Democratic Socialist Republic of Sri Lanka: National Port Master Plan
(Financed by the Japan Fund for Poverty Reduction)
The Colombo Port Development Plan – Volume 2 (Part 5)

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For Sri Lanka Ports Authority

This consultant's report does not necessarily reflect the views of ADB or the Government concerned, and ADB and the Government cannot be held liable for its contents. (For project preparatory technical assistance: All the views expressed herein may not be incorporated into the proposed project’s design.)
The short-term priority projects are identified then on the basis of:
- The severity of the issue
- Low / Medium / High
- Short term means <10 years

These 20 projects are then scored on the basis of:
- Whether or not it is a SLPA responsibility
- The complexity; and
- The impact

A minimum score of three is needed to be selected. As displayed in diagram below.
15.3 Selection Results Short Term Priority Projects

Based on the selection criteria’s the following 6 projects were selected as Short Term Priority Projects:

1. JCT Modernisation Plan
2. PVQ Upgrade Plan
3. (F)LNG Handling and Storage Facility
4. Dedicated Passenger Terminal on BQ
5. Port Community System
6. BQ Warehousing Relocation Plan

The table below displays the selection evaluation:

Table 15-1: Scoring Short Term Priority Projects

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Short Term Priority Projects</th>
<th>SLPA Responsibility</th>
<th>Impact</th>
<th>Complexity</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cargo Operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP1</td>
<td>JCT Modernisation Plan</td>
<td>✓</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>SP2</td>
<td>Dedicated berth for grains and cement</td>
<td>✓</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>SP3</td>
<td>PVQ Upgrade Plan</td>
<td>✓</td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>SP4</td>
<td>Sapugaskanda oil refinery</td>
<td>Ø CPC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP5</td>
<td>(F)LNG Handling and Storage Facility</td>
<td>✓</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>SP6</td>
<td>UCT Transformation Plan</td>
<td>✓</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>SP7</td>
<td>Dedicated Passenger Terminal on BQ</td>
<td>✓</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>SP8</td>
<td>Port Gate Upgrade Plan</td>
<td>✓</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Warehousing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP9</td>
<td>BQ Warehousing Relocation Plan</td>
<td>✓</td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>SP10</td>
<td>Relocation Mechanical and electric workshops</td>
<td>✓</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>SP11</td>
<td>The resettlement of underutilised buildings</td>
<td>✓</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Source: MTBS
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Short Term Priority Projects</th>
<th>SLPA Responsibility</th>
<th>Impact</th>
<th>Complexity</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP12</td>
<td>Port road plan (widening &amp; upgrading)</td>
<td>✓</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>SP13</td>
<td>Port Gate Automation</td>
<td>✓</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>SP14</td>
<td>PAEH Simulations</td>
<td>☿ RDA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP15</td>
<td>PAEH Development</td>
<td>✓</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>SP16</td>
<td>Securing Future Rail Path to South Harbour</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>SP17</td>
<td>Port Community System</td>
<td>✓</td>
<td>++</td>
<td>++</td>
<td>++++</td>
</tr>
</tbody>
</table>

Source: MTBS
16 Pre-Feasibility Studies

16.1 Introduction

This chapter presents the financial and economic pre-feasibility studies for the selected projects, as well as the preliminary environmental and social impact assessment.

Selected Projects
The 5 Colombo projects selected for pre-feasibility are:

1. JCT Modernisation Plan
2. (F)LNG Handling and Storage Facility
3. Port Community System
4. BQ Warehousing Relocation Plan
5. PVQ Upgrade Plan

The passenger terminal has been delivered in a separate document. The port community system and PVQ upgrade plan are plans which need to be evaluated on an operational level with in depth recommendations. SLPA has requested to focus the prefeasibility study of these two projects on the operational and technical level instead of the financial level.

In paragraph 17.2 the methodology is explained as well as the objective, framework, methods approach and basic assumptions.

In paragraph 17.3 the results are displayed, basically showing both financial and economic viability for JCT Modernization Plan, (F) LNG handling and Storage Facility and the BQ Warehousing Relocation Plan. The PVQ plan is not considered financially viable nor economically viable.

16.2 Methodology

16.2.1 Objective
The objective is to indicate whether or not the identified projects are viable from a financial, economic and 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 In case it is also financially viable, then there is no need for government subsidy.

<table>
<thead>
<tr>
<th>Economically Viable</th>
<th>Financially Viable</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>• Implement the project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Project generates sufficient return to recover the investments</td>
</tr>
<tr>
<td>✓</td>
<td>✗</td>
<td>• Implement the project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Government/SLPA subsidy is needed or the tariffs should be redefined to make the project financially feasible as well</td>
</tr>
<tr>
<td>✗</td>
<td>✗</td>
<td>• Don’t implement the project</td>
</tr>
</tbody>
</table>
**Economically Viable** | **Financially Viable** | **Recommendation**
---|---|---
| | | • It is very unlikely that a project is feasible
| x | ✓ | • Don’t implement the project
|   |   | • This is a very unlikely scenario

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.

### 16.2.2 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.

### 16.2.3 Approach to Prefeasibility
The general approach to the financial and economic prefeasibility is visualised in the following figure.

- 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 “no 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 prefeasibility the social discount rate (SDR) is considered as hurdle rate.
- Then, the **financial cash flows**: 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.

16.2.4 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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FINANCIAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perspective</td>
<td>SLPA</td>
<td>The port projects are typically part of broader project plans. For the financial analysis, SLPA’s perspective is taken as a basis.</td>
</tr>
<tr>
<td>WACC SLPA</td>
<td>10%</td>
<td>No official WACC or hurdle rate for financial viability is known.</td>
</tr>
<tr>
<td>Inflation</td>
<td>-</td>
<td>As a pre-feasibility analysis, the model is in real terms</td>
</tr>
<tr>
<td>Currency</td>
<td>USD</td>
<td></td>
</tr>
<tr>
<td>Sri Lanka Rupee exchange rate / USD</td>
<td>153.4</td>
<td>Per 1st of December 2017</td>
</tr>
<tr>
<td>Tax Rate</td>
<td>10%</td>
<td>According to the SLPA’s Financial statements:</td>
</tr>
<tr>
<td>Modelling period</td>
<td>2018-2050</td>
<td></td>
</tr>
<tr>
<td>Basis for revenues</td>
<td>SLPA tariff book</td>
<td>SLPA financial report</td>
</tr>
<tr>
<td><strong>ECONOMIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perspective</td>
<td>Sri Lanka</td>
<td></td>
</tr>
<tr>
<td>Social Discount Rate</td>
<td>7.8%</td>
<td>Based on calculation: ( r = e^*g + p )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• e: elasticity of marginal social welfare with respect to public expenditure: 1.5 (estimate, typically between 1 and 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• g: expected per capita consumption growth: 4.35% (IMF projection real GDP per capita growth)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• p: pure tie preference: 1.3 (empirical studies)</td>
</tr>
</tbody>
</table>
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 No evidence for market distortions.
- Labour 0.85 Based on an average income tax of 15%

Conversion factor Revenues: > tariff “Willingness to Pay”

WTP 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)

### 16.3 Results

The results from the prefeasibility studies are displayed in the table below. The JCT Modernisation plan, the (F)LNG project and the BQ Warehouse relocation plan are both financially feasible and economically feasible. The PVQ Upgrade plan is considered not feasible.

