to be done as per USEPA protocol. As for the Colombo Port there is no designated place for dredged material be disposed of at the Trincomalee Port. Hence, it is crucial to identify a location devoid of any possible adverse impacts for the disposal of dredged material. Especially the areas where coral patches are found and recorded by IUCN need to be avoided. The regular spotting of sperm whales, blue whales and dolphins in the outer harbour is also relevant. These areas need to be avoided for disposal of dredged material. TCLP tests need to be done to investigate the contamination potential of the receiving site due to the disposal of dredged material.
- Blasting activities are to be regulated. GSMB clearance and guidance need to be looked for in blasting of rock boulders that could be found in the sea bottom and even in the alignment of the extension of railway and road segments. The vibration and noise levels that will emanate from blasting should be considered and be compared with the permissible levels stipulated by the CEA.
- EIA/IEE or Environmental clearance to be prepared for the entire project. As per the directives given by the ADB Environmental Safeguard Policy Principles, 2009 and CEA regulations environmental clearance should be obtained.
- Material transport, handling to be done with all environmental safeguards in place. Material transport plan, including material exploitation, transport and storage needs to be worked out. All metal quarries, sand mines, and soil burrowing sites need to be scrutinized to avoid the imminent adverse impacts.
- The proposed coal yard should be protected from unintentional fire, air-borne particles etc.; The coal yard is to be designed in a manner that it would not create fire break-ups inadvertently. With the strong winds and inherent heating up within the coal heaps, fire episodes may be inevitable, but all measures need to be in place to exert full control. Such a fire occurred in the Norochcholai where a coal-fired power plant is located, and wind barriers has been introduced to control any unintentional fire break-ups. Other port activities are highly vulnerable if such fires break up and hence care should be exercised to plan it so that no such fires are to come out. Moreover, this type of coal heaps with strong winds under fickle weather could result in air-borne suspended particles and they could get deposited in the downwind direction even a couple of km away resulting in inconvenience to areas affected.
- Hydrodynamic studies are to be undertaken to ascertain calm conditions. Such studies are a usual requirement and a prerequisite for the environmental clearance by the relevant authorities such and CEA and MEPA. These studies would entail advection modelling, sediment modelling and perhaps shoreline changes with wave modelling etc. These studies help identify adverse scenarios during dredging, particularly the fate of a dredge material plume so that measures can be designed to avoid the smothering impacts especially for the flora and fauna inhabiting the site. The numerical simulation of dispersion of the dredged materials has to predict the effects on corals. The dispersion should remain limited to the dredging area itself. However, if any dispersion would extend near to the coral reefs, silt curtains shall be provided for protection thereof.
- The environmental sensitivity of the alignments for both the road and rail extensions should be investigated. Detailed investigations are to be carried out to understand the likely physical and ecological impacts of the extension of road and rail to the port premises. From figures 1 and 2 it is envisaged that no sensitive areas will be affected by the extension of road and rail.
- The Impacts on corals are to be investigated. Coral patches are known to exist in the Outer Harbour basin. The smothering effects by dredged particles and coving by oil pollution are major threats.
- Recommendations are to be made concerning facilities and staff required to combat oil spills. At present the Trincomalee harbour appears to be ill-prepared for oils spills. With the growth of the number of

vessels, the urgency to provide adequate facilities and means (as per the guidelines stipulated by MEPA) increases.

- Impacts of possible pollution, also from other existing port activities need to be studied. There is no comprehensive exercise on pollution potential undertaken by the SLPA. Hence it is difficult to assess the degree of pollution over time. Deterioration of water and sediment quality deterioration is a risk associated with the proposed activities. Therefore, monitoring is vital to be carried out.
- Plans for loading and unloading procedures needs to be worked out with contingency plans so that adverse impacts (from accidents/malfunctioning) could be addressed effectively.
- To assess the impacts from clearing of bush jungle ecological studies should be undertaken. This will establish the presence of ecologically valuable/sensitive ecosystems, and the presence of commercially valuable trees. Efforts must be made to avoid touching sensitive ecosystems or felling of such trees, as practical as possible.
- IEE/EIA studies need to be done for the extension/upgrading of the port and for the construction of the proposed railway line and road.

11.4.2 Social Aspects

The proposed railway line from the Ashroff jetty towards China Bay station, over a distance of about 1 km will cross land, now in use as residential and horticulture land. The land required for the proposed railway and road is owned by SLPA. Most of the occupants of land required, do not have title to their lands. They are illegal occupants but have lived on those land holdings for over 40 years. Most of the present occupants were born in the premises where they occupy at present, probably handed over to them by their parents or siblings. The cultural impact to them is not as large as to those who were in possession of private lands through inheritance.

Of the 116 plots to be acquired and possessed (see Table 1), 38 are encroachments where SLPA has to take possession. Of those 38, there are 18 permit holders, of them 14 are in possession of land grants under the "Jayabhoomi" concept of the government. These permits are considered as freeholds; their holders are entitled to receive compensation in the event of acquisition unless the permit holders are willing to accept land for land. The 4 households in possession of permits under Land Development Ordinance are not entitled for compensation on acquisition. Annex 3 of the Environmental Report presents the steps to be followed in the land acquisition process.

There are 50 permanent buildings and 2 temporary buildings on the land plots occupied by encroachers and permit holder's. In some plots there are more than one buildings. Of 58 plots the occupants are not known. Most likely it is a matter of users not resident in the area; their ownership status can only be ascertained at the title determination inquiries under LAA when the acquisition process commences.

It is noted that the above data is based on the survey plans prepared by the Department of Survey on the request of SLPA in 2011. Information on any increase in encroachments could be obtained only after a fresh survey. Such survey should be conducted in the framework of a preparing a Resettlement Action Plan.

Table 11-13: Details on land to be acquired for railroad construction

FVP No *	TL No.*	Lots-Range	No. of Lots	Permit Holders		Gardens /Occupants Not Known		Encroachers		Other land (Jungle)	
				No	Extent ha	No	Extent ha	No	Extent ha	No.	Extent ha
17	192B	B2-15	14	3	0.4196	5	0.6511	4	0.3912	2	0.7759
18	192C	A1-24	17	1	0.0975	11	0.5174	4	0.1945	1	1.1117
18	192C	A25-46	20	2.	0.531	9	0.2905	9	0.4332	0	0
18	192C	A47-67	18	5	0.3061	6	0.2917	6	0.2817	0	0
18	192C	A68-87	17	3	0.0682	9	0.3928	6	0.1556	0	0
18	192C	A88-99	10	0	0	6	0.3193	4	0.1887	0	0
18	192C	B1-11	11	3	0.2519	3	0.1192	5	0.2876	0	0
18	192C	B12-20	9	1	0.0911	8	0.4676	0	0	0	0
Total			116	18	1.7654	57	3.0496	38	1.9325	3	1.8876

* Final Village Plan
* TL: Tenement List
Source: Department of Survey and SLPA 2011

- Area of land plots to be acquired /possessed from the FVP 17 is = 2.2 ha;
- Area of land plots to be acquired /possessed from the FVP 18 is = 6.4 ha;
- The extent land required for the priority projects in Trincomalee Port is 8.6 ha;
- Total number of land plots to be acquired /possessed by the SLPA is 116.

The above totals do not include paths and roads.

Measures related to land acquisition and resettlement

Measures mitigating the impacts from land acquisition and resettlement fall under the following categories (a concise description of these measures is presented in ANNEX 4 of the Environmental Report):

- Compensation for the loss of assets and employment;
- Assistance to AP's in relocation and rehabilitation;
- Income rehabilitation;
- Establish Grievance Redress Mechanism;
- Make institutional arrangement to attend to gender concerns.

All these measures should be formulated and elaborated in a Resettlement Action Plan (RAP). The organizational arrangement for the implementation of the RAP are described in detail in ANNEX 5 of the Environmental Report

We have made a provisional estimate of the total compensation cost of land acquisition and resettlement, based on occupancy information of 2011. Considering the cost of land, structures and other entitlements, **the total cost estimate would amount to Rs.409, 750,000 or USD=2,678,104 (for 1 US$ = Rs.153).**

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12 Deep-water Oil Jetty

12.1 Background to the Project

Lanka IOC is looking to expand its business as mentioned in the development options. For now, the main expansion prospects identified by Lanka IOC is the bunkering business. The company sees an increasing demand in the market after it could expand the number of tanks available. A bottleneck has arisen with the current jetty, as one jetty is not sufficient to cater for discharging petroleum products and loading bunker barges. Besides these two main uses, Lanka IOC is looking to supply vessels directly with bunkering fuel.

An upgrade of the SLPA jetty could support Lanka IOC with:

- Achieving higher pump rates for bunkering fuels with new installations;
- Receiving larger 80,000 DWT vessels;
- Capturing a larger share in the Bay of Bengal bunkering market

The current jetty superstructure is financed, operated and maintained by SLPA. The pipelines infrastructure is the responsibility of Lanka IOC. A similar deal needs be made for the new SLPA jetty, but only under the condition that the deal is financially viable by SLPA.

12.2 Supporting Analyses

12.2.1 Infrastructure Development

Existing Infrastructure

The Oil Jetty incorporates one berth for alternate unloading of products and loading of bunkering barges. The available water depth is CD -12.75m.

Structures include one central operational platform and two strongpoints for berthing. The platform and the two strongpoints are equipped with fenders and bollards for breasting and mooring. Loading/unloading operations are made exclusively with flexible pipes.

Figure 12-1 Oil Jetty - Central Platform

The platform is connected to each strongpoint with light-weight steel bridges for pedestrian access. The total length of the berth is 120m.

The platform is connected to the shore with same type bridge steel bridge (approximately 80m long) which also provides for support of five pipes (plus water, fume and cabling).

Figure 12-2 Access Bridge

Observations

- The platform and the two strongpoints are assumed structurally designed as gravity structures based on caissons with a topping of in-situ concrete;
- No serious damage or malfunction of the basic structures were observed. However, some concrete surfaces showed traces of light damage due to impacts and wear;
- Steel structures in bridges seemed well maintained with only sporadic traces of corrosion near the water level. All piping appeared to be well maintained with no visible damage.

Proposed Development

The objective of the proposed development is two-fold:

- To prepare for services with larger supply vessels (Afra-max or Suez-max);
- To provide for simultaneous unloading of supply tankers and loading of bunkering barges.

The following table gives an overview of (crude oil) tanker dimensions (copied from PIANC 116).
As a general provision for tanker terminals a keel clearance of approximately 15% of draught is required.

From the table is concluded:

- Minimum depth for Afra-max: 1.15* 15.4 ≈ CD -18.0 m
- Minimum depth for Suez-max: 1.15* 17.0 ≈ CD -19.5 m

Vessel Size Reference	45 000 DWT	Panamax	Afra max	Suez max
Vessel Capacity (DWT)	46 000	73 788	117 000	148 729
Length Over All (LOA) (m)	180	228	250	277.4
Breadth moulded (m)	33.0	32.3	44.0	46.0
Depth moulded to upper deck at midship (m)	19.1	20.6	22.7	23.6
Summer Draught (m)	12.2	14.3	15.4	17.0
Ballast Draught (m)	7.7	7.0	8.6	8.4
Height from Keel to top (m)	46.4	48.1	52.5	59.1
Air Draught Full Ballast (m)	38.7	41.1	43.9	50.7
Displacement - Light Ship (mt)	10 038	14 811	20 050	24 874
Displacement - Summer Draught (mt)	56 215	88 600	120 000	173 603
Displacement - Ballast Draught (mt)	33 406	40 779	66 261	79 452
Transverse (Head On) Wind Area (m^2)	825	965	1 068	1 248
Longitudinal (Broadside) Wind Area (m^2)	2 506	4 438	4 000	4 803
Transverse (Head On) Wind Area (m^2)	715	732	769	866
Longitudinal (Broadside) Wind Area (m^2)	1 927	2 858	2 375	2 778
Deadweight at Design Draught	46 177	73 788	117 055	148 729

Table 14.1.1: Example of Dimensions of Different Classes of Crude Oil Tanker

The following capacity and length were received from LIOC concerning the existing bunkering barges:

- Barge no 1: 3.000 DWT, L = 88 m
- Barge no. 2: 1.100 DWT, L = 75 m
- Barge no. 3: 1.000 DWT, L = 65 m

Apparently - from the available bathymetric data near the tank farm - the requirement for accommodation of large tankers can only be met if a new jetty is constructed at the head of the Prima-peninsular.

The following operational philosophy is assumed at the new jetty:

- The seaside of the new jetty shall be designed for the larger tankers;
- The nearshore side of the new jetty shall be designed for smaller (?) supply vessels and possibly also for barge loading (although the existing jetty may be maintained for this purpose).

A possible location at the required water depth and the proportions of a possible new jetty are schematically shown in the figure below with a Suez-max tanker on the seaside of the jetty and a 50.000 DWT tanker on the shore side.

The facility will include:

- A central platform of approximate size 1,000 – 1,200 m²;
- Four breasting dolphins (minimum);
- Four to six mooring dolphins;
- 1100 - 1200m of access bridge with piping installed above water.

Figure 12-3: Proposed Lay-out of New Jetty

The operational platform shall be structurally independent of the breasting structures for safety. Installations shall include manifolds/ loading arms (number to be optimized according to operational requirements) and all provisions for firefighting etc. Often an open structure with a RC-platform on steel piles proves the most feasible solution at the required water depth.

Dolphins may be composed as pile clusters or based on singular mono-piles of large dimension (to be analysed based on actual soil conditions). Dolphins shall be equipped with specialized fenders and/or quick-release mooring hooks.

Figure 12-4: Mono-pile breasting dolphin (typical)

The Oil Company preferred a similar solution like the existing access bridge. However, larger bridges and pipeline corridors will be required.

12.3 Pre-Feasibility Deep-water Oil Jetty

12.3.1 Results Pre-Feasibility

The financial feasibility of the deep-water jetty is assessing under the assumption that SLPA will finance the walkway and jetty superstructure and Lanka IOC the required pipelines. A concession fee structure can be arranged to compensate SLPA investments, depending on the outcome.

Results Pre-Feasibility Analysis

The below shows the results of the economic and financial feasibility analysis for the deep-water oil jetty. The Project is **not financially feasible** due to the high CAPEX investments in the superstructure required. The business case did not include the investments necessary by Lanka IOC which includes piping infrastructure.

The project **is economically feasible** because of high potential transport costs savings which Trincomalee imports provide. These can be attributed to Lanka IOC; thus, the recommendation is to further negotiate funding with the parties involved.

An alternative would be the construction of a CBM instead of a jetty. The investments for such a project are much lower, but the new arrangement does not allow for expansion of bunkering operations sought after by Lanka IOC.

Table 12-1: Results Financial and Economic Pre-Feasibility Analysis

Project	Financial Feasibility		Economic Feasibility		Recommendation
Deep-water Oil Jetty / CBM	✗	NPV USD -8.1 M IRR: 4.2%	✓	ENPV: USD 85.1 M ERR: 29.11%	Implement Project with additional funding by possibly LANKA IOC

12.3.2 Project Scope

To set-up the business case a project case and non-project case are defined:

- **Non-project Case** – Lanka IOC continues operations with current SLPA jetty.
- **Project Case** – SLPA constructs the new jetty infrastructure and walkway. Lanka IOC invests in the pipeline infrastructure.

The table below describes the elements of the cases further:

Table 12-2 IOC Deepwater Jetty - Case Details

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Starts in 2020	Continuous
Service Level	Afra-max tankers (+/- 80,000 DWT) can be handled on the 300m outer berth. Vessel bunkering operations can be handled on the inside as well as barge bunkering. Barge bunker loading operations can continue on the old jetty.	Barge bunker loading operations can continue on the old jetty.
Business Case Scope	Until 2050	Until 2050
Throughputs	No operational bottleneck. Increase in refined oil imports for domestic consumption can be catered to as well as increase in bunker fuel demand.	Operational bottleneck reducing berth capacity to +/- 1,000,000 tons of throughput.

The project scope and investment divisions are as follows:

Table 12-3 IOC Deepwater Jetty - Cash Flow Allocation

Item	Cash Flow Attribute To
Revenues	
Regular fees and charges per tariff book	SLPA
Concession fee / royalty charges	To be negotiated by parties
Business operations revenues	Lanka IOC
Deep-water Oil Jetty Capex	
Basic Structures	SLPA
Piping and Installations	Lanka IOC
Operational Expenses	
Maintenance and repair Basic Structures	SLPA
Maintenance and repair Piping and Installations	Lanka IOC

12.3.3 Financial Pre-feasibility

Financial Model Assumptions

The table below summarizes the main financial model assumptions.

Table 12-4 IOC Deepwater Jetty - Main Assumptions

Item	Value	Comment
WACC SLPA	10%	Source SLPA on Passenger Terminal
USD / Sri Lanka Rupee exchange rate	USD 153.4	Per 1st of December 2017
Tax Rate	10%	Effective tax rate SLPA
Depreciation CAPEX Infrastructure	2%	Depreciation in 50 years
Depreciation CAPEX Equipment	10%	Depreciation in 10 years

Forecast

Non-Project Case

The main volume assumptions for the non-project case are:

- Bunkering is fixed, estimated at 360,000 tons annually. Lanka IOC reports 15,000 tons per month of bunkering fuel demand this multiplied by 2 for loading and unloading and multiplied by 12 yields the annual results;
- The refined oil forecast is derived from the national forecast;
- Throughput is capped at 794 thousand tons as the jetty capacity[13].

Project Case

The main volume assumptions for the project case are:

- Bunkering throughputs are increased to reflect market capture due to capacity upgrade;
- The refined oil forecast is derived from the national forecast;
- Throughput is not capped. Total capacity is over 3 M tons.