<table>
<thead>
<tr>
<th>Project</th>
<th>Financial Feasibility</th>
<th>Economic Feasibility</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCT Modernisation</td>
<td>✓ Npv 40.3 M USD</td>
<td>✓ ENPV USD 88.8 M USD</td>
<td>Implement Project</td>
</tr>
<tr>
<td></td>
<td>IRR: 16.2%</td>
<td>ERR: 20.8%</td>
<td></td>
</tr>
<tr>
<td>LNG Jetty</td>
<td>✓ Npv 0 USD</td>
<td>✓ ENPV: USD 1.8 B USD</td>
<td>Implement Project</td>
</tr>
<tr>
<td></td>
<td>IRR: 10.0%</td>
<td>ERR: 529%</td>
<td></td>
</tr>
<tr>
<td>BQ Warehousing</td>
<td>✓ Npv 2.5 M USD</td>
<td>✓ ENPV 15,9 M USD</td>
<td>Implement Project</td>
</tr>
<tr>
<td>Relocation</td>
<td>IRR: 11.8%</td>
<td>ERR: 16.4%</td>
<td></td>
</tr>
<tr>
<td>PVQ Upgrade</td>
<td>✗ Npv -11.05 M USD</td>
<td>✗ ENPV: -2.53 M USD</td>
<td>Do not implement project</td>
</tr>
<tr>
<td></td>
<td>IRR: N/A</td>
<td>ERR: 5.99%</td>
<td></td>
</tr>
</tbody>
</table>
17 JCT Modernisation Plan

17.1 Background to the Project

The Jaya Container Terminal (JCT) is one of the largest container terminals in the port of Colombo in terms of capacity, with a design capacity of 2.45 M TEU per annum. The table below provides an overview of the facilities at the terminal, as well as historic throughput figures.

The following key observations can be made regarding JCT’s facilities and throughput:

- Container volumes have increased from 1.5 M TEU in 2005 to 2.1 M TEU in 2015.
- The bend in the JCT’s quay wall hampers simultaneous berthing of 2 large vessels at JCT III and JCT IV, as quay length of JCT III and IV combined is 660m.
- The JCT III and IV berths have a water depth of approximately CD -15.0m, which is insufficient to handle the largest container vessels. Water depth cannot be improved due to the quay wall structure. The JCT I and II berths have an even more restrictive water depth of approximately CD -12 to -13.0m.
- Container handling equipment is outdated, with the majority of quay cranes being 20 to 30 years old.
- JCT has a terminal depth of approximately 300m, which is considered only marginally adequate.
- The bended quay wall limits the flexibility to berth vessels. To build a new quay wall in front will be very costly and challenging during construction time, in that case the full old basin should be deepened to cater for larger vessels, quay wall rehabilitated and the basin entrance, turning circle and entrance channel adjusted accordingly.

The JCT terminal needs an upgrade to at least survive another 10-15 years in the challenging market. This project is focussed around berth optimisation and the lifetime extension of the terminal considering existing lay-out of the old basin. The project is initiated to keep JCT at acceptable levels of operating, increase flexibility to handle large container vessels and to enable JCT to cope with competition. The project will lengthen the terminal lifetime in a period in which Port of Colombo requires the container terminal capacities as demand for the facilities remain strong in the future. 7

17.2 JCT Quay Extension

17.2.1 Existing Infrastructure

At the south end of Berth no. 4, it has been proposed to extend the container quay across the adjacent basin. The length of the quay extension will be approximately 120m. With this extension, no access for vessels to Feeder Berth and JCT Cross Berth on the opposite side of basin will be possible any longer. In effect this is a loss of 180m Feeder berth and 190m Cross berth. The latter is merely used for berthing of ships which do not handle cargo.

It is assumed that the basin at the back of the new quay will be filled and used as stacking area.

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7 A more detailed analysis of JCT (re)development options has been conducted, as part of a separate assignment. The options discussed in the “JCT deepening” report are variations on the JCT (re)development option discussed in this section. However, none of the proposed solutions for JCT (re)development were selected as the preferred solution.
17.2.2 Technical Observations

During the site visit it was observed that the corner section of the existing quay (assumed to be the corner caisson) has experienced some movement. This movement resulted in a vertical gap of approximately 5cm width across the apron. The water table could be seen through the gap. Apparently, the STS-crane do not actually enter the corner section. But in the future, they will have to move across this section for access to the proposed new quay extension. Further investigation of the problem is recommended.

Figure 17-2: Gap at Corner Section
17.2.3 Proposed Development
In the event that the basin behind the quay extension shall be backfilled and paved for stacking of containers the new quay shall be designed as a closed structure (caissons or equivalent) of sufficient capacity to carry container cranes.

17.2.4 Cost Estimates Quay Extension and Back Fill

<table>
<thead>
<tr>
<th>HP</th>
<th>PO</th>
<th>UP</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate (USD)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>JCT Quay Extension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Quay Structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>New quay</td>
<td>m</td>
<td>125</td>
<td>45,000.00</td>
<td>5,625,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Quay equipment</td>
<td>m</td>
<td>125</td>
<td>1,800.00</td>
<td>225,000.00</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Crane rails</td>
<td>m</td>
<td>260</td>
<td>800.00</td>
<td>208,000.00</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Crane accessories</td>
<td>Sum</td>
<td>1</td>
<td>500,000.00</td>
<td>500,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Other Works</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Dredging (-15m)</td>
<td>m³</td>
<td>75,000</td>
<td>20.00</td>
<td>1,500,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Reclamation</td>
<td>m³</td>
<td>225,000</td>
<td>6.00</td>
<td>1,350,000.00</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Pavement</td>
<td>m²</td>
<td>28,000</td>
<td>90.00</td>
<td>2,520,000.00</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Utilities</td>
<td>Sum</td>
<td>1</td>
<td>1,000,000.00</td>
<td>1,000,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Subtotal</td>
<td></td>
<td></td>
<td></td>
<td>12,928,000.00</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Site installation costs</td>
<td>10%</td>
<td></td>
<td></td>
<td>1,292,800.00</td>
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</tr>
<tr>
<td>04</td>
<td>Planning and design</td>
<td>5%</td>
<td></td>
<td></td>
<td>646,400.00</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Contingencies</td>
<td>15%</td>
<td></td>
<td></td>
<td>1,939,200.00</td>
<td></td>
</tr>
</tbody>
</table>

16,806,400.00

17.2.5 Proposed Operational Upgrades

- **RTG upgrade**
  In case additional RTGs will be required in the future, it is worthwhile to invest in a larger type of equipment, capable of stacking 1-over-6 high (41t), instead of the current 1-over-5 machines. This can increase the yard capacity of the JCT terminal with almost 20% under the condition that the terminal pavement allows for stacking of one additional layer. During the procurement process of new RTGs, it is recommended to opt for electric driven units, which require less maintenance and are much more environmental friendly. Electrification of the equipment fleet requires some additional investments in civil infrastructure to provide electrical power to the machines.
• **TOS system upgrade**
  It is recommended to upgrade as quickly as possible from the current ‘outdated’ terminal operating system Navis 3.7 version to the ‘state-of-the-art’ version N4 of the same supplier. This will enhance the terminal operations as well as the gate processes and the communication interfaces to the outer world: consignees, agents, shipping lines, port authority, customs, through automatic notifications, etc. This should also interlink with the port community system. While the conversion of a terminal operating system has a thorough impact on the ongoing terminal operations, it is of utmost importance to assign a dedicated team for this project. The new system will be utilised to its maximum including: OCR, Yard optimisation, distance to quay, equipment allocation, equipment availability, MIS reporting package, real-team operations dashboard and information, link to billing and financial central system.