Table 12-5 IOC Deepwater Jetty - Forecast

	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2035
Non-project Case												
Forecast Trincomalee Refined Oils	'000 Tons	303	375	454	541	634	733	837	948	1,064	507	817
Bunkering Non-project case	'000 Tons	360	360	360	360	360	360	360	360	360	360	360
Total forecast NPC*	**'000 Tons**	**663**	**735**	**794**	**794**	**794**	**794**	**794**	**794**	**794**	**794**	**794**

[13] Berth utilization = 40%; Operational hours= 3,600; Average pump speed= 600 kilo litre / hour

	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2035
Project Case												
Forecast Trincomalee Refined Oils	'000 Tons	303	375	454	541	634	733	837	948	1,064	507	817
Bunkering Project Case	'000 Tons	360	360	360	720	720	720	720	720	1,000	1,000	1,000
Total forecast PC	**'000 Tons**	**663**	**735**	**814**	**1,261**	**1,354**	**1,453**	**1,557**	**1,668**	**2,064**	**1,507**	**1,817**
Total Incremental Volumes	**'000 Tons**	**-**	**-**	**20**	**467**	**560**	**658**	**763**	**874**	**1,270**	**713**	**1,022**

*Forecast is capped at berth capacity of 794 thousand tons

Revenues

The revenues for the SLPA comprise income from marine services and potential concession fees or royalties per ton.

Marine Services

The table below presents the current and future design vessel for the IOC terminal. For the calculation of the marine services fees, the future design vessel characteristics have been applied for both the project case and the non-project case, as the differences in fees are minimal between the vessels.

Table 12-6 IOC Oil Terminal - Design Vessels

Item	Current Design Vessel	Future Design Vessel
		
Name	Island Express	Gem No. 3
Vessel Class	Handysize	Long Range 1
Gross Tonnage (GT)	27,969 GT	44,389 GT
Deadweight Tonnage (DWT)	45,728 DWT	79,920 DWT
LOA (m)	179.80 m	219.06 m
Draught (m)	11.97 m	13.80 m
Estimated Call Size (Tons)	40,000 Tons	75,000 Tons

Subsequently, the table below presents the SLPA marine services tariffs that are applied to the identified design vessel to estimate the marine services revenues. Cargo handling fees are not allocated to the SLPA, as

it is expected that Lanka IOC will carry out the cargo handling operations. The design vessel and tariffs result in an average marine service fee of USD 0.34 per ton.

Table 12-7 IOC Deepwater Jetty - Marine Services Tariffs

Tariff Item	Unit	Value	Tariff Item	Unit	Value
Light Dues	USD / 100 GT	3.40	Tug Service Fee	USD / Tug / Hour	200.00
Entering Dues	USD / 100 GT	4.50	Dockage Fee	USD / 100 GT	0.22
Pilotage Fee	USD / 100 GT	4.55	Landing & Delivery Fee	USD / Ton	0.22
Pilot Fee	USD / Movement	32.00			

The table below summarizes the revenues generated from marine services provided by SLPA.

Table 12-8 IOC Deepwater Jetty - Marine Services Revenues

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Port Dues	M USD	0.23	0.25	0.27	0.43	0.71	0.52	0.71	0.81
Non-Project Case									
Port Dues	M USD	0.23	0.25	0.27	0.27	0.27	0.27	0.27	0.27
Difference									
Port Dues	M USD	-	-	-	0.16	0.44	0.25	0.44	0.54

Concession Fee

The assumed (incremental) concession fee or royalties that IOC should be willing to pay to the SLPA are calculated through a shipping cost savings analysis. The table below presents the key assumptions for the shipping costs savings calculation.

Additionally, the following 2 assumptions are made:

- The SLPA is able to fully capture IOC's financial benefits from deploying larger vessels;
- IOC can compensate its own incremental CAPEX (see Table 12-14) and resulting maintenance OPEX through the additional profits resulting from importing additional volumes under the project case scenario. If this is not the case, IOC will require some of the transport cost savings to achieve a viable business case for the development.

Table 12-9 Shipping Cost Savings -- Main Assumptions

Item	Unit	Value
Assumed Loading Port	Name	Fujairah, UAE
Discharging Port	Name	Trincomalee, Sri Lanka
Distance Between Ports	NM	2,094
Empty Return	Yes / No	Yes
Total Distance	NM	4,188
Average Sailing Speed	Knots	14
Travel Time Roundtrip	Days	12.46

Subsequently, the table below presents the vessel-specific data and the resulting costs per ton of oil products for each of the design vessels. It can be observed that using the larger tanker vessels results in an estimated cost saving of USD 1.81 per ton.

Table 12-10 Shipping Cost Savings - Price per Ton

Item	Unit	Island Express	Gem No. 3	Difference
Daily Charter Rate	USD	13,000	13,500	500
Round Trip Travel Time	Days	12.46	12.46	-
Vessel Call Size	Tons	40,000	75,000	35,000
Price per Ton	**USD**	**4.05**	**2.24**	**(1.81)**

Subsequently, the difference in the price per ton is applied to the non-project case volumes; no cost savings are considered for the volumes that are not brought to Trincomalee in the non-project case. The resulting cost savings are presented in Table 12-11.

Table 12-11 Shipping Cost Savings - IOC

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Handysize Transport Costs	M USD	-	-	-	3.22	3.22	3.22	3.22	3.22
LR1 Tanker Transport Costs	M USD	-	-	-	1.78	1.78	1.78	1.78	1.78
Transport Costs Savings	**M USD**	**-**	**-**	**-**	**1.44**	**1.44**	**1.44**	**1.44**	**1.44**

Total Revenues

The table below presents SLPA's total incremental revenues.

Table 12-12 IOC Deep Sea Jetty - SLPA Incremental Revenues

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Incremental Port Dues	M USD	-	-	-	0.16	0.44	0.25	0.44	0.54
Transport Costs Savings	M USD	-	-	-	1.44	1.44	1.44	1.44	1.44
Transport Costs Savings	**M USD**	**-**	**-**	**-**	**1.60**	**1.87**	**1.68**	**1.87**	**1.97**

OPEX

The following assumptions are applied for the estimation of the OPEX:

- Operational costs related to the provision of marine services – It is assumed that the labour and fuel OPEX related to the provision of marine services amount to 50% of the marine services revenues.
- Infrastructure maintenance – A benchmark figure of 1.00% of CAPEX (as detailed in Table 12-14) per annum is applied.

The table below summarizes the OPEX items for all three cases.

Table 12-13 IOC Deepwater Jetty – OPEX

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Infra Maintenance Costs	M USD	-	-	-	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)
Marine Services OPEX	M USD	(0.11)	(0.13)	(0.14)	(0.22)	(0.36)	(0.26)	(0.36)	(0.41)
Total OPEX	M USD	(0.11)	(0.13)	(0.14)	(0.45)	(0.59)	(0.50)	(0.59)	(0.64)
Non-Project Case									
Infra Maintenance Costs	M USD	-	-	-	-	-	-	-	-
Marine Services OPEX	M USD	(0.11)	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Total OPEX	M USD	(0.11)	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Difference									
Infra Maintenance Costs	M USD	-	-	-	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Marine Services OPEX	M USD	-	-	-	(0.08)	(0.22)	(0.12)	(0.22)	(0.27)
Total OPEX	M USD	-	-	-	(0.32)	(0.45)	(0.36)	(0.46)	(0.51)

CAPEX

The capital expenses are projected for 2019, with the jetty becoming operational in 2020. It is assumed that the piping and installations are invested by Lanka IOC and are outside the SLPA business case.

Table 12-14 IOC Deepwater Jetty – CAPEX Items

Basic Structure (SLPA)		Piping and Installations (Lanka IOC)	
Platform piles	2,000,000	Piping	3,500,000
Platform superstructure	2,000,000	Mechanical works	2,000,000
Dolphins	7,000,000	Electrical and Instrumentation	1,000,000
Fenders and mooring hooks	750,000		
Access bridge	5,750,000		
Subtotal	**17,500,000**		**6,500,000**
Site installation costs -10%	1,750,000		650,000
Planning and design - 5%	875,000		325,000
Contingencies - 15%	3,500,000		1,300,000
Total	**23,625,000**		**8,775,000**

The table below summarizes the CAPEX for the project case, the non-project case, and the incremental case (differential between the project case and non-project case).

Table 12-15 IOC Deepwater Jetty – CAPEX

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Infra CAPEX	M USD	-	-	(23.63)	-	-	-	-	-
Non-Project Case									
Infra CAPEX	M USD	-	-	-	-	-	-	-	-
Difference									
Infra CAPEX	M USD	-	-	(23.63)	-	-	-	-	-

Feasibility

The feasibility is based on the incremental cash flows, to provide insight in the value that is created by developing the deep-water oil jetty. Furthermore, no taxes are considered for the feasibility assessment.

The table below summarizes the financial results. The presented cash flows result in the following financial performance indicators:

- NPV (10% WACC): USD -8.07 M
- Payback period: 18 years
- IRR: 4.20%

Hence, it is concluded that the project is not financially feasible.

Table 12-16 IOC Deepwater Jetty – Financial Feasibility

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Revenues	M USD	-	-	-	1.60	1.87	1.68	1.87	1.97
OPEX	M USD	-	-	-	(0.32)	(0.45)	(0.36)	(0.46)	(0.51)
Operational Cash Flow	M USD	-	-	-	1.28	1.42	1.32	1.42	1.47
CAPEX	M USD	-	-	(23.63)	-	-	-	-	-
Investment Cash Flow	M USD	-	-	(23.63)	-	-	-	-	-
Pre-Tax Free Cash Flow	M USD	-	-	(23.63)	1.28	1.42	1.32	1.42	1.47

12.3.4 Economic Pre-Feasibility

For the IOC Deepwater Jetty project, the following economic benefits and costs are foreseen:

- Costs
  - Incremental CAPEX
  - Incremental OPEX
- Benefits
  - Incremental Revenues
  - Landside Cost Savings

It can be observed that the economic cash flows for the IOC deep-water jetty project are similar to the financial cash flows, except for the landside cost savings. Landside cost savings are expected to be achieved through the following process:

- In some years during the forecast period, the refined oil demand in the Trincomalee region (estimated as a radius of approximately 100 km around Trincomalee) cannot be handled at the Trincomalee port, due to the current facility's calculated capacity cap of 794,362 tons per annum.
- Hence, once the facility's capacity is 100% utilized for refined oil imports (it is assumed that refined oil imports have a priority over bunkering activities), the excess demand is imported through Colombo Port under the no project case.

- Assuming similar shipping costs for refined product carriers towards Colombo and Trincomalee, the additional distance that has to be covered by truck from Colombo to serve part of Trincomalee's hinterland area results in additional landside transport costs. These costs are considered costs to the economy and can be avoided by implementing the additional capacity as envisaged in the project case scenario.

The following assumptions are applied for the calculation of the landside cost savings. Subsequently, Table 12-18 presents the estimated landside transport cost savings. It is noted that, between 2025 and 2030, excess demand diminished. This is due to the assumption that the envisaged refinery in Hambantota will commence operations, decreasing the need for refined oil imports. Once the refinery is working at full capacity, excess refined oil demand will arise again.

Table 12-17 IOC Deep Sea Oil Jetty - Landside Transport Cost Savings Assumptions

Item	Value
Assumed area that will be served by Colombo in No Project Case	Dambulla
Distance – Colombo to Dambulla	150 km
Distance – Trincomalee to Dambulla	100 km
Distance Saving	50 km
Trucking Cost per TonKm	1.50 USD
Cost Saving per Ton	75.00 USD

Table 12-18 IOC Deep Sea Oil Jetty - Landside Transport Cost Savings

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Excess Refined Oil Demand	Tons	-	-	-	-	269,958	-	272,299	563,856
Cost Saving per Ton	USD	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Landside Cost Savings	M USD	-	-	-	-	20.25	-	20.42	42.29

Subsequently, the financial cash flows need to be converted to economic cash flows to assess the economic feasibility of the project. To that end, conversion and allocation factors are applied to each of the identified cash flows. It is assumed that all cash flows can be attributed to Sri Lanka's economy; as such, all allocation factors are set to 1.0. The table below presents the assumed conversion factors for each of the economic cash flow conversions.

Table 12-19 IOC Deepsea Oil Jetty - Economic Conversion Factors

Item	Conversion Factor	Justification
Incremental CAPEX	0.9	It is expected that a substantial part of inputs will be imported. As such, potential import duties and other additional costs should be subtracted from the market prices to arrive at the economic prices. For the CAPEX, a conservative conversion factor of 0.9 is applied.

Incremental OPEX	1.0	Maintenance is the largest incremental OPEX item, representing approximately 80% of the costs. As no market distortion is apparent for this item, the conversion factor is set to 1.0.
Incremental Revenues*	1.0	No market distortions are apparent.
Landside Transport Cost Savings	1.0	

*Incremental revenues already include the seaside transport cost savings; as such, the seaside transport cost savings are not added separately, as that would result in double counting of the benefit.

The table below summarizes the converted economic cash flows. To calculate the Economic NPV (ENPV), a social discount rate of 7.83% is applied. This results in the following economic viability indicators:

- ENPV (@ 7.83%): USD 85.09 M
- ERR: 29.11%

Hence, it is concluded that the project is economically viable.

Table 12-20 IOC Deepsea Oil Jetty - Economic Cash Flows

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Benefits									
Incremental Revenues	M USD	-	-	-	1.60	1.87	1.68	1.87	1.97
Landside Transport Cost Savings	M USD	-	-	-	-	20.25	-	20.42	42.29
Costs									
Incremental CAPEX	M USD	-	-	(21.26)	-	-	-	-	-
Incremental OPEX	M USD	-	-	-	(0.32)	(0.45)	(0.36)	(0.46)	(0.51)
Economic Cash Flow	**M USD**	**-**	**-**	**(21.26)**	**1.28**	**21.66**	**1.32**	**21.84**	**43.76**

12.4 Environmental and Social Impact Assessment

Environmental Aspects

- Archaeological Impact Assessment to be done with AD, same as for Ashroff Jetty;
- Plan for dredging and dredge spoil disposal to be made as per USEPA protocol, like for Ashroff Jetty;
- Blasting activities to be regulated, same as for Ashroff Jetty;
- EIA/IEE or Environmental clearance to be prepared for the entire project, same as for Ashroff Jetty;
- Material transport, handling and storage to be done with all environmental safeguards in place, same as for Ashroff Jetty;
- Hydrodynamic studies to be undertaken for calmness be maintained, same as for Ashroff Jetty;
- Environmental sensitivity to be investigated for pipeline extension;
- Impacts on corals to be investigated, same as for Ashroff Jetty;
- Oil spill combat requirements to be investigated, same as for Ashroff Jetty;

- Impacts of possible pollution, particularly from other existing port operations to be studied, same as for Ashroff Jetty;
- Potential impacts of loading and unloading of oil and bunkering to be investigated;
- Oil spill contingency plan to be worked out with the provision of spill recovery equipment;
- Risk assessment for oil pipeline and storage and bunkering be studied. This study should look into the possible bursts of pipes, structural failures, sabotages, wear and tear, corrosions and other pipe material deteriorations, fire hazards, natural disasters etc.;
- A possible geo-technical analysis of the sea bed is necessary before placing the CBM.

12.5 Alternative option: Conventional Buoy Mooring system (CBM)

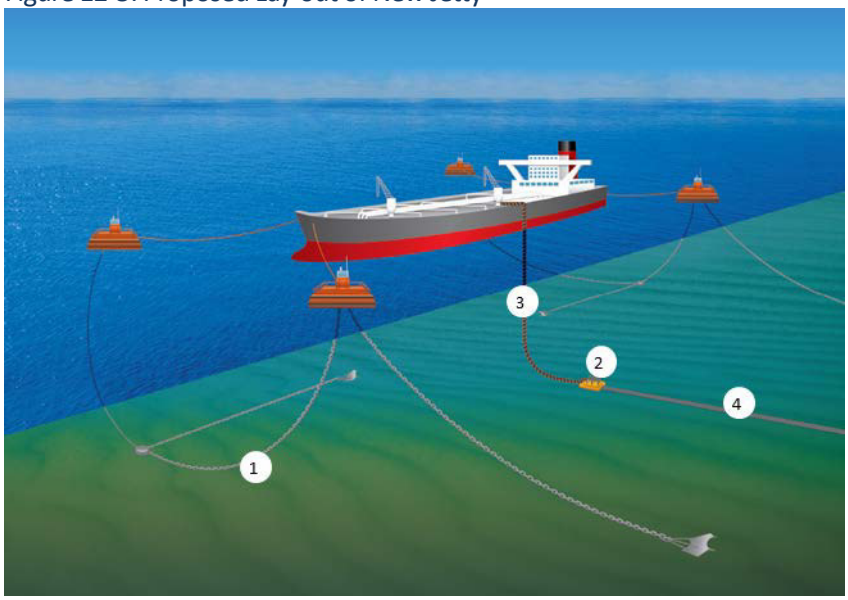
12.5.1 Introduction

The construction of a new deep-water oil jetty requires considerable capital investments. As mentioned in the previous section, the capex is estimated at around USD 23 million, including design engineering costs, the civil construction works for the basic structure, installation costs and 15% contingencies. To reduce the initial capex requirements, an alternative option can be proposed: a Conventional Buoy Mooring system (CBM), sometimes also referred to as Multi-Buoy Mooring system (MBM).

12.5.2 Basic concept of a CBM system

Conventional Buoy Mooring systems are in use for the transfer of products such as crude and LPG between liquid bulk tankers and shore facilities. It is a mooring facility consisting of three to eight permanent mooring chains with anchors, holding the vessel in a fixed position. the number of mooring chains is a function of the vessel size, metocean conditions and navigational constraints. The figure below shows the basic concept of a CBM.

Figure 12-5: Proposed Lay-out of New Jetty



1) Multiple buoys (mooring chains with anchor)
2) Pipeline End Manifold (PLEM)
3) Offloading hose, connecting the tanker to the subsea PLEM
4) Subsea pipeline

The CBM system allows the tankers to safely maintain position during loading or offloading activities. Typically, three to four mooring buoys are used for station keeping of the tanker. After mooring the tanker to the buoys, a submerged hose string will be picked up and connected to the midship manifold. The other end of the hose string is connected to a pipeline end manifold (PLEM), which in turn is fixed to a subsea pipeline, transferring the product to/from the onshore installations.

12.5.3 Preliminary layout

At Lanka IOC the current SLPA jetty is not sufficient to cater both for discharging petroleum products and loading bunker barges. The design and installation of a CBM system can result in the following advantages:

- Enabling access for larger vessels at the CBM system, ranging from 50,000 up to 80,000 DWT;
- Increasing berth availability for bunker barges at the current jetty;
- Less capital investment required compared to the construction of a new deep-water jetty.

While the projected Afra-max vessels require a water depth of CD -18.0 m the location of a CBM system will be similar to the proposed location of the new deep-water jetty. In that area, natural water depth of more than 18.0 m is available.

Figure 12-6: Proposed Lay-out of New Jetty

The proposed location for the CBM still allows for unlimited access for cargo vessels to the Ashroff jetty up north and doesn't impact the potential ship lay-up areas south of China Bay.

12.5.4 High level capex estimate

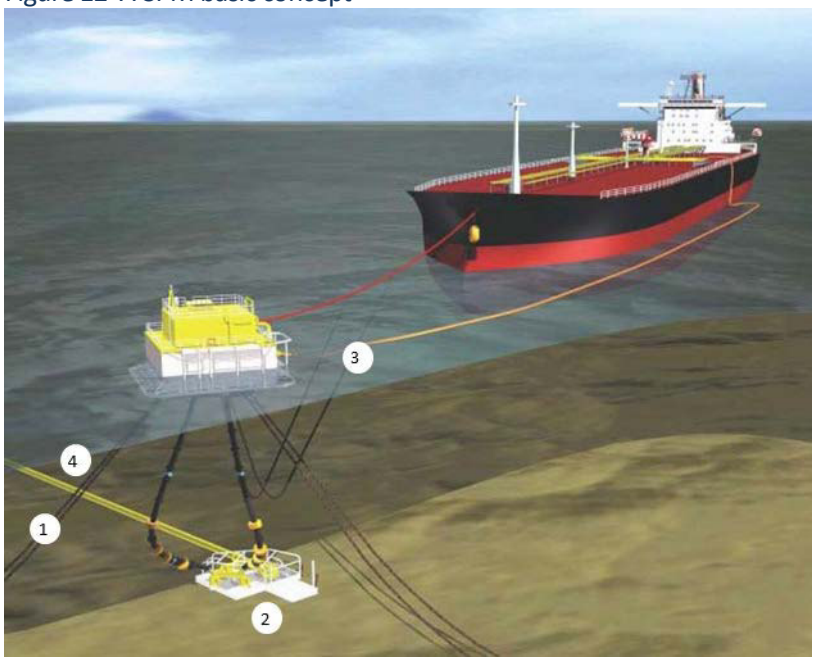
Compared to a new deep-water jetty, a CBM system is much cheaper in terms of investment. Approximately USD 150,000 to USD 250,000 is estimated for the investment per buoy alone. The number of buoys required will depend on the vessel size, metocean conditions and navigational constraints. In general, three to eight buoys (permanent mooring chains with anchors) will be installed to enable safe operations. This corresponds to an initial investment of USD 750,000 to USD 2,000,000.

12.5.5 Third option

Instead of the construction of a new (fixed) deep-water jetty or the installation of a conventional buoy mooring system, another alternative could be proposed, i.e. a Single Point Mooring system (SPM). The single point mooring buoy consists of a buoy that is permanently moored to the seabed by means of multiple mooring lines. The buoy contains a bearing system that allows a part of it to rotate around the moored geostatic part.

When moored to this rotating part of the buoy with a mooring connection, the vessel is able to freely weathervane around the geostatic part of the buoy. As the moored vessel rotates itself into the dominant environment, the system will minimise the loads on the mooring system of the buoy.

Figure 12-7: SPM basic concept



1) Single mooring chain with anchor
2) Pipeline End Manifold (PLEM)
3) Offloading hose, connecting the tanker to the subsea PLEM
4) Subsea pipeline

The mooring system will also be combined with a fluid transfer system that enables connection of (subsea) pipelines to the tanker. The fluid transfer system includes submarine hoses between the pipeline end manifold (PLEM) at the seabed and the buoy, and flexible hoses between the buoy and the tanker. In the buoy a swivel provides the fluid transfer path between the geostatic part and the rotating part of the buoy.

A SPM system is designed for deep water liquid transfer operations – up to 100 m water depth – and enables access for unlimited vessel sizes. Due to its more complicated design and robustness, the initial investment in a SPM system is reasonably high, approximately USD 15.0 million is estimated. Compared to a CBM system and taken into account the rather limited throughput of petroleum products at Lanka IOC, it will take many more years to pay back the initial investment in a SPM system. Hence, it will be difficult to justify the investment in a SPM.

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Appendix I TOR Trincomalee Port Development Plan

Tor Ref	Nr.	Text TOR	Trinco Zoning	Draft Trinco PDP	Fin. Trinco PDP
(i)	1	Review other transport plans and urban development plans and evaluate consistency among them. Draft a zoning map of the port to identify future port development areas to be secured, and to be incorporated into the land use plan.	X		
(ii)	2	Identify strategic non-containerized commodities where Trincomalee port has relative advantages to be a distribution and/or processing centre in the nation and/or the region, following a market assessment of such commodities.	X		
(iii)	3	Prepare a cargo and passenger traffic forecast for Trincomalee port for the next 30 years, based on different scenarios of the economic development, taking into account the strategic commodities, urban development, industrial development plans, and economic activities in hinterland, among others.		X	
(iv)	4	Assess current port operation, infrastructure and related institutions. The assessment covers cargo handling, navigation, worker's capacity and training, vehicle flow, capacity and condition of facilities, land use within and around the port, and impact of construction of PAEH and railway link; and identify the development needs for the port, including the need to redevelop obsolete facilities.		X	
(v)	5	Suggest measures to improve the physical, operational, and institutional efficiency of multimodal connectivity.		X	
(vi)	6	Prepare a list of priority projects to be carried out in the next 10 years including cost estimations and economic and financial viability assessment.		X	
(vii)	7	Undertake a preliminary environmental assessment, social assessment, and assessment of the potential need for land acquisition and resettlement for the prioritized projects in line with ADB's Safeguard Policy Statement (2009), as well as the government's environmental regulations and policies. Where potential climate change risks exist, necessary adaptation steps to mitigate the risks must be recommended for inclusion in the project design.			X
(viii)	8	Identify the needs for information technology application in the port.		X	
(ix)	9	Evaluate the environmental impacts of the port's operation on residential and commercial areas around the port and prepare recommendations to manage and alleviate negative impacts both in the short and long term.			

(x)	10	Prepare a phased Trincomalee Port Development Plan for the next 30 years, taking into account consistency with other transport plans and urban development plans.		X	
(xi)	11	Establish a land use plan for the port with zoning, access to the port, and related auxiliary facilities that cater for the overall port development.		X	
(xii)	12	Recommend projects to be implemented with possible external financing from development partners or potential financing by the private sector.			X
(xiii)	13	Draft the Trincomalee Port Development Plan and finalize it by incorporating comments from stakeholders.	X	X	X

Appendix II Development Plans SLPA Assessment

Introduction

This appendix describes an assessment on SLPA initial development plans for Trincomalee. Furthermore, expansion plans and private initiatives are addressed in this chapter.

Development Plans SLPA

For the port of Trincomalee MTBS identifies three sets of development projects to assess:

- First, the three short-term projects as described in the SLPA Port Development Master Plan 2016-2045, which near an implementation stage. (Paragraph 0)
- The conceptual development plans for the port of Trincomalee consisting of expansion plans. (Paragraph 0)
- The four private initiatives which are shared with the consultant where private parties request lands around the port Trincomalee or access to port area. (Paragraph 0)

Each plan will be evaluated separately. Following the assessment, a statement will follow whether to incorporate the plan in the development options. Private initiatives are in principal to be accommodated as much as possible as they serve needs of the country, the port and the port area. In that case, economic viability of the plans is left for the companies themselves. The four private initiatives will be included in the port zoning report though their implementation is still uncertain. The table below displays a summary of the consultant assessment of the plans. The prioritisation indicates whether the project is relevant in the short-term (0-3 years); medium-term (3-10 years) or long-term (10+ years).

Table 12-21: Overview Assessment Consultant

Plan	Inclusion dev. Options	Priority
Short-term Projects		
Rehabilitation and Extension of the Rail Connection to the Ashroff Jetty	+	Short-term
Fish Farming Project	-	Optional
Ship Repair Facility Project	+	Short-term
Long-term SLPA Concepts		
Multi-purpose Terminal 1 (expansion of the Ashroff jetty)	+	Short-term
Multi-purpose Terminal 2	-	Long-Term
Container Terminal 1	-	Optional
Container Terminal 2	-	-
Passenger Terminal	+	Medium-Term
Deep-water Oil Jetty	+	Medium-Term
Dockyard	-	Long-Term
Service Jetties	+	Medium-Term

Private Initiatives		
Biomass Export Storage Area	+	Short-Term
Ilmenite Export Area	+	Medium-Term
LNG Hub Terminal and Storage Tanks	+	Short-Term
Fertiliser Manufacturing Facility and Storage Area	+	Short-Term

Short-Term Projects

Several short- and long-term development projects have been identified for the Trincomalee port area. Three relevant identified short-term development projects are discussed below.

Rehabilitation and Extension of the Rail Connection to the Ashroff Jetty

Currently, all handled gypsum and coal destined for the Norochcholai power plant and Puttalam cement plant can only be transported by road. To improve efficiency of the port facility, as well as to reduce congestion and accidents on the roads, a rail connection to the Ashroff jetty is planned for development. In a first phase, the rail line is to be extended to the TTA facility. Even though the TTA warehouse complex is on the same premises as the Ashroff jetty, this will not allow cargo to be directly loaded onto rail transport from the vessels.

Table 12-22: Rail Connection to the Ashroff Jetty

Rail Connection to the Ashroff Jetty	Item	Value
	Location	China Bay Station to Ashroff
	Land Extent	-
	Sea Area Extent	-
	Investment	Public Investment
	Project Period	2016 - 2020
	Current Stage	*Unknown*
	Inclusion in development options	Included as an essential development plan. A rail head near or at the Ashroff quay would increase efficiency in loading coal and clinkers in rail wagons.

Assessment Consultant

The extension of the railway project is essential for the functioning of the Ashroff Jetty as location for bulk throughput. Current operations with cargo being loaded from vessels onto trucks is highly inefficient and time consuming. The transfer of dry bulk by trucks to the hinterland can be categorised the same. The expansion of the railway including shunting yards is key for current operations and future operations of TTA and the Ashroff Jetty, thus the expansion should be realised as soon as possible. The plan will be incorporated in the port development options. To create more space for a coal storage yard, the area near the Ashroff quay is expected to be filled. Subject to research the railhead location needs to be identified.

Fish Farming Project

ADB

Technical Assistance Consultant's Report

Project Number: 50184-001
February 2020

Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Trincomalee Port Development Plan – Volume 3 (Part 4)

Prepared by

Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

The SLPA aims to implement several fish farms in the port, following a successful pilot project. To this end, M/s Oceanpick submitted a proposal to develop fish farms in the Trincomalee vicinity.

Table 12-23: Fish Farming Project

Fish Farming Project	Item	Value
	Location	Town Jetty, King's Garden, Trincomalee Bay
	Land Extent	Town Jetty and 1 Acre of King's Garden
	Sea Area Extent	3.28 ha
	Investment	Private Investment
	Method of Procurement	RfP
	Project Period	2016 - 2020
	Current Stage	Implementation Phase
	Inclusion in development options	Optional, this project should be separated from the port area. It can be an optional development, not included in this document. Fish farming would be subject to the fishery ministry.

Assessment Consultant

This project adds to the economic diversity of the port and the city. It is however not essential to port functioning nor does it interfere with port operations. With its shallow waters, the Tambalagam Bay is a good location for the development of fish farms. This would release the Trincomalee waterfront for recreational purposes.

Ship Repair Facility Project

SLPA intends to lease out the Mud Cove maintenance and repair facility to a private party. Thereto, M/s Dino TMS has submitted a proposal, which includes plans to further expand the repair facilities and develop a training centre. The details and status of the project are provided in the table below.

Table 12-24: Ship Repair Facility Development

Ship Repair Facility Development	Item	Value
	Location	Mud Cove facility (Trincomalee Bay)
	Land Extent	7 Acres, including Mud Cove slipway and pier
	Investment	Private Investment
	Method of Procurement	RfP
	Project Period	2016
	Employment	50 People
	Current Stage	Pending Procurement Committee Approval
	Inclusion in development options	Included. This concept has been added in the development options as service jetty and dockyard concept. However, the location of the service jetties will first be concentrated near the Ashroff jetty a have a compact and efficient setting.

Assessment Consultant

Mud cove development can be launched for private parties interested in this business opportunity. However, the basic service facility for crew boats and other small boats should be developed first, due to the current lacking such facility. Mud Cove can continue as an auxiliary function to the port in private hands. The function will be included in the development options with an additional development option for service jetties.

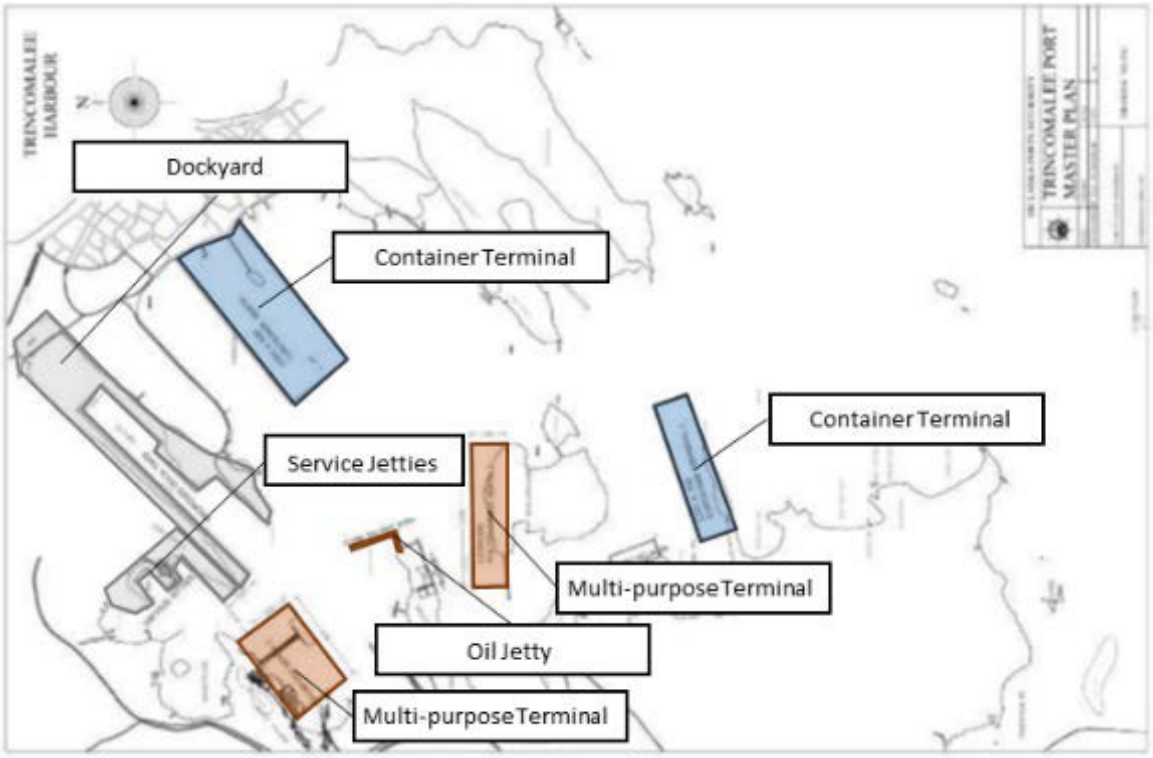
Long-Term SLPA Concepts

The long-term developments, focusing on capacity expansion, include:

- 2 multi-purpose terminals;
- 2 container terminals;
- a passenger terminal;
- an oil jetty;
- a dockyard; and
- service jetties.

The envisioned locations of these projects are visualized in Figure 12-8; subsequently, the individual projects are discussed in more detail. Per project an assessment is given to identify the viability and significance of the project.

Figure 12-8 Trincomalee - Overview of Long-Term Developments



Multi-purpose Terminal 1 (expansion of the Ashroff jetty)

Increasing demand for bulk cargo handling in the port, resulting from increasing industrial activities in Sri Lanka's eastern and north-eastern regions, has led to the need for additional berthing space. As such, the SLPA intends to expand the Ashroff jetty over three phases. The details of the expansion project are provided in the table below.

Table 12-25 Trincomalee - Multi-Purpose Terminal 1

Multi-Purpose Terminal 1 – Trincomalee	Item	Description
	Location	Ashroff Jetty
	Berth 1	400m

Berth 2	350m
Berth 3	400m
Water Depth	CD -13m
Investment	USD 80.0 M
Method of Procurement	Tender Procedure
Project Period	2018 – 2022
Current Stage	Concept
Inclusion in development options	Included. The Ashroff Jetty expansion has been incorporated in the development options. The shape and phasing have been changed due to analysis of bathymetric data.

Assessment Consultant

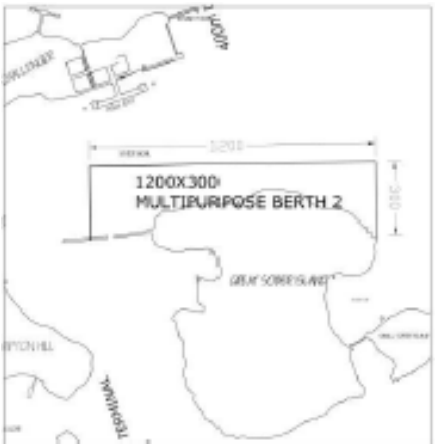
The expansion of the Ashroff Jetty is essential to accommodate future growth in dry bulk cargo running through Trincomalee. The extended berth can have additional storage capacity and the multiple berths can accommodate more ships. The proposed expansion of the quay is different from what is envisaged by SLPA in the table below. Chapter 9 provides the details to the proposed expansion by the consultant.