• **Operators per equipment**
  Current shift system can be compared to the other operators. SLPA uses two operators for most types of container handling equipment; this compares to 1.3 or 1.7 operators per equipment in other terminals. A cost reduction could be made here without impacting the productivity.

• **Shift system**
  SLPA works in a shift from approx. 12 hours (07:00 – 18:00 day shift) - (17:30 to 07:00 night shift). Overlap within the shift change is not uniform. In many international cases container terminal operators have preferred a 3 * 8 hours system. This results in less labour force once a different roster scheme is applied.

• **Labour Unions**
  The labour unions in the Port of Colombo are strong, impacting the flexibility to change shift systems or to reduce labour. It is noteworthy that CICT has been set-up without labour unions. Some other major container ports in the world have organised a common labour pool for all terminal in their ports. This has resulted in more effective labour utilisation and less workers. In the case of Port of Colombo it is noted that with a mixture of private and public terminals the labour pool can not easily be implemented.

• **Yard behind new quay extension**
  Ideally the stack should be placed at the back of the new quay. Technical issues are the settlement of soil (solutions for quick settlements are also available in the international markets) which takes time before the yard can be constructed. Having the stacking yard there would allow operations to optimise the distance between stack and ship operations. It is understood however that SLPA will not develop the yard in this section as overall yard area is sufficient.

• **Equipment maintenance.** No computerised maintenance management system (CMMS) is in place and new systems should be evaluated to optimise preventive maintenance and corrective maintenance as well as spare part management, job work planning and availability of equipment. A well-known and accepted key performance indicator for the maintenance is the MMBF, mean moves between failure to monitor the status of the equipment. It is important to note that ordering of spare parts should not be hindered by budget constraints especially when the equipment is vital for the operations. Currently there is imbalance between the number of units under repair and the optimum available equipment.
• Communication in operations
The new TOS system will improve communication between all container handling equipment in operation through wireless communication. This compares to today’s situation with VHF (radio post).

• Interterminal traffic
The interterminal traffic is very important for the Port of Colombo Transhipment hub. The ITT traffic is around 3000 movements per day. Today the transport is outsourced but the level of quality and availability of trucks is questionable. The service level agreements should be readdressed. It needs a thorough assessment aiming for more efficient container transport guided by an automated data exchange system. SLPA should take the initiative on this issue. This traffic should have easy terminal gate procedures and should not be hampered by queues on the main road. Special lanes are suggested. Charging the Shipping line should be reduced to the minimum and mostly recovered by port dues. It is important to have full digitalised booking system between and within terminals for quick movement of ITT. The inter terminal traffic is considered part of the services in a transhipment hub.

• OOG cargo
Out of Gauge cargo needs to be located at designated areas which do not interfere with main operations. New areas may be found after the review of yard optimisation and demolishment of buildings.

• Safety and environment
The international safety procedures on Occupational Health and Safety have to be applied. Personal protection equipment (PPE) like helmets and safety jackets as well as safety shoes are required. The following international dock workers regulations are relevant in all SLPA terminals;

For container terminals:
• International Labour Organization (ILO) Code of Practice for Safety and Health in Ports (2005);
• General Conference of the International ILO Convention concerning Occupational Safety and Health in Dock Work, C-152, (1979);
• General Conference of the ILO Recommendation concerning Occupational Safety and Health in Dock Work, R-160;
• International Maritime Dangerous Goods Code (IMDG Code).

And for other terminals:
• IMO Code of Practice for Solid Bulk Cargo (BC Code);
• International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code);
• International Code for the Safe Carriage of Grain in Bulk (International Grain Code);
• Code of Practice for the Safe Loading and Unloading of Bulk Carriers (BLU Code); and

Figure 17-4: Safety issues

• **ISPS**
The ISPS code needs to be adhered to. Gate security needs to be improved. No public cars / bicycles / motorbikes should be allowed on the terminal and persons need to be registered in and out.

• **Twin lifts and dual hoist or tandem lifting**
The news cranes will have to accommodate twin lift handling, i.e. capable of handling two 20ft containers in one move. For twin lift the crane should have a lifting capacity of 65 tons under the spreader or 80 tons under hook. Dual hoisting or tandem lifting would allow to lift four 20ft simultaneously or two 40ft containers in one move. This would improve the crane productively heavily. For tandem lift the cranes should be able to lift 130t under the spreader or 160t under the hook. Dual hoisting will make the cranes more heavy and this weight cannot be supported by existing quay structures.

• **Crane outreach and heights**
To handle ULCS (vessels wider than 48m), a crane outreach of 24-25 rows is recommended. The height is depending on the structure of quay, vessel design and tidal influences. For example the CICT cranes have an outreach of 22 rows and a maximum lifting height above rail of 45m. The height has reportedly been too limited for the latest ULCS vessels. SLPA has ordered three STS for JCT V with an outreach of 19 rows, limiting the future vessel sizes to neo-panamax classes of around a maximum width of approx. 48.2m. This related to a vesselsize of about 13,000 TEU.

• **Hatch covers**
The existing cranes have no back reach resulting in the hatch covers positioned underneath the crane (in between the crane legs). The logistics on the quay is hampered by this. This has been described in the section on port operations of container terminals. Three new cranes will be purchased with sufficient back reach. Additional cranes ordered in future, if any, needs to have the same specifications.

Figure 17-5: Operations issues
Existing cranes.
The JCT I and II berth have a crane rail gauge of only 18m. This limits cranes to panamax type, 13 rows across. These cranes are aged and are not up to efficient feeder operations anymore. Replacement with the cranes from UCT (when converted to general cargo) or the obsolete feeder berth may be investigated. Regarding the cranes at JCT III and IV, the following observation is made:
The quay cranes do not match with the vessels berthing at JCT3 and JCT4 in terms of height, speed and outreach. There are three options:
1. Just some refurbishment to lengthen the life span. The data received lead to the conclusion that the cranes as-is have just a limited life span left.
2. Check the status of the cranes to see whether the cranes can be modified. These modifications can be lengthening the boom, increasing the height of the cranes, maybe add a back reach to the cranes. This is more a theoretical than a practical thought due to the technical status of the cranes.
3. Look for refurbished cranes at the used equipment market to replace most of the quay cranes with new ones. New cranes are no option unless JCT will stay at least 20 more years in operation.

**Existing JCT III and IV required actions:**
1. Detailed study of the yard layout.
2. Remove first RTG block behind the quay cranes when new cranes arrive with back reach (hatch cover area).
3. Assessment of the technical status of all equipment.
4. Review the landside layout, demolish old buildings, free-up space for container storage and roads.
5. Refurbish the surface of the apron and the yard.
6. Build empty container block stacks, carry out an assessment of empty container handler (ECH) or Top-Lifters.
7. Investigate the need for additional or replacement of prime movers.
8. Review the maintenance equipment and repair area; demolish workshops and replace where needed.