Multi-purpose Terminal 2

Commissioning of the planned Sampur Coal Power plant, and the resulting boost to industries in the north-eastern region, is expected to increase the demand for handling bulk cargo in Trincomalee port. As such, it is expected that the port will need to be able to accommodate bulk carriers with a draft of 18m. To this end, a second deep-water multi-purpose terminal is envisioned to be developed on the Great Sober Island. The island will subsequently be connected to the mainland through a bridge. The details of the project are provided in the table below.

Table 12-26 Trincomalee - Multi-Purpose Terminal 2

Multi-Purpose Terminal 2 – Trincomalee	Item	Description
	Location	Adjacent to Great Sober Island
	Quay Wall Dimensions	1200m x 300m
	Minimum Water Depth	CD -18m
	Maximum Water Depth	CD -21m
	Investment	USD 100.0 M
	Method of Procurement	Tender Procedure
	Project Period	2025 – 2035
	Current Stage	Pre-Feasibility

	Inclusion in development options	Included as a potential container terminal, but the use as multipurpose terminal has not been excluded.

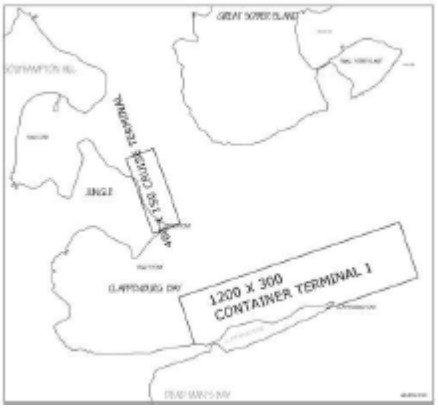
Assessment Consultant

The expansion of the Ashroff Jetty is sufficient to meet demands of Trincomalee port thus the forecast doesn't show direct need for the second multi-purpose terminal. There might however be a function of container terminal development at Sober Island as demand may emerge in the future.

Container Terminal 1

Following the expected industrial developments within the port's economic zone, demand for containerised cargo handling is likely to increase. As such, the SLPA intends to develop a container terminal nearby the Industrial Zone. The details of the project are provided in the table below.

Table 12-27 Trincomalee - Container Terminal 1

Container Terminal 1 – Trincomalee	Item	Description
	Location	Adjacent to Clappenburg Bay
	Quay Wall Dimensions	1200m x 300m
	Minimum Water Depth	CD -21m
	Maximum Water Depth	CD -23m
	Yard Area	16ha
	Investment	USD 100.0 M
	Method of Procurement	Tender Procedure
	Project Period	2025 – 2035
	Current Stage	Pre-Feasibility
	Inclusion in development options	The location is included due to the natural water depth. Function will change to potential Floating LNG.

Assessment Consultant

The country's container cargo handling capacity is sufficient for the foreseeable future with the terminals and expansion projects in Colombo and Hambantota. Multipurpose berths on the Ashroff quay can provide for some container cargo throughput capacity. Once container traffic is developing a dedicated container terminal facility can be created. The location for such facility is probably at Sober Island rather than the projected Clappenburg as noted in the picture here above. The main reason is that hinterland connectivity near Clappenburg is more difficult and more costly.

Container Terminal 2

The proposed 2nd container terminal aims to serve the Indian East coast, as travelling distance and time to the Indian East coast are substantially shorter from Trincomalee, as compared to Colombo. However, it must be noted that transhipment activities in Trincomalee would require Ultra Large Container Ships (ULCS) to deviate substantially from the main East-West trade, whereas Colombo requires only a small deviation. The details of the project are provided in Table 12-28.

Table 12-28 Trincomalee - Container Terminal 2

Container Terminal 2 – Trincomalee	Item	Value
	Location	Adjacent to Powder Bay
	Quay Wall Dimensions	1500m x 600m
	Minimum Water Depth	CD -18m
	Maximum Water Depth	CD -21m
	Investment	USD 200.0 M
	Method of Procurement	PPP Tender Procedure
	Project Period	2025 – 2035
	Current Stage	Pre-Feasibility
	Inclusion in development options	Excluded as container terminal. The distance to the port would make this option inefficient. The location is useful for potential cruise development.

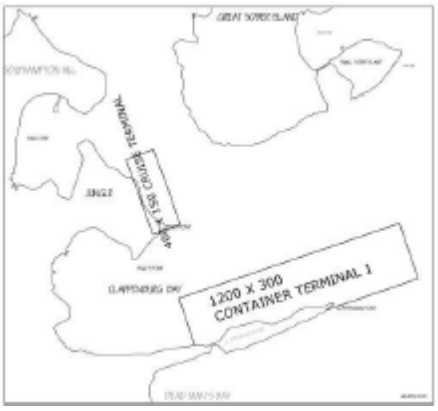
Assessment Consultant

The country's container cargo handling capacity is sufficient for the foreseeable future with the terminals and expansion projects in Colombo and Hambantota. Multipurpose berths on the Ashroff quay can provide some container cargo throughput capacity. The location near the city is more logical for a cruise terminal / marina development.

Passenger Terminal

The Trincomalee area comprises many tourist destinations, such as beaches, diving locations, and cultural heritage. As such, the development of a passenger terminal is envisioned to boost the tourism sector and capitalize on the region's attractions. The details of the project are provided in the table below.

Table 12-29 Trincomalee - Passenger Terminal

Passenger Terminal – Trincomalee	Item	Value
	Location	Adjacent to French Point
	Quay Wall Dimensions	400m x 150m
	Minimum Water Depth	CD -18m
	Maximum Water Depth	CD -18m
	Investment	USD 100.0 M
	Method of Procurement	Tender Procedure
	Project Period	2020 – 2030
	Current Stage	Pre-Feasibility
	Inclusion in development options	Excluded, the land at French point is proposed to be acquired, but no development options are considered.

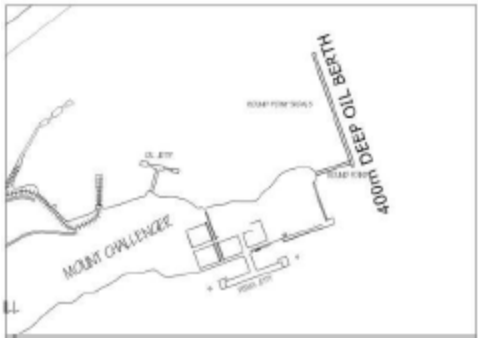
Assessment Consultant

Trincomalee' s natural riches offer the opportunity to develop a cruise berth, but this would be most optimal at the city side. The vessels can be optimally serviced there, and this doesn't necessitate the development of costly services around a cruise berth far from the city. Small berths around the bay can offer access for smaller boats coming from the city terminal. The connectivity from the city towards the country's highway network should be assessed carefully when the city front is chosen as preferred option.

Deepwater Oil Jetty

Due to continuously increasing demand for petroleum products, larger vessels can be attracted to increase cost-efficiency of petroleum products imports. As the current berthing facilities do not provide sufficient water depth, the SLPA intends to develop a new deep-water oil jetty that enables the accommodation of larger vessels. The details of the project are provided in the table below.

Table 12-30 Trincomalee - Oil Jetty

Deepwater Oil Jetty – Trincomalee	Item	Value
	Location	Adjacent to Prima Flour Jetty
	Quay Wall Length	400m
	Water Depth	CD -23m
	Investment	USD 25.0 M
	Method of Procurement	Tender Procedure
	Project Period	2020 – 2030
	Current Stage	Pre-Feasibility
	Inclusion in development options	Included as deep-water oil jetty. The shape has been adjusted in the proposal.

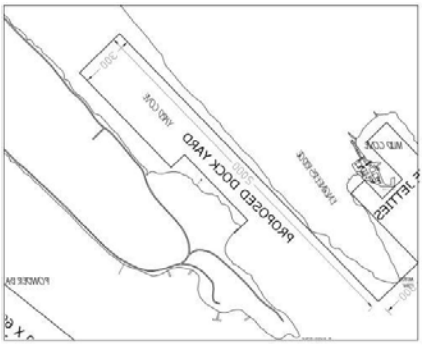
Assessment Consultant

Principally, the driver for the construction of the deep-water oil jetty is private demand. If the industry indicates it needs to accommodate larger vessels with deeper draught, the port authority should try to accommodate within reasonable possibilities. The location for the deep-water oil jetty is excellent. As such, it could also possible accommodate a LNG jetty presented in chapter 9.

Dockyard

Following industrial and economic development in the Trincomalee region, and subsequent development of the Trincomalee port, it is expected that maritime traffic will increase substantially in the Trincomalee region. As such, the SLPA intends to develop a dockyard to leverage the increased traffic by expanding the services portfolio provided to incoming vessels. The details of the project are provided in the table below.

Table 12-31 Trincomalee - Dockyard

Dockyard – Trincomalee	Item	Value
	Location	Yard Cove
	Area	10 ha
	Investment	To be determined
	Method of Procurement	Tender (BOT structure)
	Project Period	2020 – 2030
	Current Stage	Pre-Feasibility
	Inclusion in development options	Excluded, the costs of this set-up are high and the dockyard option is taken into consideration as an expansion of Mud Cove.

Assessment Consultant

The long shape of the bay is ideal for dockyard activities thus development costs could be relatively low. There is however limited direct demand for these facilities also taken into account the dockyards in Colombo. Currently the newbuilding markets are in distress and demand for construction is limited. The repair markets are however expected to rise in future as many commercial vessels which have been built in the last decade will face maintenance requirements. The larger sized vessels do not have many locations where repairs can be carried out as many dockyards around the world were designed for ships with less beam and limited lengths. With the limited activity on newbuilding, the yards in the Far East are now focussing on the repair markets. However, also Sri Lanka could play a larger role in this market should private demand for these facilities emerge.

Service Jetties

Similar to the envisioned dockyard, the service jetties aim to capitalize on the expected increase in maritime traffic. The details of the project are provided in the table below.

Table 12-32 Trincomalee - Service Jetties

	Item	Value
	Location	Adjacent to Mud Cove
	Quay Wall Length	2,200m
	Water Depth	CD -7m to CD -8m
	Investment	USD 100.0 M
	Method of Procurement	Tender Procedure
	Project Period	2020 – 2030
	Current Stage	Tender phase / securing financing
	Inclusion in development options	Excluded. The service jetties have been firstly allocated to the Ashroff jetty.

Assessment Consultant
The SLPA service jetties are allocated to the Ashroff Jetty. Paragraph 9.3 indicates the development option.

Private Initiatives
The four private initiatives obtained by MTBS for assessment are:

- Biomass Export Storage Area
- Ilmenite Export Area
- LNG Hub Terminal and Storage Tanks; and
- Fertiliser Manufacturing Facility and Storage Area.

The privately proposed areas as indicated in the development plans are represented in Figure 12-9. The description of the plans and assessment follow. It is important to note that these plans are incorporated in the zoning options to indicate development potential, but no assessment is made by the consultant as to the economic viability nor the environmental impact if incorporated.

Figure 12-9: Proposed Locations Private Initiatives

Biomass Export Area

The Biomass Group, through its subsidiaries in Sri Lanka, has enlisted 40,000 farmers directly to plant Gliricidia trees. These will be used to produce pellets at a proposed pellet manufacturing plant at the Trincomalee industrial zone. The company has also requested one hectare of storage area land near the Ashroff Jetty for storage of Biomass pellets. The pellets are exports as bulk material to major power companies in Japan. The project would encompass the first bulk exporting commodity in Sri Lanka.

Table 12-33: Biomass Export Area

Biomass Export Area	Item	Value
	Location	Near Ashroff Jetty
	Investment	Private
	Year of Operations	2019
	Annual Throughput	150,000 Tons
	Current Stage	Proposal Phase
	Required Area	1 ha.
	Inclusion in development options	Included / optional. This area at the Ashroff quay can be part of a larger development of the SLPA plot.

Assessment Consultant

This initiative should be accommodated in the Trincomalee port area where there is ample space for the 1 ha storage area and from where a belt system can be accommodated towards the quay. Biomass shall add to the economic diversity of the country.

Ilmenite Export Area

Iluka Lanka Resources operates an ilmenite quarry near Puttalam for which they need an export location. Ilmenite is the primary mineral used for titanium production. The company inquired to make use of the expanded Ashroff Jetty to export the minerals in containers. It prefers access to the extended rail to TTA where the warehouse would be.

Table 12-34: Ilmenite Export Terminal Area

	Item	Value
	Location	Ashroff Jetty / TTA
	Investment	Private
	Year of Operations	2021
	Annual Throughput	-
	Current Stage	Inquiry Phase
	Required Area	1 ha.
	Inclusion in development options	Included / optional. This area at the Ashroff quay can be part of a larger development of the SLPA plot.

Assessment Consultant

This initiative should be accommodated in the Trincomalee port area where there is ample space for the 1 ha storage area. Ilmenite could add to the economic diversity of the country.

LNG Hub Terminal and Storage Tanks

Energy World International LTD proposes to finance and construct:

- An LNG loading and off-loading facility; and
- An LNG Hub terminal and LNG storage tank capacity of 80,000 cubic metres.

Table 12-35: LNG Hub Terminal and Storage Tanks

	Item	Value
	Location	North of airport
	Investment	Private
	Year of Operations	-
	Annual Throughput	-
	Current Stage	Proposal Phase
	Required Area	+/- 30 ha
	Inclusion in development options	Excluded, the area is too far away from the main port

	area. More information on the business case is needed.

Assessment Consultant

More information on the business strategy of the company is needed to fully assess the plan. CEB has several plans to generate energy through LNG supplied gas plants as much as 12% of energy generation in 2035. Currently, none are envisaged in Trincomalee though. The question is whether domestic demand for LNG can be serviced through Trincomalee. The port does however offer excellent depth for the LNG vessels and the location is strategic for possible international distribution as envisioned by the company. One of the possibilities in this regard is floating LNG storage as there is ample space and depth at Trincomalee. The most logical location for this would be Clappenburg bay as this bay is relatively remote from the other port activities and the city.

Fertiliser Manufacturing Facility and Storage Area

Ceylon Phosphates LTD proposes to build a facility which produces Single Superphosphate (SSP) fertiliser for the domestic Lankan market as an alternative to importing finished products. Phosphate will be imported through the Ashroff Jetty to produce the fertiliser. The facility could deploy three production modules with 0.6 M tons' production capacity after a five-year construction period.

Fertiliser Manufacturing Facility and Storage Area	Item	Value
	Location	5th Mile post & Ashroff Jetty
	Investment	Private & Public
	Year of Operations	-
	Annual Throughput	1.8 M tons of fertiliser – phosphate quantity unknown
	Current Stage	Proposal Phase
	Required Area	+/- 140 ha
	Inclusion in development options	Included, this area is prime industrial development area.

Assessment Consultant

The proposed factory offers a good opportunity to service the fertiliser demand of the country, whilst saving it from expensive imports. The scale and nature of the manufacturing facility does however need careful planning as environmental issues might arise. This plot of land should be connected by road, making it accessible from the port.

Appendix III Assessment other Plans

Introduction

Sri Lanka is a nation in development, with large investments pouring to enable the country to grow. Trincomalee especially is an area with growth potential both in port development and, in a larger scope, regional development. Several of the development plans intertwine with port development. In this regard, this chapter contains two assessments on current plans for the Trincomalee area:

- The CTEC (Colombo Trincomalee Economic Corridor Development); and
- The Trincomalee Master Plan.

CTEC – Colombo Trincomalee Economic Corridor Development

The Colombo – Trincomalee Economic Corridor Development is of great value to the country and to the Trincomalee region as well. In this section the consultant underlines and emphasises the importance of several key conclusions from the CTEC April 2017 report.

1. *"Bulk imports could be directed towards existing capacity in Trincomalee to complement Colombo; Could specialize as "Energy Port" for the country"* – CTEC, APRIL 2017, p. 52

This statement is in line with the port vision for Trincomalee, as the bay is especially suited to handled deep-water bulk vessels keeping in mind constraints in Colombo port. A good hinterland connection would make Trincomalee an efficient 'Energy Port.'

2. *"However, Industry consultations have highlighted concerns regarding logistics infrastructure and customs processes."* – CTEC, APRIL 2017, p. 59

Especially customs procedures should be decentralised according to international best practices. Customs procedures should enable logistical efficiencies without compromising on safety, security and tax collection. Luckily, automation of customs procedures provides for the achievement of these goals.

3. *"Central Expressway will help by-pass existing urban conurbations and smoothen flow of heavy vehicles."* - CTEC, APRIL 2017, p. 63

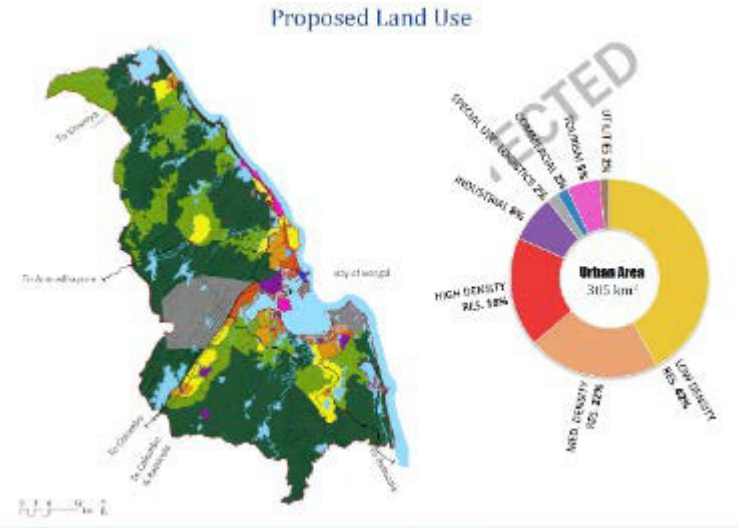
The importance of central expressway connecting Colombo to Trincomalee for the port cannot be understated. Currently, the transport costs inhibit export business settling in Trincomalee. The central expressway would create synergies between the ports.

Input on Ministry of Megapolis & Development Trincomalee Master Plan

MTBS both reviewed the June 2017 and October 2017 version of the draft report. The four comments made below on the June 2017 version were not incorporated in the October version.

In October 2017 Surbana Jurong Consultants under the commission of the Ministry of Megapolis and Western Development presented the Trincomalee Master Plan, which is a zoning report for the greater Trincomalee area. The plan details amongst others the areas designated for port and logistics development as shown in the figure below. This section presents inputs and suggestions for adjustment considering the port master plan. The first input is the port zoning already presented in this chapter.

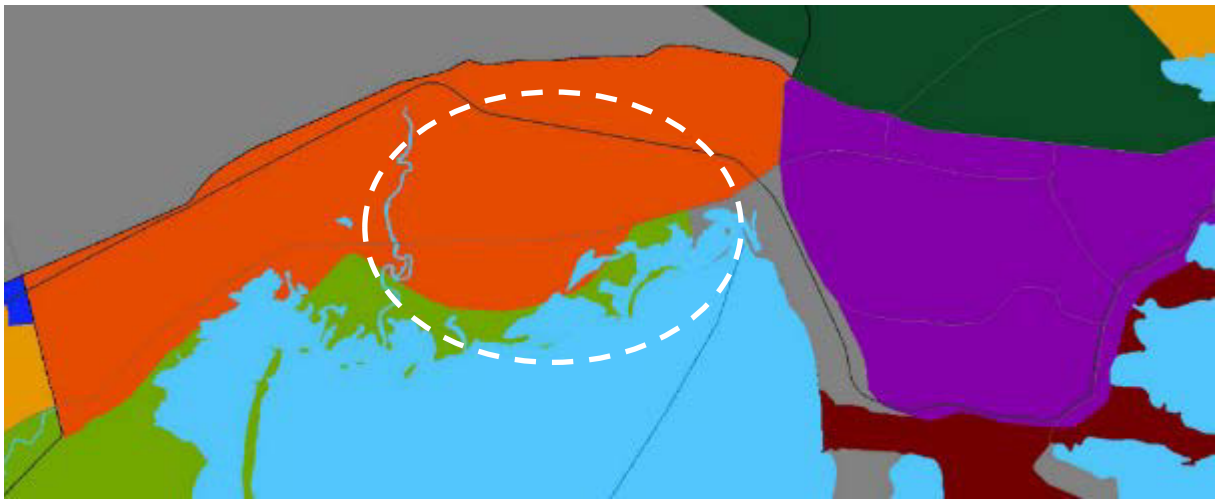
Figure 12-10: Example Proposed Land Use Trincomalee



Source: Surbana Jurong Consultants

1. **High density residential area north of Tambalagam bay**

The area should not be allocated to high density residential area as this area is a prime area for potentially non-water-based industries. The SLPA plot FTP5 is partly located in this area. The plot of land had some encroachment and some agriculture taking place. The land is flat, making the costs of preparation low and it can be connected via a port road along the railway to ensure easy access for goods to flow.



2. Defence area above the airport

The definition of defence area is unclear in this regard. SLPA owns some lands west of the rail line which is not suitable for development. The area east of rail line is suitable for industrial development. The border for the 'defence area' crosses this rail line into the potential development area.

3. **The arterial road crossing the industrial area**

This arterial road currently is not paved. For future development of the port access roads SLPA proposes another route for the road as can be viewed in paragraph 9.1. SLPA wants to create a corridor of industrial activity along the rail and a soon to be constructed port road. There is a clear plot between the government area with tanks and the railway line which can be utilized for industrial activities. As such the purple area is not rightly bordered in the urban plan.

4. **Potential port development areas designated otherwise**

Several areas have potential for port development which are designated otherwise in the zoning plan. An alignment of these functions is wanted. Specifically, these areas include:

A. The waterside land north of Clappenburg for potential port development
B. Sobar Island
C. Clappenburg Island
D. The island north or town jetty

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Appendix IV Mitigation measures for land acquisition and resettlement

Mitigation measures to cope with significant Impacts from proposed priority projects at the Ports of Colombo and Trincomalee

A3.1 Loss of assets and employment

When a project results in the involuntary relocation of people the flowing steps should be taken:

1 Screen the project early on to identify past, present, and future involuntary resettlement impacts and risks. Determine the scope of resettlement planning through a survey and/or census of displaced persons, including a gender analysis, specifically related to resettlement impacts and risks.
2 Minimize human displacement and resettlement wherever possible
3 Identify all project impacts and record all losses properly
4 Pay compensation as per the NIRP and to comply with the safe guard requirements of the World Bank
5 Improve the standards of living of the displaced poor and other vulnerable groups, including women, to at least national minimum standards. Provide them with appropriate income sources and legal and affordable access to adequate housing.
6 Develop procedures in a transparent, consistent, and equitable manner if land acquisition is through negotiated settlement to ensure that those people who enter into negotiated settlements will maintain the same or better income and livelihood status.
7 Disclose a draft resettlement plan, including documentation of the consultation process in a timely manner, before project appraisal, in an accessible place and a form and language(s) understandable to affected persons and other stakeholders. Disclose the final resettlement plan and its updates to affected persons and other stakeholders.
8 Conceive and execute involuntary resettlement as part of a development project or program. Include the full costs of resettlement in the presentation of project's costs and benefits. For a project with significant involuntary resettlement impacts, consider implementing the involuntary resettlement component of the project as a stand-alone operation.
9 Encroachers could be provided with land for land, since SLPA has adequate land resource to allocate to the displaced encroachers.
10 Permit holders equivalent to free holds if willing also could be given land for land with compensation for the structures at replacement cost.
11 Water, electricity and other facilities which they enjoyed prior to displacement should be provided as part of the project cost.
12 Income restoration programme should be implemented to restore the income of affected people to enjoy a life equal or better than what they had prior to the displacement.
13 Implement a programme to empower women.
14 Liaise with the educational authorities to find schools of equal standard or better for children who had to seek new schools due to displacement (if the affected are accommodated with in the port premises this requirement does not arise)
15 Settlement planning will take account of the local socio-economic development context
16 Maintain a continuous consultations and dialogue with the affected before, during and some period after resettlement to create trust, and built confidence to avoid conflicts and misunderstanding with the project implementers.

A3.2 Relocation and Rehabilitation

The occupants of land within the port premises who need to be evacuated to build facilities for the improvement of the Trincomalee Port need to be relocated without disruption to their day to day activities. The suggested mechanism is to:

1 Offer them alternate land plots within the port area and pay compensation for the improvements made on the land at replacement cost without taking into consideration the depreciation and salvage material. Infrastructure facilities and services should be available to them at the same service level as they experienced before or higher.
2 Offer the grant permit holders cash compensation if they are willing and allow them to settle elsewhere.
3 If the port authorities prefer to preserve as much as land possible owned by them, and if the affected people wish to live in condominiums construct a condominium and allocate housing units in the condominium to the displaced people. If the value of the assets lost by an affected person, is more than the cost of the housing unit allocated to him, the affected person is entitled to receive the balance due to him.

A detailed plan for relocation and rehabilitation has to be prepared by the project's proponent in a so-called Resettlement Action Plan (RAP).

A3.3 Income Rehabilitation

If any AP, due to land acquisition, loses his/her income fully or partially, the project should implement a plan to restore the income of APs, as the NIRP and ADB social safeguard statement of 2009 specifically mentioned that the affected people should not be impoverished, and their socio-economic standard should not fall below the pre-project standards they enjoyed.

A detailed plan for relocation and rehabilitation and the other issues listed in 3.3.1 to 3.3.3 must be prepared by the project's proponent in a so-called Resettlement Action Plan (RAP).

A3.4 Cost Estimates for the Resettlement of APs at the Port of Trincomalee

Any development project involving land acquisition triggers resettlement due to displacement of people. For the works related to the extension of the Ashroff Jetty (access of railway), land will be required between the jetty and the existing China Bay railway station.

There are two sets of regulations in operation for the payment of compensation for the acquired assets under the Land Acquisition Act (LAA) approved by the parliament of Sri Lanka namely 2008 and 2013 regulations; the 2013 regulations are applicable to designated projects. Initially, this regulation covered 16 road projects, but it has been extended to projects implemented by the Ministry of Megapolis and Western Development. If compensation to the Aps is to be made under the 2013 regulations, the approval of the Cabinet of Ministers is a prerequisite. The National Port Master Plan may or may not fall within the 2013 regulations as the project has not yet reached the implementation stage. In this stage we have based our computations of the cost of land acquisition and resettlement for the extension of the railway to the Ashroff Jetty on the 2008 regulations.

Cost of Land

The compensation is payable only for private lands. The encroachers who occupy the state land (SLPA land) are not entitled to receive compensation except for any improvement(s) made on the land. Those who are in possession of land with grants received from the government (Jayabhoomi Grants) are entitled for compensation since such holdings are considered as free holds. And the holders of grants can sell such lands with the permission of the relevant authorities (Divisional Secretary /District Secretary).

According to the plans prepared by the Department of Surveys in 2011, the extent of land with grants belonging to 14 households is 0.98 ha (381 perches). The compensation payment of this extent of land may well occur after 2-3 years from now. Any estimate for the payment of compensation for the land to be acquired should consider the time factor.

It is reasonable to value a perch of land at Rs.500,000 as the land value in the area will rise with the planned development of the port. Therefore, the cost of the land could be assessed as:
381 * Rs.500,000 = **Rs. 190,500,000 or US$ 1,245,098** (1 US$ = Rs.153)

Cost of Structures

Currently, there is no information on the extent of buildings (floor area) to be demolished. It is deemed reasonable to adopt the amount spent by the Ministry of Western Development and Mega polis for a housing unit to resettle a family displaced due to the implementation of the projects under their purview.

Number of buildings to be displaced is 52. The estimated cost amounts:
52 * Rs 3,500,000 = **Rs. 182,000,000 or US$ 1,189,542** (1 US$ = Rs.153).

Sub Total of compensation payable for land and structures is **Rs. 372, 500, 000 or USD=2,434,640**

Other entitlements

In addition, there are other entitlements payable to the affected depending on the types of expenses and disturbances each may face; no details for such entitlements are currently available. It is prudent to allocate 10% of the above subtotal to cater for such payments.

On this basis, the total cost estimate amounts to **Rs.409, 750,000 or USD=2,678,104**

A3.5 Grievance Redress Mechanism in resettlement programmes

Well formulated mechanism should be in place for the resolution of grievances of APs in development induced resettlement projects. They are institutions, instruments, methods and processes by which a resolution to a grievance of an AP could be sought and provided. Project implementing authorities should take adequate care to minimize grievances through careful designs and good participatory management. Problems do occur, and grievances are inevitable even under extremely efficient planning and expert management due to unforeseen circumstances. A built in institutional mechanism to redress grievances would be an ideal forum to listen to the grievances of the APs and find solution to their problems. The suggested system would help to alleviate suspicions and misunderstanding between the APs and the project management. It helps APs easy access without incurring much expense to seek timey solutions to their problems. It facilitates to achieve project objectives without many hiccups.

The RAP should identify the potential social and economic impacts associated with land acquisition and relocation and illustrate the measures and procedures needed to redress or mitigate grievances. Some of the inadequacies of compensation, delay in payment of compensation significant social impacts would be

severance or disruption of relationship, marginalization, disruption of children's education and access to facilities within easy reach Increase in violence and sexually transmitted diseases due to influx of construction labour from areas outside the project, whose tenure is temporary, and not subject to peer pressure and lack of concern to observe the accepted social norms.

The main purpose of the measures of redresses should be recommended in RAP to avoid economic and social hardships to people resulting from the construction effects of the project.

A3.6 Institutional Arrangement to Attend to Gender Concerns

The PMU should recruit a female officer with experience in gender issues to deal with the concerns of women. Alternatively, the PMU could obtain the services of relevant officers attached to the Divisional Secretariat to handle such issues.

Appendix V Sample LNG terminal

The following information illustratively describes the LNG Gate terminal in Rotterdam, located on 42 hectares of land at Maasvlakte 1 in the Port of Rotterdam, the Netherlands.

The terminal (in red marked on the picture), has a throughput capacity of 12 billion m³ (BCM) per annum and consist of three storage tanks, a regassification plant, two conventional ship berths and one small scale berth for inland barges.

The terminal is designed to unload LNG vessels, load LNG to vessels and to road trucks and to perform transhipments. The Gate terminal is the main import terminal of gas into the local and international gas pipeline grids.

LNG Gate terminal in Rotterdam

The Gate terminal facilities consist of:

- Total land area 42 hectares;
- Two jetties to unload LNG Carriers of sizes between 65,000 m3 and 267,000 m3
    - Jetty 1,2 – max vessel LOA is 350m (and minimum lengths of 90m) for the accomodation of approximately between 6,500 m³ and 267,000 m3.
    - Jetty 3 – max vessel LOA 180m is design for inland barges and ships upto about 20,000m³ (40,000m³ in future)
- Three (3) storage tanks (full containment tanks) with a net capacity of 180,000m3 each and total working capacity of 540,000 m³;
- Eight Open Rack Vaporisers (ORV), for which the warm cooling water of the local power plant is used for vaporisation of the LNG to enable a firm daily redelivery capacity equivalent to 12 billion m³ of gas per annum (12 BCMA), equivalent to approximately 1,67m (n) m3 per hour (~40m (n) m3 per day);
- The minimum delivery rate of the terminal is 139,000 m3(n)/h;
- The depth alongside jetty 1,2 is CD – 14.5m. With maximum loaded draft for vessels of 12.5m;
- The depth alongside the jetty 3 is CD - 10m. Maximum loaded draft of 7.5m;

Other details of jetty 1,2

- Maximum vessel beam at jetty 1,2 is 55m;
- Maximum approach speed to fenders at jetty 1,2 is 12cm/s, accidential 15cm/s;
- Maximum docking angle 5 degrees;
- Jetty 1,2 are equipped with cargo SVT arms of 20 inch. (three unloading and one vapour return);
- Jetty 1,2 connectors for quick connect 16 inch type hydraulic couplers;
- Working design pressure 100mLC;
- Usual working terminal pressure 50 to 250mbar;
- Terminal design maximum unloading rate is 14,5000 m^3/h for jetty 1 and 12,500 m^3/h for jetty 2;
- Return vapour temperature -130celsius after 1 hour at full rate vapour return;
- Heel to be maintained in the terminal is 30,000 m^3 for 3 tanks (10,000m^3 per tank);
- LNG density range 440-480 kg/m^3.

Appendix VI Implementation plan

This section contains the proposed timelines for the implementation of the various plans. The section details:

- Timeline for major recommendation (grouped by activities).
- Implementation plan Short Term Priority projects including detailed timeline
- Long term development plan including timeline.

The overview of the implementation plan follows the detailing below.

Implementation Plan - Recommendations

Equipment selection and procurement
The project has the following time line:

- Tender start in 1st half 2019 – 6 months
- Delivery and installation - 12 months
- Operational – begin 2021

IT hardware development (Servers, Network, CCTV)
The project has the following time line:

- Tender start in 1st half 2018 – 6 months
- Implementation - 6 months
- Operational – 1st half 2019

IT software development (cargo management, harbour management, gates system)
The project has the following time line:

- Tender start in 1st half 2018 – 6 months
- Implementation - 8 months
- Operational – 3rd quarter 2019

Port Community System
The project has the following time line:

- Task force and orientation in till 1st half 2018
- Tender advisory service till 3rd quarter 2018
- Project start begin 2019
- Project end 2022, operational start 2023

Environment
The project consists of measuring and monitoring, guidelines, HSSE department, green policy, ISO certificates and international conventions.
The project has the following time line:

- Activities to start by begin 2019
- Reorganisation departments to run till end 2020.
- Compliance issues till end 2020
- Green policy till end 2020
- ISO 14001 certificate by end 2022

Lay-up developments
The project has the following time line:

- Identification locations, start in 2nd half 2018 – 3 months
- Construction of buoys - 6 months
- Operational – 2nd quarter 2019

Implementation Plan – Short term priority projects
The time planning for the short term priority projects are displayed in this paragraph.

Ashroff Jetty
The project has the following time line:

- Tender phase second quarter 2018 – fourth quarter 2018
- Construction phase A, starts beginning of 2019
- Operational start phase A, starts beginning of 2021
- New equipment by 1st quarter 2021

Navigation aids
The project has the following time line:

- Tender phase 1st half 2018
- Construction starts second half 2018
- Operational start at second half of 2019

Port access road development (port A15 to A6 heading North West)
The project has the following time line:

- Tender phase 2nd half 2018 till end 2019
- Construction starts 2020 till end 2nd half 2021
- Operational start at second half of 2021

Rehabilitation and extension of rail connection (China Bay to Ashroff jetty)
The project has the following time line:

- Tender phase 2nd half 2019 till 2nd half 2020
- Construction starts 2nd half 2020 till end 2nd half 2021
- Operational start at second half of 2021

Develop promotional plan for industrial and logistical zones
The project has the following time line:

- Tender phase 1st quarter 2018 till 2nd quarter 2018
- Preparation and roll out plan, start 2nd quarter 2018 till end 2018
- Operational start beginning of 2019

SLPA land use plan
The project has the following time line:

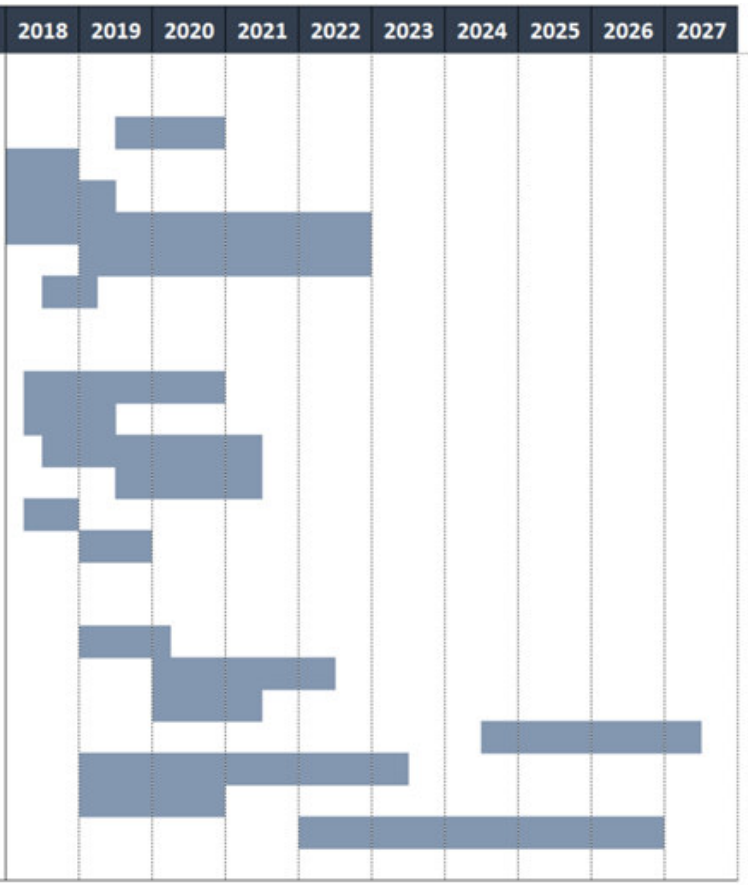
- In-house plan for phasing of land development, start at 2019 till 1st half 2019
- Preparation and roll out plan, 2nd half 2019 till end 2019
- Operational start beginning of 2020

Implementation Plan - Long term developments

The long-term developments of the port infrastructure are displayed in next overview.