The output of the studies is an action plan aiming at increasing the efficiency, capacity, reliability of the facility and consequently reduction of operating cost.

**Training of employees**
Regular training, training on the job and training for new equipment should be implemented. Managers should familiarise themselves with the latest developments in the industry by following courses, literature and special port visits abroad.

**Scrap/amortisation of old tractors and trailers (not in running condition anymore)**
A huge area of several thousands of square metres is occupied with tractors and trailers that are out of service and which will/cannot be repaired anymore. Due to complicated administrative procedures, it seems to be difficult to amortise and/or scrap this fleet of equipment that by far exceeded both the financial and economic lifetime of these assets. Evacuation of this site could generate some revenues (scrap value) and would result in a much more clean, neat and tidy looking area with additional valuable space.
• **Labour indication for modernisation**

The following text box shows an approximation of the required labour force after modernisation. The actual number might become different due to policies, operational practices etc.

---

**Sample on manpower**

This box describes a generic container terminal organization.

**Assumptions:**
The facility is handling cargo 7 days a week 24 hours per day in three shifts.
The throughput is 2,500,000 TEU; TEU factor is 1.7 thus 1,500,000 boxes
The workload per quay crane, based on 18 cranes is 85,000 lifts per year.
Assuming 20 moves per hour crane productivity results in 50% crane utilisation. Rounded, on average 10 cranes are in use. Each crane drives 4 RTG’s and 5 prime movers.

A crane team consists of one crane driver, a tallyman, 4 RTG drivers, 5 prime mover drivers and 2 twist lock handlers, thus 13 employees per shift. Three shifts per day (8 hrs) plus a fourth spare team is 52 employees per crane.

Total: 520 employees.

A waterside- and a landside- shift leader plus spare are 8 employees.
Four reefer mechanics per shift plus spare is 16 employees.
Four gate operators per shift plus spare are 16 employees.
Five empty / special cargo handlers per shift plus spare are 20 employees.
Total: 60 employees

Planning and operations management:
Estimated: 25 employees.

Equipment Maintenance:
Crane engineers, 12
RTG engineers, 12
Prime movers and empty handler’s engineers, 16
Electric engineers, 12
Planners, spare part procurement, management, 18
Total: 70 employees

Terminal management, administration, invoicing, personal, IT, marketing and sales:
Estimated: 65 employees

Based on the calculations above a JCT container terminal has 740 employees.
Some tasks maybe overlooked or could be underestimated thus assume a total of **800 employees**.

Note: These estimates are assuming a container terminal as a business unit. Port Authority tasks, like Customs, ITT, Port IT systems, Harbour Master, Security, Pilots, and Tugboats are not included in the headcounts. Some tasks like lashing can be done via a port labour pool. All terminals call these lashing services when needed.
• **Gate configuration**
  This topic is analysed in more detail (OCR and truck appointment) in the logistics section in paragraph 8.2.3. Regarding the gate positions mentioned in that section an alternative can be made. In case the stack at the back of the new quay is not developed the opportunity arises to develop the main gate in this section, as illustrated by the yellow dot. Main traffic flow directions at the terminal will go counter clock wise as ships will be moored on starboard side instead of port side today (in case two vessels of more than 330 m are berthed at JCT III-IV).

Figure 17-6: JCT traffic pattern on terminal
17.2.6 Cost Estimates Operational Upgrade

Table 17-2: Cost Estimates Operational Upgrade

<table>
<thead>
<tr>
<th>HP</th>
<th>PO</th>
<th>UP</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate (USD)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td></td>
<td></td>
<td>JCT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>operational</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>upgrade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td></td>
<td></td>
<td>Equipment &amp; IT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td></td>
<td></td>
<td>RTG’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td></td>
<td></td>
<td>Other Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td></td>
<td></td>
<td>IT Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td></td>
<td></td>
<td>Project Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

01 Quay Cranes Crane 3 8,300,000.00 24,900,000.00
02 RTG’s RTG 12 1,250,000.00 15,000,000.00
03 Other Equipment 1 5,000,000.00 5,000,000.00
04 IT Systems 1 4,000,000.00 4,000,000.00
05 Project Cost 1 500,000.00 500,000.00

02 Subtotal 49,400,000.00
03 Contingencies 15% 7,410,000.00

Sum 56,810,000.00

Note: Other equipment consists of some additional prime movers replacement and reachstacker for general operation.
17.3 Miscellaneous Works

17.3.1 Proposed Development
There is a need for upgrading of outdated workshop facilities and gate-facilities. The gate area needs to be upgraded to allow for modern OCR equipped gate. To create this area also an existing old workshop needs to be replaced, also due to the development of the PAEH.

The following building areas are tentatively assumed for demolition and reconstruction:

- Workshop: 500 m²
- Gate complex: 100 + 400 m²

17.3.2 Cost Estimates Misc. Works

Table 17-3: Cost Estimates Misc. Works

<table>
<thead>
<tr>
<th>HP</th>
<th>PO</th>
<th>UP</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate (USD)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>JCT</td>
<td></td>
<td>Miscellaneous works</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Workshop and gate</td>
<td></td>
<td>Sum</td>
<td>1</td>
<td>500,000.00</td>
<td>500,000</td>
</tr>
<tr>
<td>01</td>
<td>Demolition works</td>
<td></td>
<td>m²</td>
<td>500</td>
<td>1,000.00</td>
<td>225,000</td>
</tr>
<tr>
<td>03</td>
<td>Gate (a)</td>
<td></td>
<td>m²</td>
<td>100</td>
<td>1,000.00</td>
<td>208,000</td>
</tr>
<tr>
<td>04</td>
<td>Gate (b)</td>
<td></td>
<td>m²</td>
<td>400</td>
<td>500.00</td>
<td>500,000</td>
</tr>
<tr>
<td>02</td>
<td>Subtotal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,433,000.00</td>
</tr>
<tr>
<td>03</td>
<td>Site installation costs</td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td>143,300</td>
</tr>
<tr>
<td>04</td>
<td>Planning and design</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td>71,650</td>
</tr>
<tr>
<td>05</td>
<td>Contingencies</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
<td>214,950</td>
</tr>
</tbody>
</table>

1,862,900.00
17.4 Pre-Feasibility JCT Modernisation Plan

17.4.1 Introduction

The financial pre-feasibility of the JCT modernisation plan is assessed through generation of the business plan for JCT. A detailed separated study on the options to expand JCT and deepen the basin has also been conducted. The deepening solutions have not been chosen as preferred solution due to high commercial risks and technical constraints. Hence this paragraph is focussed on modernisation of JCT terminal and the assumptions and results of the financial pre-feasibility analysis. Please note that the upgrade of JCT berth 1 to a general cargo area is not part of the business case.

The financial pre-feasibility is based on additional revenues and costs which are incurred when executing the JCT modernisation plan. For example, it is assumed that throughputs will diminish when not implementing the plan and that the lifespan of the terminal is shorter with 10 years.

The main benefits of execution of the JCT modernisation plan are the following:

- Shipping lines can be offered a higher service level.
- Two large vessels can be handled at the same time (increased berthing flexibility).
- The yard area created behind the quay extension can be used for stacking.
- A continuation of revenues for SLPA.
- The prevention of possible and eminent equipment malfunction.