- Marina
  - Concession & tenders 1st half 2019, construction 8 months, start operations 2nd quarter 2020
- Cruise terminal
  - Concession & tenders 1st half 2020, construction 18 months, start operations 2nd half 2022
- Industrial developments and Logistics (zone F of port zoning)
  - Concession & tenders 1st half 2020, land development till 2nd half 2021, operational by 2nd half 2021
- LNG terminal (bunker station and possible role for power station near Trincomalee Bay)
  - Concession & tenders 1.5 years, construction 1.5 years, development as and when demand arises
- Sampur area energy development
  - Concession & tenders till end 2020, construction 2.5 years, start operations after mid 2023
- Dock yards developments at Mudcove
  - Concession & tenders in 2019, construction 1 year, start operations beginning of 2021
- Container terminal development (near sober island)
  - Planning and design(2yr), Reclamation (1yr), tender and construction (2yr), equipment (in parallel), operational as and when demand arises

Implementation plan	Start	Duration (# months)
Recommendations		
Equipment (selection and procurement)	01/07/2019	18
IT hardware development (servers, network, CCTV)	01/01/2018	12
IT software development (cargo mgmt system, harbour master mgmt, gates s	01/01/2018	18
Port Community System	01/01/2018	60
Environmental Impact	01/01/2019	48
Ship lay-up developments	01/07/2018	9
Short Term Priority Projects		
SP1-Ashroff Jetty Upgrade Phase 1	01/04/2018	33
SP2-Navigation Aids	01/04/2018	15
SP3-Port Access Road Development	01/07/2018	36
SP4-Rehabilitation and Extension of the Rail Connection to Ashroff Jetty	01/07/2019	24
SP5-Develop promotional plan for industrial and logistics zones	01/04/2018	9
SP6-SLPA Land Use Plan	01/01/2019	12
Port Development Options		
Marina Development	01/01/2019	15
Cruise Terminal	01/01/2020	30
Industrial Development & Logistics	01/01/2020	18
LNG Terminal (indicative, as and when demand arises)	01/07/2024	36
Sampur Area Energy Development	01/01/2019	54
Dock Yard developments at Mud Cove	01/01/2019	24
Container Terminal Development (indicative, as and when demand arises)	01/01/2022	60



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Appendix VII Environmental Sustainability, Monitoring & Reporting

This annex describes a common way to monitor and report the environmental conditions of a port. Commonly these reports are known as environmental sustainability reports. This report would refer to the sustainability targets as set by the Port Authority in their masterplan or annual report.

The task of such a report is to understand the increase or decrease of impacts on the environment, and to communicate to the general public what has been done or what is planned to be done to reduce emissions and to improve the climate in and near the port.

The report can have many forms but generally consists of an introduction and the following seven areas on which modern ports commonly monitor and report environmental conditions:

- A general description of the port and the logistics areas
- Energy, Air, Water, Waste, Noise, Nuisance and Nature.

Requirements for monitoring:

1. Description of the sustainability target (mission on environmental sustainability)
2. Description of activities
3. Definition of the port-zone
4. An institutional framework in which private companies and public companies within the port zone are required to measure or estimate their emissions (CO_2, NOx, SO_2, PM10 and sometimes PM2.5, Methane, Ammonia and Ethane[14]) and report this to an (independent) entity responsible to report annually on environmental sustainability. An electronic environment reporting system in which the companies make their annual environmental report is a handy tool in the data collection a can be made mandatory by laws.
5. A set of environment monitoring stations in the port and near the port which are able to monitor air quality, noise, emissions wind force and wind directions and air-pressure on an hourly basis.
6. Key boundary levels of exhaust emissions, noise and air quality are specified as maximum values not to be exceeded. This is often stipulated in the environmental licences provided to companies in their licence to operate or concession contracts. The stipulation is often governed by national environmental / climate laws or by district / municipality laws and / or by applied international legislation on dangerous goods for example.

Sustainability targets

The port authority or the (local) government reports a sustainability target such as the following example:
To become more sustainable through energy transition and sustainable utilisation of sources to get to an energy neutral situation in 2030. This means that all energy will come through own generate energy without usage of fossil fuels or through purchase of sustainable energy. For this often an *energy program* has been formulated to come to more sustainable energy usage with targets like the following:

- 30% energy utilisation by sustainable sources (wind, solar, earth heating, use of industrial residual heat).
- A reduction of 10% CO_2 footprint in 2030 compared to 1999, and so on.

It such be clear that such quantitative targets can only be set when a zero-level measurement have been under taken with a measurement system in place. That exercise would provide the as-is situation against which improvements can be measured.

[14] A chemical cluster would typically have several additional reporting values.

In the next paragraphs the seven elements are further explained through the use of examples from the Port of Moerdijk. This Dutch port in the neighbourhood of Rotterdam contains all elements of a modern industrial port, in a concise manner, has dry and liquid bulks, container and general cargo and a petrochemical industry. Furthermore, it is located near villages and near nature reserve areas.

For example: The strategy of the Port of Moerdijk is based on the 'Triple P' principle of People, Planet and Profit. Reference is here also made to the UN sustainability development goals (SDGs). The idea behind this is that sustainable development requires a balanced development process, aimed at promoting the resilience and quality of nature (planet), the physical and mental wellbeing of the inhabitants (people) and healthy economic development (profit). Improvement of one may not be at the expense of the other. The right balance strengthens the total and not just the individual parts.

Description of activities
In the description the port and the port's activities are described. The description includes the size (ha) and volume of throughputs and the amount of people working in the port.

For example: The port of Moerdijk is an industrial port located south of the port of Rotterdam with open access to sea and inland rivers. The port handled liquid bulk, dry bulk, general cargoes, containers and consists of a industrial parc and logistics parcs. The port is operated by the (privatised) Port Authority Moerdijk. In 2016 the total volume handled was 17 million tons of which 4.9 million ton in containers. In 2016 the industrial parc encompassed 432 companies totalling 8,835 employees. Combined with port suppliers a total direct employment of about 17,059 people.

Definition of the port zone
Here the port zone is stipulated and when relevant the zoning in the port is expressed. For example: The port encompasses 2.635 ha and is located near highways, rail and inland water ways. The port is zoned into five sections, an industrial parc, an eco-parc a seaport area, logistics area and a service area. There are four populated areas (located in red) in the proximity.

Logistics

The total seagoing vessels in 2016 numbered 1,900 and inland waterways mounted to 11,383 vessels. The total volume transported increased by 5.7% to 17.5 million tons, compared to previous year. In 2016 about 886,00 tons of products was transported by rail of which the majority was steel and chemical products.

The port has a lengthy network of pipelines connecting local industry to the ports of Rotterdam and Antwerp.

Institutional framework

An institutional framework should be in place in which responsibilities on environmental monitoring and reporting is clearly defined. For complicating matters, reference is often made to various institutes to which responsibilities are allocated.

In the case of Port of Moerdijk the collector of data and the reporting entity have been placed in a separate workgroup for which a *foundation* named "Sustainable Connections Moerdijk" was formed. The stakeholders in the foundation are the Port Authority, Government departments, municipalities, representatives from a cluster of local businesses, Water supplier and the local energy board. The target for this foundation is to formulate a program which contributes to the environmental missions of the stakeholders. With other words the foundation needs to formulate a plan which service the main sustainability ambitions of each stakeholder. Sustainability means that the Moerdijk port and industrial area has an optimal balance between ecological, economic and social aspects.

The port of Moerdijk has implemented an electronic environment reporting system which compiles the relevant data. As the foundation is independent data collected is secured.

Monitoring stations

A set of environment monitoring stations is required near the port to monitor air quality, noise, emissions, wind force and wind directions and air pressure on an hourly basis.

The main objective is to measure near the city or villages in order to understand the (negative-) effects on the population. Often ports start with one or two measurement stations but for a good coverage of the port a monitoring station can be placed in each compass quadrant.

In the case of Port of Moerdijk four measurement stations were established near the main villages surrounding the port.

Key boundary levels

Key boundary levels of exhaust emissions, noise and air quality are specified as maximum values not to be exceeded. Following key boundary levels are often applied in the air measurement stations:

Type	Unit	Hourly boundary level	Annual average boundary level	Day level
NO2	µg/m3	200	40	
PM10	µg/m3	50	40	
PM2.5	µg/m3	NA	25	
Benzeen	µg/m3	NA	5	
Noise (day)	Decibel (dB(A)			50
Noise (evening)	Decibel (dB(A)			45
Noise (night)	Decibel (dB(A)			40

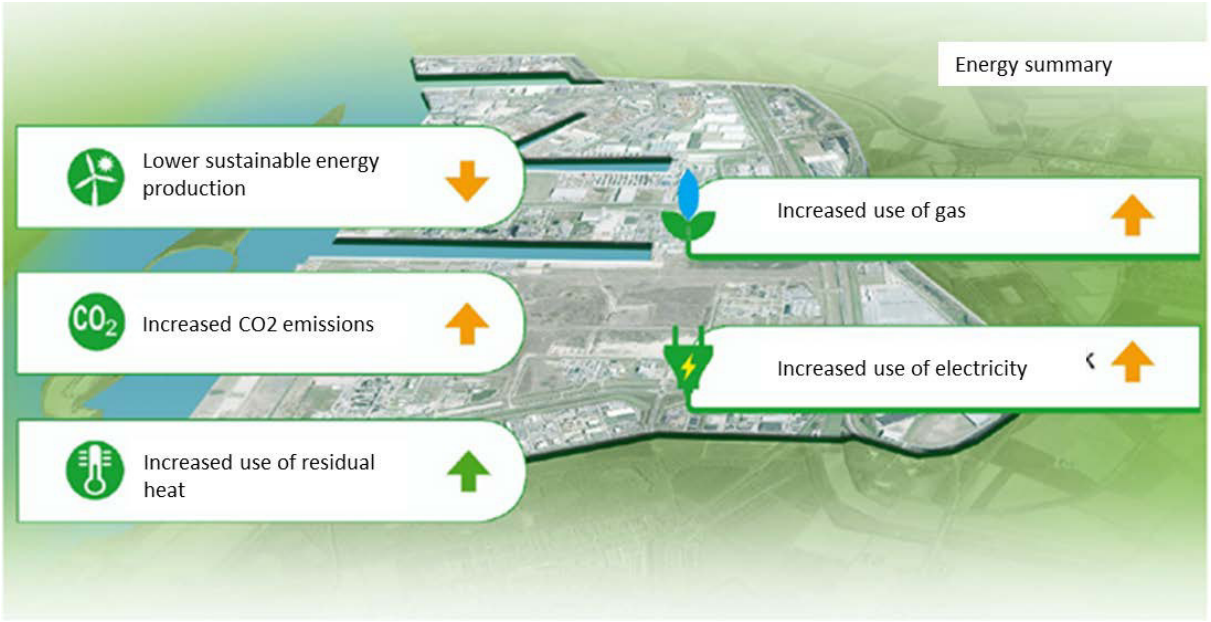
It should be noted that these levels relate to a specific area (the entire port) and not for specific companies. Through modelling with timing and wind directions, the contribution of specific zones can be illustrated.

For CO_2 and SO_2 the exhaust limits are often separately specified per company and its industrial activity. Each company needs to report its exhaust by enforced laws and when this is combined, it offers the entire CO_2 exhaust in the port in kg.

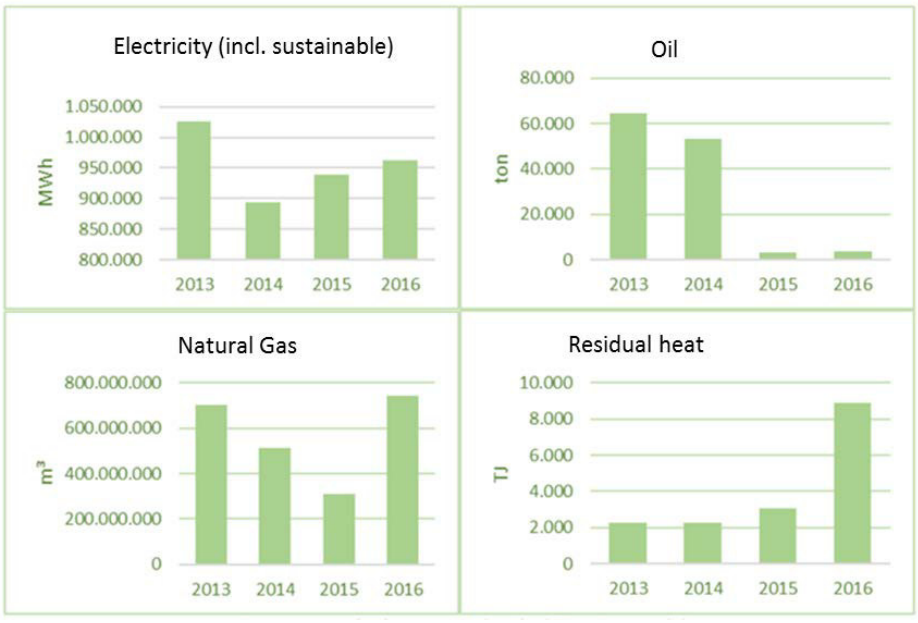
In the next paragraphs the seven themes are discussed these themes are Energy, Air, Water, Waste, Noise, Nuisance and Nature.

Energy

Under this section the energy utilisation is described. It displays the total consumption of energy bought and produced by the companies located in the port: electricity (Mwh), of Oil (tons), of natural gas (m^3) and industrial heat (in Terrajoule Tj). A sample of reporting the summary is illustrated in next figure.



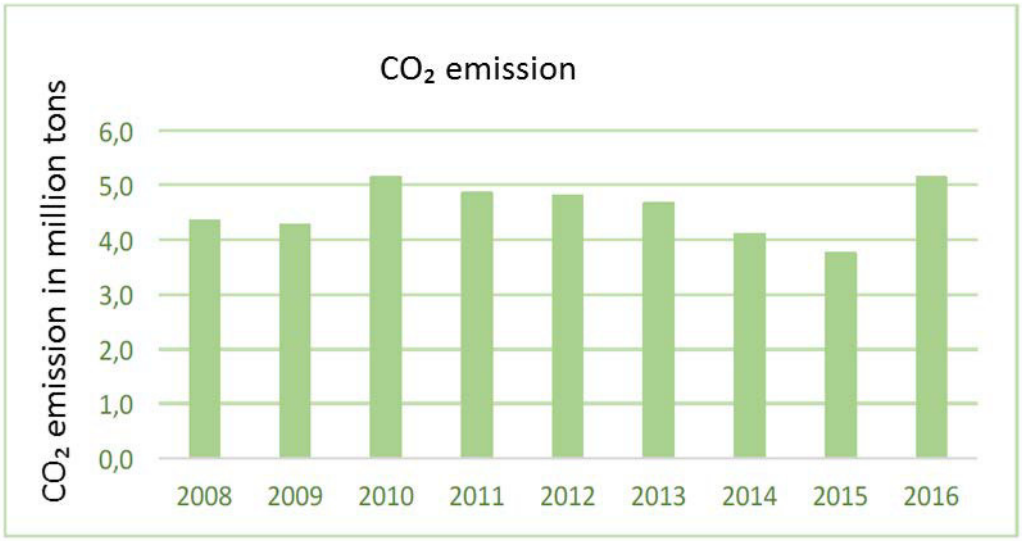
The performances illustrated in this figure refer to a yarer in which two new large industries started in the port. This had an increased effect on the energy usage and hence the emissions increased as well. Positive was the reuse of residual heat for which a specific project was executed. Each company is required to report its energy usage on an annual basis, this produces the following graphics.



Electricity purchased by companies within the port

The Port of Moerdijk showed that the energy production was 2.5 times as large as the energy consumption by local companies. The port as such is a net producer and exporter of energy. An element added in the port was the re-utilisation of residual heat from the industries by transferring this to other port companies.

The CO_2 footprint is measured through the electronic environmental annual reporting system in the port. Each company which has an environmental licence is required by law to report its CO_2 exhaust. This provides the following graphic. The target for reduction has not been met in 2016 due to a new large industry which started operations in the port. Next to residual heat, the port wants to increase the energy from wind, solar power and biomass to speed the energy transition and re-use the CO_2 for greenhouses.



What has been done :

- The port of Moerdijk started to a project for the re-utilisation of residual heat by a project with as purpose to transport residual heat from the industry towards the local energy firms. It has been estimated that this residual heat is similar to the consumption of 50,000 households. Further the project intends to transport CO_2 towards greenhouse horticulture which uses the CO_2 for the cultivation of cucumbers and peppers.
- The port has promoted the use of solar panels in the port. About 9 MW is planned to be installed by local companies.
- The port introduced LED lighting at all public places in the port including access roads. The LED lightning is also part of the sustainability vision of the port.