17.4.2 Project Scope

The current estimated lifetime of Jaya Container Terminal considering the state of equipment especially and operational aspects is considered to be lengthened by 10 years following the modernisation plan. It can be further noted that due to the state of JCT, equipment malfunctions can severely impact performance in the next years if no additional investments are made.

The table below describes the differences when implementing the JCT modernisation plan (project case) versus not implementing the plan (non-project case).

<table>
<thead>
<tr>
<th></th>
<th>Project Case</th>
<th>Non-project Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Starts in 2019</td>
<td>-</td>
</tr>
<tr>
<td>Operations</td>
<td>Starts in 2020</td>
<td>Continuous</td>
</tr>
<tr>
<td>Service Level</td>
<td>Two 366m large vessels can be handled at the same time adding to higher service level to the shipping lines.</td>
<td>Malfunctions may hamper service</td>
</tr>
<tr>
<td>Terminal estimated lifespan</td>
<td>Until 2035</td>
<td>Until 2025</td>
</tr>
<tr>
<td>Throughputs</td>
<td>Diminishing with 4% per year until end of life time</td>
<td>Diminishing with 8% per year until end of life time</td>
</tr>
</tbody>
</table>

The modernisation plan includes the following elements:

- JCT quay extension
- Miscellaneous works which includes gate upgrades and demolishing and replacement of maintenance shops
• Purchase of IT and equipment.

17.4.3 Financial Pre-feasibility

Forecast
The main assumptions of the forecasts are:
• Starting volume for 2017 is 2.0 M TEU
• In the non-project case JCT’s volume diminish with on average 8% per year due to opening of new terminals and general deterioration of the facility as no incremental or additional future CAPEX expenses are accounted for.
• In the project case volumes will diminish by 4% as from 2020 onwards due to opening of additional terminals in the port of Colombo, whilst still offering reasonable service levels.
• Under the non-project case JCT will stop operations in 2025; under the project case an additional 10 years until 2035.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCT Project Case Forecast</td>
<td>M TEU</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
<td>1.8</td>
<td>1.7</td>
<td>1.6</td>
<td>1.3</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>JCT Non-Project Case Forecast</td>
<td>M TEU</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.9</td>
<td>1.7</td>
<td>1.6</td>
<td>1.5</td>
<td>1.4</td>
<td>1.3</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Please note that the additional revenues used for the calculations are the revenue driver. Which means that the difference between the project and non-project case is considered. In the non-project cast JCT will shut down in 2025.

Revenue Estimations
SLPA provided the following estimations of container handling revenues excluding the marine side handling fees:
• 54.0 USD per TEU

OPEX Estimations
SLPA provided the following data regarding OPEX for JCT. The number excludes security personnel costs:
• 29.0 USD per TEU

Of the 29.0 USD 50% is assumed to be labour costs.

CAPEX Estimations
The CAPEX estimations as seen in paragraphs 17.2 and 17.3 total 75.5 M USD and consist of:
• Quay extension and back fill: 16.8 M USD
• Operational upgrade including equipment and IT: 56.8 M USD
• Miscellaneous works including gate upgrades and new workshops: 1.9 M USD

The investments are expected to be made in 2019 with start of operations in 2020. Depreciation is linear with 25 years expected life span and no residual value to be conservative in estimates.
## Results

The results show a project financial IRR of 16.6% and a payback period of 8 years. As a financial investment, this result is sound. The NPV of the project is positive (40.3 M USD) thus making it financially feasible.

A few important notes regarding the results need to be made:

- The pre-feasibility results are based on high level assumptions as no JCT actual financial figures are available.
- CAPEX figures have been estimated conservatively but based on international benchmarks.
- No additional CAPEX investments are considered in the project case. It is to be noted that future investments in equipment replacements can be expected over the lifetime of the project to keep the terminal operational until 2035. This fact has been partially mitigated by reducing JCT volumes by 2% per year in the project case to attribute to a possible downsizing.

### Table 17-4: Financial pre-feasibility Result JCT

<table>
<thead>
<tr>
<th>Output</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV - Free Cash Flow</td>
<td>40,282,880</td>
<td>USD</td>
</tr>
<tr>
<td>FIRR</td>
<td>16.24%</td>
<td>%</td>
</tr>
<tr>
<td>Payback Period</td>
<td>8</td>
<td>Years</td>
</tr>
</tbody>
</table>

The results in the figure below display the additional revenues and costs for JCT when the modernisation plan is fully executed. The financial data reflect the difference between the two cases. The figure shows the initial capital expenditure in 2019. After the 2025 the revenues (and costs) continue for an additional 10 years, compared to the non-project case in which JCT was closed.

### Figure 17-7: Results Financial Pre-feasibility JCT
### Table 17-5: Results Financial Pre-feasibility JCT ('000 USD)

<table>
<thead>
<tr>
<th>Assumption</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental Revenues</td>
<td>54 USD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per TEU</td>
<td></td>
<td>3,846</td>
<td>7,259</td>
<td>10,278</td>
<td>12,936</td>
<td>15,265</td>
<td>17,296</td>
<td>70,155</td>
<td>57,662</td>
</tr>
<tr>
<td>Incremental OPEX</td>
<td>29 USD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per TEU</td>
<td></td>
<td>-</td>
<td>(2,066)</td>
<td>(3,899)</td>
<td>(5,520)</td>
<td>(6,947)</td>
<td>(8,198)</td>
<td>(9,288)</td>
<td>(37,676)</td>
</tr>
<tr>
<td>CAPEX - JCT Quay Expansion</td>
<td>16,806</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPEX - JCT Operational Upgrade</td>
<td>56,810</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPEX - JCT Misc. Works</td>
<td>1,863</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPEX - Total</td>
<td>75,479</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax Expense</td>
<td>10.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Cash Flow</td>
<td>(75,479)</td>
<td>1,781</td>
<td>3,327</td>
<td>4,584</td>
<td>5,692</td>
<td>6,662</td>
<td>7,508</td>
<td>29,533</td>
<td>24,328</td>
</tr>
</tbody>
</table>

### 17.4.4 Economic Feasibility Results

The conversion factors for the financial cash flows are set to except for the labour costs. Labour costs are estimated at 50% of JCT OPEX. The project is estimated to create substantial economic value based on these results:

#### Table 17-6: Economic Indicators Pre-feasibility Result JCT

<table>
<thead>
<tr>
<th>Output</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV - Economic Cash Flows</td>
<td>88,785,997</td>
<td>USD</td>
</tr>
<tr>
<td>ERR</td>
<td>18.5%</td>
<td>%</td>
</tr>
</tbody>
</table>

#### Table 17-7: Results Economic Pre-feasibility JCT ('000 USD)

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incremental Revenues</td>
<td>-</td>
<td>3,846</td>
<td>7,259</td>
<td>10,278</td>
<td>12,936</td>
<td>15,265</td>
<td>17,296</td>
<td>70,155</td>
<td>57,662</td>
</tr>
<tr>
<td>Economic Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incremental Labour Costs</td>
<td>- 878</td>
<td>1,657</td>
<td>2,346</td>
<td>2,952</td>
<td>3,484</td>
<td>3,948</td>
<td>16,012</td>
<td>13,161</td>
<td></td>
</tr>
<tr>
<td>Incremental Other OPEX</td>
<td>- 1,033</td>
<td>1,949</td>
<td>2,760</td>
<td>3,473</td>
<td>4,099</td>
<td>4,644</td>
<td>18,838</td>
<td>15,483</td>
<td></td>
</tr>
</tbody>
</table>
17.4.5 Potential for Private Financing and PPP

The SLPA currently fully owns and operates the JCT, and intends to do so in the remaining operational years of the terminal; hence, leveraging expertise of external private parties through a PPP is considered unlikely.