What are next steps:

- A start has been made with the environmental impact assessment to create a windmill parc on the west and south corner of the port.
- A new energy program for 2021 will be made.

Air quality

Under this paragraph the air quality measurement and reporting is shown. The port should have several monitoring stations which is able to measure the air quality. The air quality measurement by the port became mandatory through municipality laws.

At the port of Moerdijk four air quality stations where implemented since 2008. The stations are located near the major population centra Moerdijk, Zevenbergen, Zundert and Strijensas. At the stations the air quality is measured every hour.

The key boundary levels of air quality are specified as maximum values which should not to be exceeded.

Measure station Moerdijk	Criteria/ measurement	Value	Unit
NO2	Boundary level (hourly value)	200	µg/m3
	Measurement highest hourly concentration	105	µg/m3
	Boundary level (annual average)	40	µg/m3
	Measured annual average	21	µg/m3
PM10	Boundary level (day value)	50	µg/m3
	Measured highest day concentration	74	µg/m3
	Number of allowed trespassing of day value	35	number
	Number of measured trespassing	11	Number
	Boundary level (annual average)	40	µg/m3
	Measured annual concentration	20	µg/m3
PM2.5	Boundary level (annual average)	25	µg/m3
	Measured annual average	14	µg/m3
	Measured highest day concentration	49	µg/m3
Benzeen	Boundary level (annual average)	5	µg/m3
	Measured annual average	1.3	µg/m3
	Measured highest day concentration	58	µg/m3

What has been done:

- The measurement of the air quality is continuously followed. All measured value was within boundary limits except for PM10 which did exceed the boundary level but was still within allowed levels of trespassing.

What are next steps:

- The port started to measure also toluene, ethylbenzene, mp-xylene en o-xylene to understand the value developments. No boundary levels have been specified for these items sofar. The concentrations were declining despite increased industrial activities. The air quality as such improved.
- Through data modelling base on the wind directions and air quality measurements the contribution of port and the industrial terrain are specified.
- The target is that the air quality remains stable at the surrounding village Moerdijk despite planned expansion of industrial activities.
- The port likes to implement a real life "smell" system which will measure smell and can be used for tracing the source.
- The measurement of air quality will be continued and the results will be shared with the individual companies.

Water

Under this paragraph the utilisation of water is shown. The water supplier reports to the individual entity for reporting on environment, the water usage. This is either:

- drinking water. Used for drinking and general usage.
- industrial water. The latter is of a different water quality and used for industrial processes like cleaning, spooling and cooling.

Another two elements are measured:

- The indirect discharge of spoiled water and the rainfall discharge to the sewage system
- The use of cool water from the river and the discharge of cool water to the river.

The port of Moerdijk used 1.06 million m^3 of drinking water, in 2016. Equivalent to the annual usage of 7,100 households. About 5.4 million m^3 of industrial water is consumed.

Water discharge at the sewage system is cleaned at a sewage cleaning system nearby the port. The water supplier uses a measurement for waste water and this is reported back the environmental reporting unit.

What has been done:

- The port supported the development of new waste water pipeline system which is developed to re-use waste water to the maximum extend.
- The port aims to reduce the cooling water from the river

What are next steps:

- The port wants to create a water management plan to reduce the cool water and to create sustainable usage of waste water where possible.
- The water management should provide clear measurable objectives on water projects.

Waste

This section describes how much waste is produced and how much waste is processed or recycled on own premises and how much waste is transported to other locations. The objective is to be able to show an improvement in the reduction of waste and or the increase in re-cycling (circular economy).

The port promotes re-utilisation of waste through re-cycling. Another focus area is to create energy from waste burning and waste separation.

The data on waste is provided through the companies (public and private) active in the port which are required to report via the electronic environment system. Waste reporting normally split between handling and disposal.

Waste handling is classified as waste recycling, waste to energy, burning, dumping and waste separation. The disposal of waste is commonly split between disposal within the country and outside the country and whether it is dangerous waste or not.

In the case of Port of Moerdijk, about 2.3 million tons of waste was produced by the established companies. For comparison, every person in The Netherlands produces about 500 kg of (household) waste per year. Part of this is locally *handled* and part of it is *disposed*.

What has been done:
The reporting entity has expressed that it conforms to the national waste targets (national waste plan) rather than specifying own ambitions. The national waste plan targets are formulated as:

1. Reduce the amount of waste
2. Make waste management effective and reduce its effect on the environment.
3. Promote production chain approach or circular economy approach to reduce effect on the environment.

The companies at the port of Moerdijk exchange raw materials, energy and exchange residual flows. Residual flow from one company are re-used as raw materials for other companies (common to the chemical industry). Also, CO_2 exhaust is filtered and re-used for pigment in the paper industry. At the waste burning station, energy is used for new electricity.

What are next steps:
The port is creating an energy (re-)utilisation project to further promote green energy and to promote waste reduction and recycling. Further individual companies work also on their own sustainability targets. Together they strive forward for a more circular economy. This is an economic system in which (raw-)materials are

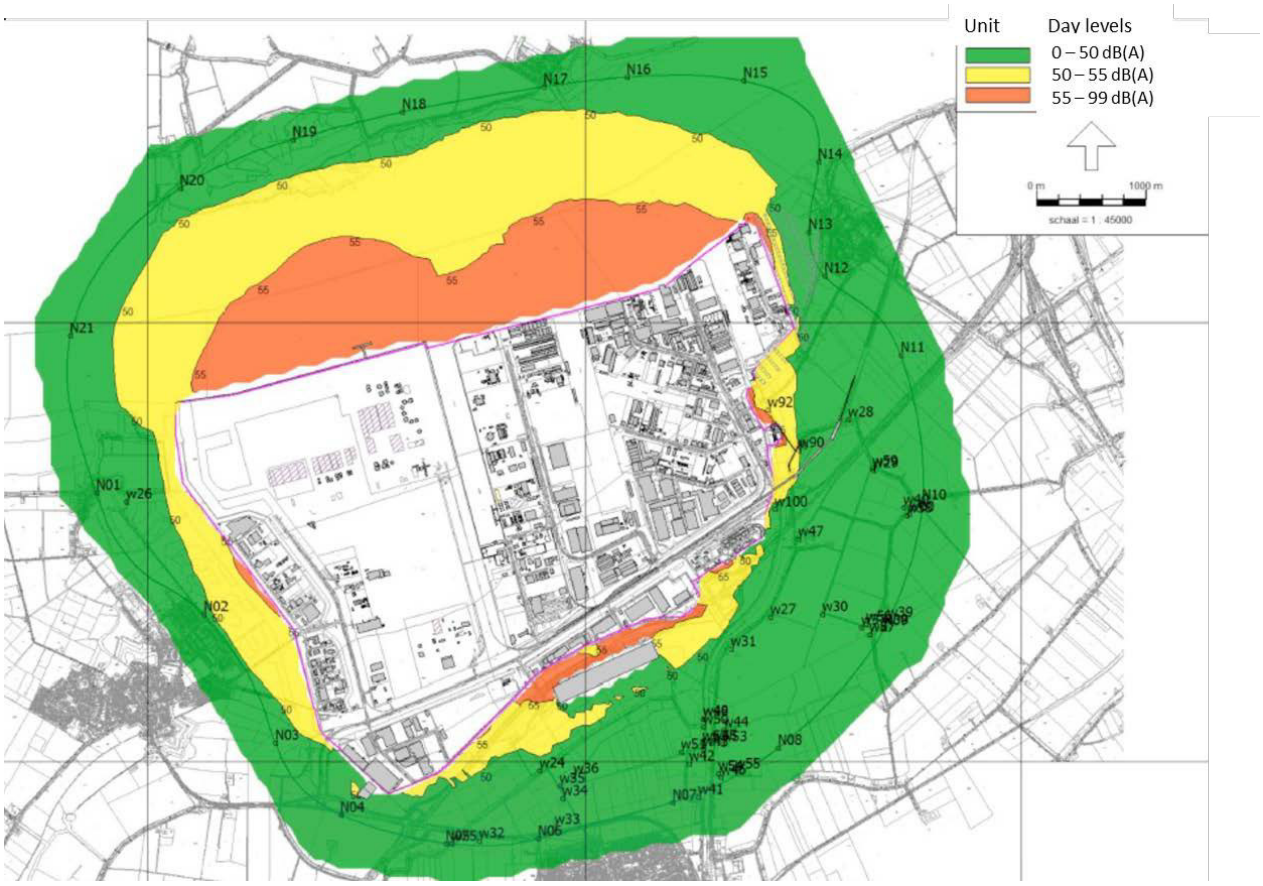
reduced, re-used, and re-cycled as much as possible. Companies in this way will also save production costs and increase their share in sustainable energy and reduce CO_2 footprint.

Noise

Noise is an important element for nuisance of nearby villages or cities. Hence for ports it becomes important to find the right balance between their noisy activities (freedom for business activities) and an acceptable living and working environment. Often noise is regulated through the company's licence to operate or an environmental climate law with separate levels for medium and heavy (noisy-) industry.

When noise is allocated under the licence to operate or concession contracts, it is important that this also reflects the situation of surrounding activities. The combined noise should not be exceeding the boundary levels measured at the villages. In order to manage the noise (when allocating the concessions) in a fair manner, a zone noise modelling is made to establish the individual noise limits when combined do not trespass the boundary level at the measurement stations.

At the port of Moerdijk activities are allowed in the heavy (noisy) industry, the noise measurements were illustrated as follows.



The port did not trespass the noise boundaries at the measure stations.

What has been done:

- Today the port acts still within the noise boundaries. However, for the future expansion the noise levels may go up. A plan is under development to optimise the noise modelling to allow port growth without trespassing the noise boundaries.

What are next steps:

- The port plans aim to reduce the noise to the surrounding. Noise barriers and forest may be some of the solutions.

Nuisance

The nuisance from households living in the surrounding city and villages form an important element in the port-city acceptance. It requires good registration, analysis and communication. The objective is to have a minimum of complaints related to the port. The communication on complaints should be accurate, responsive and transparent, in order to service the general public.

Often a separate entity (outside the port Authority) is responsible for the collection and registration of complaints and they are in charge of control and trespassing.

Nuisance by the general public may relate to many different sources. It is important to understand which of the complaints relate to nuisance caused by the port users. The independent entity will try to locate the cause of the complaint and will try to identify the source of the problem.

Once the cause is attributed to the port, the complaint is categorised into for example air quality, noise, water, noise, gas flaring and general.

Each of the segments can be subcategorised like for air quality: Chemical smell, smog, burnt rubber, cadaver, dung and so on.

As many complaints may be caused by the same event it can be categorised as a nuisance cluster. A cluster is a day in which five or more complaints are received. Noteworthy is the registration of health issues (ranged from headache to insomnia and nausea.

The port of Moerdijk registered 212 complaints in 2016, 35% less than the year before. 85% of the complaints related to air quality with a dominance to chemical smells and smoke. 7% of the complaints were related to health issues. In only 21% of the cases a causer could be identified.

What has been done

- In phases, the port has placed 26 eNoses (electronic noses) which can register smell in an early phase. The system is coordinated by the entity in charge of registry of nuisance, has now an early warning system and is better equipped to understand the cause of the problem. The eNoses report real-time changes in the air and can note CO_2 concentrations but do not register any specific chemical substances.

eNose mounted onto a lightpole.

What are next steps:

- The intention is to report more pro-active on environmental nuisance through quarterly reports on the nature and origin of the nuisance. A special taskforce has been formulated to disseminate the results also through social media.
- Improve on the analysis between complaints and registered incidents to better understand cause and origin.

Nature

Nature in and around the port is a contribution to the wellbeing of people and fauna and flora. Hence the preservation of nature is an important task within the theme environment.

The nature target of a port can be the preservation of what is there but can also be proactive contribution to nature or compensate through nature elsewhere due to port developments.

These issues are profound in Europe where the European nature-2000 regulation and the bird and habitat regulation requires compensation to nature when port development is destroying nature.

In which level the port is contributing to nature preservation and compensation may heavily depend on the local laws and regulations, local environmentalist groups as well as on the ambition of the port management. In the port of Moerdijk investments in nature are made in various fashions. Examples are:

- Green buffer zones (forest and bushes)
- Butterfly zones
- Ecological shore line for birds (swimming birds)
- Ecological ground wall (for sand martins)
- Ecological mowing zones
- Groundwater levels adjustments for birds

In 2016 Port of Moerdijk counted 74 flora and fauna species under which 57 bird species. The largest sallow colony of the province is located in the port due to the ground wall specifically made for them.

What has been done:

- The port makes an annual inventory of flora and fauna through organising counting days.
- The port has formulated a nature-management plan in which is stipulated how to care for the nature within the port boundary in the next five years. The plan also ensures the practical implementation of licenses related to nature to become easier and faster. New terrains available for development will get one license for all nature required exemptions.
- A pilot project was started to check and test company's business plans on expansions for the next 3 – 5 years against the legislation on nature. With this pilot compliance on business plans versus nature regulations is tested.

What are next steps:

- As extension on the nature-management plan a management plan for protected species is planned. This is a step in which the nature required fauna- and flora- exemptions can be gained quicker once such plan is in place. Further improvements on monitoring is probably required and possibly support of nature local and regional organisations can be sought.
- The objective is to attract more breeding birds on an island in front of the port.
- Development of biking/hiking paths along "industry and nature".
- Inventory of the new EU nature regulations and the port's obligations related to this.
- Development of nature to ensure port expansion can be compensated.

Appendix VIII Guideline to measure the CO_2 emissions of a port

Guideline to measure the CO_2 emissions of a port.
In this annex it is explained how a company or a Port Authority can measure or estimate its CO_2 emission. Please note that the examples are indicative calculations for understanding purposes only.

In developing carbon footprint inventories, GHG quantification protocols[15] define that the emission-producing activities for ports should be grouped by the following three scopes:

- Scope 1 - Port Direct Sources. These sources are directly under the control and operation of the port administration entity and include port-owned fleet vehicles, port administration owned or leased vehicles, buildings (e.g., boilers, furnaces, etc.), port-owned and operated cargo handling equipment (to the extent the port is an operating port), and any other emissions sources that are owned and operated by the port authority or port company.
- Scope 2 - Port Indirect Sources. It refers to the indirect GHG emissions from generating electricity by sources which are not owned by the port but such electricity is used by the port. These sources include port purchased electricity for port administration owned buildings and operations. Note that tenant power and energy purchases are not included in this Scope.
- Scope 3 - Other Indirect Sources. These are indirect GHG emissions due to port activities but occur from sources not owned by the port. These sources are typically associated with tenant operations and include ships, trucks, cargo handling equipment, rail locomotives, harbour crafts, tenant buildings, tenant purchased electricity, and port and tenant employee commuting (train, personal car, public transportation, etc.).

It should be noted that the port administration entity can have various activities depending on its institutional setting. For example, a land-lord port does not have operating activities whereas the port authority as operator, does have operating activities.

The following table illustrates the several scopes.

Scope 1	Scope 2	Scope 3
Port equipment (fuel-based*)	Port equipment (electrified**)	Ocean going Ships
RTG's (diesel)	STS cranes (electric)	Inland going ships
RMG (diesel)	RMG cranes (electric)	Terminal trucks going outside
Terminal tractors	RTGs (electric)	Tenants cars, vans
Reach stackers	Other electrified equipment	Tenants port operators (incl. equipment, buildings etc.)
Empty handlers	Reefers	Private Trucks
Forklift trucks	Administration buildings (total electricity usage incl. ICT)	Tenant locomotives
Spreader TT	Gate complexes	Tenant shipyard
Utilities (fuel based)	Yard lightning	

[15] Green House Gas Protocol as developed by WRI and WBCSD, ISO 14064-1

Own port equipment (fire brigade trucks, ambulance, vans, cars)	Berth lightning
Marine dept. equipment	Roads and premises lightning
Port Support boats	Cold ironing
Port Tugs	Port Locomotives (electrified)
Vans, cars	
Cleaning machines	
Equipment cleaning stations	
Port Locomotives (diesel)	
Other port support equipment	

* Most of the cases this relates to fuel burning equipment, but it can also be electrified equipment in case the port generates its own electricity (which is still not very common)
** in case electricity is bought from third parties (this is normally the national grid)

Emission Inventory Development Methodology

An emission inventory usually contains the total emissions for one or more specific greenhouse gases or air pollutants, originating from all source categories in a certain geographical area and within a specified time span, usually a specific year. The methodology adopted for this here follows referred documents by World Port Climate Initiative (WPCI), Green House Gas protocol and ISO 14064. The following steps can be applied in determining the Green House Emissions:

1. Purpose for developing emission inventory
2. Approach for developing inventory
3. Determination of the boundary
4. Listing terminal sources
5. Collect port specific data
6. Estimate CO_2 emissions
7. Proposing green technologies
8. Monitoring % reduction in emissions after implementing technologies

Purpose for developing emission inventory

The purpose of developing an emissions inventory is a key policy decision that must be established at the start of the process by the management. It will guide subsequent decisions regarding the level of detail, accuracy and the boundaries of the inventory. The aim of the emissions inventory is to develop strategies to set up a carbon emissions management system for the accurate tracking and reporting of carbon emissions and reduce carbon emissions in the entire port system in the future.

Often local legislation is required to get the institutional setting in place. Letters of cooperation and MOU's are sometimes the first step to create a common understanding and goal.

Approach for developing inventory

Commonly three methods can be defined in developing a carbon footprint of the port:

1. Activity-Based - Uses source specific data;
2. Surrogate-Based - Uses surrogates to estimate activity and/or emissions; and
3. Hybrid Based- Uses varying combinations of activity and surrogate approaches.

The activity-based method is the most detailed approach, resulting in the most accurate results and is commonly applied in a situation in which detailed data measurements are available.