Private investments may however be possible. The table below presents pros and cons for private investments in the brownfield terminal development. From these factors, it is concluded that private investments are likely not attractive for the JCT brownfield development.

<table>
<thead>
<tr>
<th>Pro</th>
<th>Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected positive NPV from investment</td>
<td>Existing terminal with limited lifespan</td>
</tr>
<tr>
<td>JCT is an operational terminal; hence, there is no ramp-up for volumes</td>
<td>JCT’s market share in the port is expected to decrease over the remaining lifetime of the terminal, resulting in a commercial risk for an investor</td>
</tr>
<tr>
<td></td>
<td>As JCT is an existing terminal, share allocation to the private investor for the brownfield investment is complex, as compared to a joint greenfield investment</td>
</tr>
<tr>
<td></td>
<td>The investor may require that the terminal is not phased out before it can recoup its investment; this results in decreased port planning flexibility for the SLPA.</td>
</tr>
</tbody>
</table>
17.5 JCT 1 Upgrade to General Cargo Technical Assessment

17.5.1 Existing Infrastructure

The JCT 1 Upgrade to general cargo assessment is not part of the JCT modernization planned aimed at improving JCT operations. It is a reference writing for SLPA for future changes to JCT to provide more general cargo berthing space in the port.

Berth nos. 1 and 2 have a total length of 600m in one alignment. Water depths are 12m/13m (CD) respectively. Berth nos. 3 and 4 have a total length of 660m also in one alignment, but with a bend relative to berth nos. 1 and 2. The water depth is here 15m (CD).

The quays are designed as a gravity structures based on pre-fabricated RC caissons with sand fill. Caissons are topped with a RC superstructure which transfers quay loads, including seaside rail forces to the caisson.

Caissons are founded at -12.5m (Berth 1) on a base layer of graded rock. The thickness of the rock base varies, supposedly reflecting the top level of a natural rock base.

The cross section of Berth 1 is shown below. It shall be observed that the rail gauge for the STS-cranes is only 16m along Berths 1 and 2.

Figure 17-8: Berth 1 Quay Structure

17.5.2 Technical Observations

The corner at the north end of Berth 1 was briefly visited (see photos below). No apparent signs of structural weakness were observed, other than superficial wear and tear. Two old STS container cranes were parked at the northernmost end of the rail track.
17.5.3 Proposed Development
Berth 1 is proposed transformed from container berth into a specialized general cargo berth with an increase of the water depth from the present CD -12m to CD -13m.

Transformation of the berth into a general cargo berth is assumed to result in a relief of the very significant, concentrated load impacts from STS-cranes. This change in design conditions may result in a reduction of the overturning moments on the caisson and consequently in less concentrated foundation pressures under the caisson onto the bedding layer of graded rock. In this case it may be possible to remove material from the seabed down to at least CD -13m without jeopardizing the stability of the quay.
It is recommended to review the design calculations to investigate if the desired draught can be achieved without major reconstruction works, other than some redressing and stabilization of the seabed in front of the quay.

If this way forward is not possible it will most likely be necessary to introduce a new, advanced quay front with a RC slab on a row of piles, as previously proposed and described for the PVQ-Jetty.

For a total quay length of 300 m and partly based on the cost estimate for the PVQ-Jetty the following costs are roughly estimated:

- Minimum solution (redressing of seabed): 300m of 10,000 USD/m = 3.0 mio USD
- Reconstruction as per PVQ-Jetty: 300m of 30,000 USD/m = 9.0 mio USD
17.6 Environmental Impact Assessment

- Risks associated with the demolition of structures on, and infrastructure of the quay; emissions (noise, dust, gaseous), unprofessional handling and indiscriminate disposal of hazardous waste (asbestos, polluted soil).
- Impacts related to dredging (spreading suspended material with possibly contaminants, hazards from blasting, indiscriminate disposal of dredge spoil. When the dredging commences the area in which the dredger works creates a plume of suspended particles resulting in murky water. This could disturb the entire other areas of inner harbour unless controlled. Depending on the current patterns this plume could even affect the other parts of the harbour basin giving hindrance to the port activities.
- Existing workshops have polluted the soil and oil/grease flows into the drainage. The same can happen in the new workshops planned.
- Occupational health risk associated with demolition and construction works.
- It should be noted that in case the basin behind the new 120m quay wall is not filled, additional care of this water pocket is required and water circulation should be provided. It is apparent that the inner harbour basin gets collected both dry and wet weather flow from outside the port premises through outfalls. This wastewater laden with suspended particles get deposited in the harbour basin as calmness is introduced within the inner harbour. The study done by Jayaweera (1999) showed that the inner harbour has been polluted particularly with faecal matter. As a result, dissolved oxygen levels are depleted. Hence the extension of quay wall would leave a pocket of water filled with pollutants. That would therefore cause further deterioration of water quality, likely resulting in bad odour.
18 LNG FSRU Colombo Break Water

18.1 Background to the project

In its 2017 document “Vision 2025” the Sri Lankan government indicated that inadequate physical infrastructure services are a significant drag on growth. One of the measures to upgrade the energy infrastructure is to shift from coal fired power plant in current CEB projects to LNG fired power plants.

In recent years there is a boom in LNG demand arising from a shift towards this cleaner fuel. The number of importing countries is increasing and the exporting volumes as well. The big factor in the next decade is the emergence of the US as a net exporter of LNG. Floating storage units become a popular form to provide LNG storage to power facilities.

In 2017 the Sri Lanka government set a tender for the conversion of 300 MW power plant to LNG. In the future a 2 x 300 MW power plant units will be added. The conversion will most likely take place in 2020 to cater for the national energy demand.

An import facility needs to be created to facilitate LNG imports for the national demand. SLPA has chosen to facilitate this demand with a floating storage and regasification unit in the south port break water initially. Due to expansion in the port this facility will likely be moved to either the expanded South Port break water or a new energy hub.

This analysis assumes SLPA will construct the jetty and that the private party will cater to the management of the FSRU vessel. This is a form of a PPP deal, but alternatively the jetty structure could be constructed by private parties as well.

18.2 Supporting Analyses

A “standard” LNG carrier can transport about 125,000 – 145,000 m³ of LNG which is sufficient to fuel an 800 MW power plant for about one month. These vessels would measure about 300m with a beam of 43m and has a draught of 12m.
Newer types of LNG FSRU now opt for 173,400 m³ (a dwt of 93,500 long DWT, GT 113,000) with a LOA of 300m, a beam of 46.5m and a draught of 12.5m. This FSRU cost around USD 200 to USD 230 M and can be constructed in 2.5 years. The vessel would have a maximum discharge capability of 14400 cu.m./hr.