The Surrogate-based method is used in situations in which data is incomplete or not available. In that case comparable sources are used for the determination of the emission footprints. In this exercise the approach is often based on lower detailed requirements and can be accomplished in less time and costs but often comes with less accuracy of the results.

If there is the desire or need to more finely determine the port's footprint knowing that further action will be needed and the resources are available, then a hybrid approach can be used to focus attention on the most significant source categories (typically ocean-going vessels, heavy-duty equipment and heavy duty transport but unique to each port).

Finally, a detailed approach may be taken if it is known that emission reduction measures will be planned and implemented (either by regulation or voluntarily).

Determination of the boundary
It is important to set the boundary of the measurement. In defining the boundaries of the emissions inventory, there are three boundaries that define and determine the scope of emissions that will be included in the assessment. They are:

- Physical;
- Organisational and,
- Operational boundaries.

It should be noted that ships only use full power at sea and in the approach to the port different speeds are applied. Also, they use only auxiliary engines while at berth. Therefore, a boundary of 2 kilometres at sea is often applied.

Listing terminal sources
At least the following equipment types should be reviewed:

- Cargo handling equipment. This group together with the ships generate the most emissions in the ports. The group consists of for example; STS cranes, RMG cranes, tractor trailers(TT), Reach stackers, Empty container handlers, forklifts, reefers and trucks visiting the port.
- Utilities and reefers. Utilities are for example lightning, pumps, general electricity consumptions. The reefer boxes generate emissions during their port stay.
- Ships in the port generate emissions through their auxiliary engines on board whilst in the port.
- Locomotives if applicable.

Other equipment as specified in the table with the three scopes mentioned above.

Cargo handling equipment
First of all, an inventory of cargo handling equipment needs to be made in which type of horizontal movers and vertical lifters are expressed by type and engine. Secondly the annual hours of operations are needed for an in-depth calculation under the activity based approach.

For an annual activity-based inventory, the following list is an example of the data that can be collected for each piece of fuel-burning cargo handling equipment:

- Internal equipment identification number/name
- Equipment type

- Model year
- Equipment and engine manufacturer(s)
- Model designation(s)
- Fuel type
- Rated power (e.g., kW or horsepower)
- Emission control devices or methods (other than standard for the model and year)

Data frequency

- Annual hours of operation
- Fuel consumption (per year or per hour)
- Average load factor while operating

Emission data

- Emission factors appropriate to the types of engines in the inventory, kg pollutant/kW-hr or kg pollutant/litre or kg fuel (or lbs pollutant/gallon fuel) obtained from the GHG protocol.
- Control factors (percent reduction offered by identified emission control devices or methods)

In case of the recharging data is not available then this should be included in the overall energy purchased consumption for buildings. Preferably the purchased consumption should be specified by the mix of power generating technologies. In case of electrified STS cranes the power consumption (in MW-hrs) should be estimated from the utilities bills or drop meters.

Not all of the source data listed above is directly needed for estimating emissions. Items such as the internal identification number, manufacturer, and model designations can be used in subsequent planning if equipment changes are considered as a means of reducing emissions.

Collect port specific data

The collection of port specific data refers to questions like the following:
Understanding the national power. What is the CO_2e KWh of the national grid? What is type of diesel applied in the port? Are all equipment's and their running hours available? Is their mandatory law in place for reporting emissions? Has there been a major improvement in respect to STS cranes or RTG cranes which influence the base or reference year?

In case huge gaps of data exists, the CO_2 calculations can still be conducted on a hybrid or on a surrogate method using examples from similar equipment elsewhere.

Estimate CO_2 emissions

In this paragraph examples calculation methods for CO_2 are provided for the cargo handling, marine tugs and heavy-duty truck moves.

Cargo handling equipment

Depending on the information collected, emissions can be estimated using fuel or energy figures. For both fuel-based and energy-based calculations, it is important to calculate the emissions from equipment using different fuels separately, because the emission factors are different for each fuel. In addition, fuels classified as biofuels (e.g., biodiesel and ethanol) should be calculated separately, even if the biofuel is a component of a fuel blend (such as a B20 blend of biodiesel and petroleum diesel).

In case of fuel, the equation per unit would be:
Emissions (kg pollutant/yr) = Fuel consumption (litres fuel/yr) x Emission Factor (kg pollutant/litres fuel)

Example and tractor trailer at the terminal:

Suppose:

- Fuel consumption: 40,000 litres/year (obtained from the equipment owner or operator, from fuelling records or estimates)
- Emission factor: 2.75 kg CO_2/litre (from GHG Protocol value of 74.01 kg CO_2/gigajoule (GJ), with a lower heating value of 0.0371 GJ/litre: 74.01 kg/GJ x 0.0371 GJ/litre = 2.75 kg CO_2E/litre)

Result: 40,000 litres/year x 2.75 kg CO_2/litre = 110,000 kg CO_2/year or 110 tonnes CO_2E /year

Typical running hours at large container terminals and diesel consumption

Type	Terminal Trucks	ECH
Running hours per unit / year	4,000	3,700
Diesel consumption / unit / hour	10 l/h	10 l/h

Source: MTBS

In case of energy, the equation per unit would be:

Emissions (kg pollutant/yr) = Rated Power (kW) x Load Factor (unitless) x Operating Time (hours/yr) x Emission Factor (kg pollutant/kW-hr)

Example of a RMG at the terminal:

Suppose:

- Rated power: 60 kW (obtained from the equipment owner or operator; more specifically from documentation related to that specific piece of equipment or an identical piece of equipment)
- Load factor: 0.65 (to be obtained by other measurements)
- Operating time: 3,500 hours per year (obtained from the equipment owner or operator, either from hour meter or from an estimate based on operating schedule)
- CO_2 emission factor: 661 g CO_2/kW-hr (calculated from engine BSFC of 209 g/kW-hr[16], fuel C content of 86.3%[17]: 209 g/kW-hr x 0.863 x (44/12)[18] = 661 g/kW-hr or 0.661 kg/kW-hr)

Result: 60 kW x 0.65 x 3,500 hrs/yr x 0.661 g CO_2/kW-hr = 90,226 kg CO_2/yr or 90.2 tonnes CO_2E/yr

Typical running hours at large container terminals and electric consumption

Type	STS cranes	RMG
Running hours per unit / year	4,000	3,500
Electric consumption unit / hour	117 kWh/h	60 kWh/h

Source: MTBS

Marine department equipment

[16] BSFC is an example typical of large diesel engines

[17] The carbon content of diesel fuel is from "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006 (15 April 2008) - Table A-37: Carbon Content Coefficients and Underlying Data for Petroleum Products"

[18] The factor of (44/12) is the ratio of the molecular weights of CO_2 (44) to carbon (12). This calculation assumes all of the carbon in the fuel is burned to CO_2.

This section discusses methods that can be used to develop estimates of greenhouse gas emissions from harbour craft and vessels. Harbour craft are characterized by vessels that spend most of their time within or near a harbour and typically are in harbour transit, manoeuvring, and idling modes. Vessels falling under the harbour craft source category include a wide variety of vessel types and applications that tend to operate in and around a harbour or port, relatively close to shore or that are used specifically for assisting with port operations or local public transportation. Harbour craft differ from ocean going vessels in that they do not traverse oceans or seas in typical operation. Examples of harbour crafts are for example:

- Assist Tugboats – assist ocean going vessels during manoeuvring and docking
- Towboats and Push boats –move barges and other floating objects
- Local ferries –carry passengers to specified locations near ports, harbours, and cities
- Excursion vessels – used in commercial sightseeing
- Crew boats –ferry crew members between ships and shore
- Work boats –carry workers to offshore locations
- Government vessels – including police, fire, and coast guard vessels
- Commercial fishing vessels – used in the commercial fishing industry
- Pleasure craft – usually privately owned small boats and yachts

As with all transport sources, estimating emissions from harbour crafts and alike requires gathering as much information as possible on the vessels and engines being modelled. Ideally, information would be collected on the population of the vessel fleet, the types and sizes of the vessels in use, the number and power rating of the engines in each vessel, the amount and types of fuel consumed, and the types of activities as in modes of operation that the vessels encounter in daily operation.

Once the characteristics of the fleet are known, greenhouse gas emissions from harbour crafts can be estimated using the following general equation:
emissions (g pollutant/yr) = emission factor x fuel consumption

The California Air Resources Board (CARB) provide the grams of pollutant per gallon of distillate fuels consumed by engines in the transportation sector.

Vessel Type / g per gallon distillate consumed	CO_2	N_2O	CH_4
Harbour crafts	10,138 g	0.0832 g	0.416 g

Example fuel based:

Suppose:

- Fuel consumption: 10,000 gallons/year (from fuel meter readings/fuel receipts)
- Emission factor: 10.14 kg CO_2/gallon (see above)

Result: 10,000 gallons/year x 10.14 kg CO_2/gallon = 101,400 kg CO_2/year or 101.4 tonnes CO_2/year
In this case, the corresponding activity would be gallons of fuel consumed over a specified period and can be regarded as the most simplified approach.

When a more sophisticated approach is required it would be preferable to have the emission factor expressed in terms of grams of pollutant per kilowatt-hour rather than grams per gallon, the corresponding activity would then be kilowatt-hours. This creates a more reliable calculation, but characteristics and operating parameters of each vessel engine would be required. In the expanded equation below, these factors are taken into account.

The calculation method could be as follows:
emissions (g pollutant/yr) = rated horse power (kW) x load factor (unitless x operating time (hours/yr) x emission factor (g pollutant/kW-hr)

The next table illustrates default load factors by vessel type used by the state of California to estimate the emissions of various types of harbour crafts.

Vessel Type	By propulsion	By Auxiliary
Tugboat	0.31	0.43
Crew boat	0.45	0.43
Ocean tug	0.68	0.43
Workboat	0.45	0.43
Excursion boat	0.42	0.43

Source: California State Authority

Greenhouse gas emission factors for various sized engines expressed in terms of grams of pollutant per unit of work are typically available from state or national environmental protection or regulatory agencies. During the certification process, engines are tested under varying speed load combination to ensure that their emissions are below the allowable limits established through emission standards. Although CH_4 and CO_2 are routinely measured during certification, special testing is required to measure N_2O and this data may be harder to obtain.

Example energy based for an excursion boat:
Suppose:

- Rated power: 1,000 kW for a tugboat (obtained from the engine manufacturer, owner or operator)
- Load factor: 0.42 (see above)
- Operating time: 1,000 hours per year (obtained from the equipment owner or operator, either from hour meter or from an estimate based on operating schedule)
- CO_2 emission factor: 652 g CO_2/kW-hr (obtained from CARB[19])

Result: emission = 1,000 kW x 0.42 x 1,000 hrs/yr x 652 g CO_2/kW-hr = 273,840,000 g CO_2/yr or 273.84 tonnes CO_2/yr

Note a tugboat would have considerably more power often up to 5050 KW or 6772 BP for a 80t BP ASD tugboat.

Heavy-duty truck moves
Similarly, emissions for the heavy-duty trucks moving in and out of the port can be calculated. Here the number of trips and the average trip distance (regional distance) needs to be determined. Another issue is the idle time on terminal and the running at the terminal.

The annual distribution of the port truck fleet can be determined by an examination of port tenants' records of vehicle arrival and departure if license plate information is collected at the gate(s). In many cases this information is gathered for accounting purposes either manually or electronically, however most modern

[19] California Air Resources Board (CARB)

terminals use optical character recognition systems (OCR) or radio frequency identification devices (RFID). Whether recorded manually or electronically, the gathered license plate information is ultimately forwarded to government motor vehicle departments, which maintain registration information of these vehicles, to determine trucks age distribution.

At the terminal transport includes idle or very low speed operation of trucks as they wait at gates or in queue, and running which occurs as goods are picked up or dropped off. Therefore, in estimating at the terminal greenhouse gas emissions is based on both hours of idle operation as well as distance travelled. The corresponding emission factors would be expressed in terms of grams of pollutant per hour and grams of pollutant per mile or kilometre driven.

Estimates of the hours of idle operation can be obtained through survey of terminal operators or by actual measurement of queue times at gates. Emission rates of greenhouse gases expressed in terms of grams per hour are readily available from regulatory agencies such as the California Air Resources Board (CARB), as presented in the table below.

Transportation in the port and regional activity are traditionally estimated on a gram-per-distance-travelled basis and take into consideration an overland boundary representing the extent to which the port has influence over, or is accountable for, the emissions associated with goods moved by truck. In some instances, it has been assumed that the port is responsible for and has influence over the emissions from trucks from the point of entry across the overland boundary on the way to the port, and to the first point of rest (initial destination) upon leaving the port. After the initial destination or the first point of rest, additional emissions associated with the movement of these goods is traditionally assumed to be under the influence of, and therefore, the responsibility of the importer or its agent.

The average distance driven per truck trip either at the port or regionally can vary widely. Average trip lengths can be determined through travel surveys where truck drivers or owners are questioned regarding their origin prior to visiting the port and their intended destination upon departure. Alternatively, devices such as global positioning systems (GPS) have been used to electronically track the activity of subsets of the heavy duty truck fleet. Once the average truck trip length has been established, emissions are estimated using a gram per distance travelled emission factor (see below table) multiplied by the total miles driven.

The following tables illustrate the idle time emissions and the Expressway transport emissions[20].

Type emissions for idle hours (g/hr)	CO_2	CH_4	N_2O	CO_2E
Heavy-Duty diesel	4,640	0.183	0.037	4,655.3

Source: CARB

Type (g/km)	CO_2	CH_4	N_2O	CO_2E
US advanced technology	987	0.04	0.03	997.1
Modern engine	1,011	0.05	0.03	1,021.4

[20] Sources include: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1996, Table C-10

8 E.U. 60% Load - Transport Statistics Bulletin: Road Freight Statistics 2005, DfT SB (06), 27 June 2006 9 E.U. Fuel Use - Digest of UK Energy Statistics, Department of Energy & Climate Change.

Uncontrolled	1,097	0.06	0.03	1,107.6
EU articulated Diesel truck > 33t				
Average load	943.7	1.53	1.02	1,293.0
Fully loaded	1,123.5	1.53	1.02	1,472.7

With this information two examples are provided, the detailed approach including idle times and the more general approach based on fuel consumed. The latter is based on fuel consumption rates and greenhouse gas emission factors per unit volume of fuel to determine the emission estimates.

Example heavy duty trucks with waiting times at terminals:

Suppose:

- 1,000 advanced technology heavy-duty trucks in the port truck fleet
- Average Idle Time: 30 minutes per truck trip
- Average Trip Distance at the Terminal: 1 kilometre per truck trip
- Average Regional Trip Distance: 60 kilometres per truck trip
- Truck Trips: 1,000 trips per year

Results idle time at terminal: 1,000 trucks x 1,000 trips/year x 30 min/trip x 1 hr/60 min x 4,655.3 g CO_2E/hr = 2,327,650,000 g CO_2E /yr or 2,327.65 tonnes CO_2E /yr

Results terminal running time: 1,000 trucks x 1,000 trips/year x 1 km/trip x 997.14 g CO_2E/km = 997,140,000 g CO_2E /yr or 997.14 tonnes CO_2E /yr

Results regional transportation: 1,000 trucks x 1,000 trips/year x 60 km/trip x 997.14 g CO_2E/km = 59,828,400,000 g CO_2E /yr or 59,828.4 tonnes CO_2E /yr
Total heavy-duty diesel CO_2E = 3,325 + 59,828 = 63,153 tonnes/year

Example heavy duty truck based on the fuel consumption approach:

Suppose:

- 1,000 heavy-duty trucks in the port truck fleet
- Truck Trips: 1,000 trips per year
- Average Fuel Consumed per Trip: 5 gallons per truck trip

Results: emissions = 1,000 trucks x 1,000 trips/year x 5 gallons/trip x 10,248.1 g CO_2E/gal = 51,240,500,000 g CO_2E /yr or 51,241 tonnes CO_2E /yr

Proposing green technologies

The following items are often considered in improving the carbon footprints:

- Routing of trucks and equipment. As transport units travel continuously across the port, a reduction in *travel distance* would directly contribute to emission reductions
- Reduce idle time. The *waiting time* of ships, equipment and trucks generate emissions whilst not contributing to activities. Once waiting times are reduced or engines are switched off whilst waiting (for example for trucks) a significant reduction of emissions can often be realized.
- Upgrade the diesel to bio-diesel. The CO_2 emissions by RTGs are often one of the highest contributors to emissions in port. Reducing the carbon value of diesel through using blended diesel (30% biodiesel) contributes directly.

- Upgrade to E-RTG. It has been reported that E-RTGs can reduce CO_2 emissions by 70% compared to conventional RTGs.
- Improve the modal split. The amount of exhausts are reduced when shifting from truck to rail and or inland barges. The energy consumption per ton mile per inland barge is 83% less comparedto goods transported by truck and 50% less compared to rail transport.[21]
- Reduce consumption in the port through less lights, avoidance of trips and installation of LED lights.
- Improve the engine types and introduce clean engines (for example; trucks with modern engines, LNG power on port vessels, electric bikes and electric cars for port personnel)
- Cold ironing. Ships could use shore power instead of their auxiliary engines whilst at berth. It should be noted that cold iron contributes only to CO_2 emissions once the shore power is generated by effective means. Often shore power sourced through coal fired power stations does not reduce the CO_2 emissions. Important is the CO_2/kWh of the national grid. Studies indicated that if the shore power is more than 800g CO_2/kWh, cold ironing would increase the CO_2 exhausts[22] rather than reduce it.

Monitoring % reduction in emissions after implementing green technologies

Important is to be able to repeat the CO_2 calculations annually (preferably in similar manners) in order to understand the trend in CO_2 produced. A common way is to institutionalise the CO_2 measurements through local environment legislation. In that case the relevant port users are mandatory obliged to report on the exhausts. Before this is done it is important to fully describe the method of calculations aligned with international guidelines on GHG emissions as for example by the Greenhouse Gas Protocol or in the ISO protocol 14046-1.

In a phase preceding the mandatory reporting situation, a pilot could be started to implement such situation and to monitor the CO_2 produced.

[21] European commission, inland waterway transport

[22] Hall, 2010