December 2016, Maran Gas has firmed up its move into floating storage and regasification units (FSRUs), this weekend signing an order for its first vessel, with an option for two additional LNG carrier newbuildings, at Daewoo Shipbuilding & Marine Engineering (DSME) in South Korea. DSME will build the 173,400m³ FSRU for Maran Gas Maritime at Okpo shipyard on Geoje island, for delivery in the first half of 2020. The shipyard values the three-vessel deal at US$589 million.

### 18.2.1 LNG Ships

At the end of 2015 there were 424 LNG ships in worldwide service. There is no universally accepted naming convention for LNG ships but the following names are often used.

<table>
<thead>
<tr>
<th>LNG type</th>
<th>Vessel size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medmax</td>
<td>75,000 m³</td>
</tr>
<tr>
<td>Conventional or standard</td>
<td>125,000 – 145,000 m³</td>
</tr>
<tr>
<td>New conventional or standard</td>
<td>150,000 – 175,000 m³</td>
</tr>
<tr>
<td>Qflex</td>
<td>210,000 - 216,0000 m³</td>
</tr>
<tr>
<td>Qmax</td>
<td>260,000 – 267,000 m³</td>
</tr>
</tbody>
</table>
The LNG vessels can be reconverted into FSRU by placing the vaporisers on board. The conversion is common practise in this market.

Worldwide about 24 floating storage sites are present including facilities under development in countries like Indonesia, Singapore, Pakistan and South Africa.

18.2.2 FSRU versus Onshore terminals
There are advantages and disadvantages between an onshore terminal and a floating FSRU

<table>
<thead>
<tr>
<th>Onshore Terminals</th>
<th>FSRU’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; million ton per annum, large scale power stations &gt; 1000 MW</td>
<td>Used for &lt; 3 million ton per annum (usually for about 1.5 – 2 million-ton throughputs or small-scale power stations up to 1000 MW.</td>
</tr>
<tr>
<td>Provides a more permanent solution</td>
<td>Allows for quicker fuel switching (vaporisers on board)</td>
</tr>
<tr>
<td>Offers long-term supply security</td>
<td>Greater flexibility if there are space constraints or no useable ports</td>
</tr>
<tr>
<td>Greater gas storage capacity</td>
<td>Capable of operating further offshore</td>
</tr>
<tr>
<td>Generally, requires lower operating expenditures (OPEX)</td>
<td>Generally less CAPEX</td>
</tr>
<tr>
<td>Options for future expansions</td>
<td>Less land regulations</td>
</tr>
<tr>
<td>Storage tanks normally in proximity of quay</td>
<td>Storage tanks located at distance and fed by gas pipeline</td>
</tr>
<tr>
<td>Long construction times and high fixed costs</td>
<td>Limited implementation time but risk involved that operator can easily move out</td>
</tr>
<tr>
<td>Maintenance easier</td>
<td>Disadvantage: ship maintenance</td>
</tr>
</tbody>
</table>
To supply the power station in Colombo both options can be provided for. Only the FSRU can be offered in a fast timeframe when it is positioned at the northern break water. A fixed terminal is not possible to construct in a short time. Construction time would be at least 5 to 8 years. For this option either a liquid bulk island is required or as fixed terminal in the future as part of North Port development.

18.2.3 Floating Storage

There are two options adopted worldwide to moor FRSU vessels.

1. With Jetty between FRSU and visiting vessel
2. Without jetty between FRSU and visiting vessel

**With Jetty between FRSU and visiting vessel**

The first option is to moor the vessel behind a jetty which would allow the visiting vessels to moor on the opposite side of the jetty. This has the advantages that mooring can be efficient and without difficulties on the replacement of water whilst pushing the ship to the berth. The disadvantage of this system is that a jetty has to be constructed which dimensionalise the berthing spot of the FSRU. With other words the flexibility to change the FSRU is more limited.

Schematically this is shows on the picture below.
Without jetty between FRSU and visiting vessel

The second options are to moor the FSRU on a jetty next to the breakwater and mooring the visiting vessel next to the FSRU.

The advantage of this system is that the berth of the FSRU is not limiting the size. Another advantage is that there is no major structure required between the vessels which is particular of interest when the FRSU should be replaced to another location. The disadvantage is that the visiting vessel needs to moor side by side to the FSRU which in practise increases the risk and the time of mooring compared to a fixed jetty.

Reviewing both options the latter is the preferred option when the facility is built on the North-western breakwater with the intention to replace the facility once WCT II is developed.

18.2.4 Safety

When assessing safety distances for a FSRU (Floating Storage and Regassification Unit) or an LNGC (Liquefied Natural Gas Carrier) development for a LNG Terminal, with the purpose to provide the elements to assess whether the proposed development sites are viable, no International regulations define deterministic safety distances to be applied to the assessment of LNG installations, in particular to FSRU developments.

International regulations provide, instead, risk-based criteria for the assessment of the compatibility of an LNG plant with the territory, based on accidental distances associated to accidental event frequency. Consider also that a recent IFC Guideline (EHS Guidelines for Liquified Natural Gas Facilities) of April 2017 requires "provisions for safe distances between reservoirs and between the facility and adjacent buildings" but without providing any value. It also says that if you cannot have "safe distances" then you need other prevention measures.
For Colombo port it is advised to review the corresponding risk of locating a FSRU near to the city. As per international practise and elaborated here below, it is recommended to take a least 2km distance from urban residential areas. This guideline would enforce the argument to place the FSRU on the breakwater rather than near the shore.

**International and National Standards on Safety Distances and territorial compatibility**

The only internationally known acceptability criterion specific for risk around LNG installations (onshore) is given in Annex L of European Standard EN1473:2007 (it has to be noted that this criterion is given as “informative” only, and is not mandatory).

The EN1473:2007 criterion is based on the assessment of the cumulative frequency of occurrence of all plant accidents causing a given level of damage. From the value of frequency of occurrence and the Consequence severity class, three Risk Levels are identified based on a Risk Matrix approach:

- **Level 3**: situation which is undesirable and cannot be tolerated. Remedial action required (Not Acceptable);
- **Level 2**: situation which shall be improved. A level at which it shall be demonstrated that the risk is made As Low As Reasonably Practical (ALARP);
- **Level 1**: normal situation (Acceptable).

The identification of the three risk levels for outside plant boundaries according to frequency and consequence classes is made based on the following Matrix (a similar matrix exists for assessment of risk inside plant boundaries):

**Figure 18-2: Determination of Risk Levels outside the boundary plant (from EN1473:2007)**

![Risk Levels Matrix](image)

The attribution of the frequency to a frequency class follows the criteria given in the matrix, the attribution of the consequence to a consequence class follows the criteria given in the following Figure (from Annex K, EN1473:2007).
In the USA, NFPA59A provides requirements for the safety of LNG onshore installations. NFPA 59A defines “design spills” and provide criteria to assess exclusion zones in terms of allowable thermal radiation flux at the plant property line and as minimum distances from Containers (onshore tanks) and property lines (minimum distance from a container of capacity >265 m3 is minimum 30 m). If the separation distances between equipment and property lines required by NFPA59A are met, and if the design spill exclusion zones remains inside the plant boundaries, this is considered to be sufficient to ensure safety of the nearby area. The NFPA59A, as the European Standard EN1473, however do not explicitly consider the LNG ship but are applicable to onshore plants.

At European Level, LNG installations follow the rules for Major hazard Plants (“Seveso” EU Directive). The approaches adopted in European Countries to assess compatibility of Major Hazards installations with the territory (Land Use Planning) are different, and all of them have in common the need to assess, for a specific establishment and site, distances associated to predefined levels of damage to human beings or to predefined values of individual risk. The allowable land uses are then defined, according to the various criteria, with a deterministic, semi-probabilistic or fully risk-based approach.

Two documents prepared by a research Institution (Sandia National Laboratories) on behalf of the USA Department of Energy, provides discussions on spill scenarios and related hazard distances with potential impact on public safety, mainly with reference to accidental (collisions and grounding) and intentional spills from an LNG ship (Sandia, 2004 and 2008). These reports however provides a discussion on the various hazard distances that are associated to different hypotheses of breach on the ship hull, with specific emphasis on terrorism issues, and do not provide a firm value of safety distances to be utilised in a generic case. The Sandia 2008 report, in addition, provides an analysis focused on very large LNG carrier, with capacity higher than 200.000 m3, as example.

Another Informative Publication by SIGTTO (Society of International Gas Tanker and Terminals Operators), the Information Paper no. 14 "Site Selection and Design for LNG Port and Jetties", at chapter 10.2.4 (Hazardous Penetration) specifies that "It therefore becomes feasible to consider ways to analyse port approach channels so that any risk of cargo containment rupture can be removed and the remote possibility of an uncontrolled release of LNG reduced to non-credible proportions", suggesting - de facto - to approach the problem with a Risk Based methodology to check whether it is possible to rule-out the largest events based on reliability considerations.

As a conclusion, no specific value of safety distances is given by international or National standards for LNG installations, and in particular for FSRU units. All standards refer to an analysis of “credible” or “representative” accidental scenarios to assess, case by case, damage distances associated to a tolerable risk value.
As a further element, in the following Figures 13 and 14 information on distances from (onshore) LNG regassification plants and populated areas are given, for two European plants, located in Barcelona (Spain) and Zeebrugge (Belgium).

Figure 18-4: LNG Terminal in Barcelona (Spain)

Figure 18-5: LNG Terminal in Zeebrugge (Belgium)
18.2.5 Technical Assessment

Liquefied gas will be supplied in tanker vessels. The gas will be transformed into vapor (re-gasification process) in the terminal and transported to the power plant via a submerged/buried pipeline connection.

For this priority project pre-feasibility study, the LNG terminal is planned to be located behind the outermost section of the main breakwater, i.e. north of the proposed West Container Terminal. It is however foreseen that the outermost section of the main breakwater may be relocated further north within the foreseeable future, with implications the for the location of the LNG terminal.

This breakwater location is only foreseen if LNG is required to be handled in the short term (< 5 year horizon), as the North Port Island Terminal – part of the preferred Energy Hub North Port option – is not considered feasible in the short term. If the LNG terminal becomes a medium to long term development, the identified island terminal option becomes the preferred implementation option. In that case also storage tanks can be accommodated. In general a LNG terminal with land based storage would have the size of approximately 42 hectares based on the Rotterdam LNG Gate terminal, further specified in the annexes.

It is therefore proposed that the permanent works of the LNG terminal shall be constrained to a workable minimum.

The terminal is therefore proposed to include:

- A dedicated tanker berth with a central operational platform
- Dolphins for breasting and mooring
- Bridges and catwalks

Re-gasification capacity shall in this case be provided as a floating unit to be permanently moored at the berth and later relocated in the event of a change to the breakwater.

The cost estimates for these works are as follows:

<table>
<thead>
<tr>
<th>HP</th>
<th>PO</th>
<th>UP</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate (USD)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td></td>
<td></td>
<td>LNG-Terminal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td></td>
<td></td>
<td>LNG-terminal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td></td>
<td></td>
<td>Platform</td>
<td>Sum</td>
<td>1</td>
<td>6,000,000.00</td>
</tr>
<tr>
<td>02</td>
<td></td>
<td></td>
<td>Dolphins</td>
<td>Nos</td>
<td>8</td>
<td>1,000,000.00</td>
</tr>
<tr>
<td>03</td>
<td></td>
<td></td>
<td>Bridge and catwalks</td>
<td>Sum</td>
<td>1</td>
<td>2,000,000.00</td>
</tr>
<tr>
<td>06</td>
<td></td>
<td></td>
<td>Subtotal</td>
<td></td>
<td></td>
<td>16,000,000.00</td>
</tr>
<tr>
<td>07</td>
<td></td>
<td></td>
<td>Site installation costs</td>
<td>10%</td>
<td></td>
<td>1,600,000.00</td>
</tr>
<tr>
<td>08</td>
<td></td>
<td></td>
<td>Planning and design</td>
<td>5%</td>
<td></td>
<td>800,000.00</td>
</tr>
<tr>
<td>09</td>
<td></td>
<td></td>
<td>Contingencies</td>
<td>15%</td>
<td></td>
<td>2,400,000.00</td>
</tr>
</tbody>
</table>
Indicatively, the cost of a submerged pipeline is estimated at USD 12,000 -15,000 per metre.

### 18.2.6 LNG bunkering

It is noteworthy that in the future the facility should also be able to supply bunkering to LNG vessels. An ever-growing segment of ships are converting to LNG and the major shipping lines are investing in new LNG vessels.

LNG as a bunker fuel is expected to become a new standard for commercial shipping. The driving force is the IMO regulations to reduce emissions from ships. The sulphur content of fuels have to be reduced to < 0.5% by 2020. As stricter standards on exhaust emissions from merchant ships have taken effect around the world, LNG, which can significantly reduce not only SOx, but also CO2 (which is a cause of global warming), and NOx (which is a cause of acid rain), is expected to see wider use as vessel fuel. Hence it is a solution which shipowners adopt in their new ship ordering strategy. For existing ships either cleaner fuels (MGO/MDO instead of HFO) or scrubbers have to be applied. As such, ports and shipping companies are preparing themselves, together with the bunker industry for this. Ports like Rotterdam and Zeebrugge already have implemented LNG bunker facilities. In Rotterdam the LNG bunkering is organised by small LNG barges with carrying capacities of 3,000m3 or 6,500m3. Next to this the facility offers direct LNG truck loading. In Zeebrugge a 5,000m3 LNG bunker barge is available. Meanwhile in Singapore, bunker offerings are still in a trial phase and so far has been focussed on truck-to-ship supplies. The Maritime and Port Authority of Singapore has announced to set aside USD 9 million for initiatives aimed at boosting LNG bunkering in the port. There are two LNG suppliers in Singapore and Fuel LNG completed the first commercial LNG bunkering in September 2017 which was a truck-to-shore operation. Also the port of Yokohama in Japan wants to offer LNG bunkering as part of the Transpacific trading route.

As mentioned the main demand for LNG as bunker fuel still needs to develop. In Rotterdam ship to ship transfer is already taking place due to the inland barges and some coastal vessels which are equipped LNG as fuel. In container shipping CMA CGM ordered nine 22,000 TEU container vessels which shall be powered by LNG. Each vessel has the capacity to carry 18,000m3 of LNG. Moreover United Arab Shipping ordered 17 ready-fit LNG vessels, 6 of 18,000 TEU and 11 of 14,000 TEU. This is an indicator that LNG will also be applied in the very large categories, of which vessels can only call at deep drafted hub ports. Furthermore many local vessel may actually be powered on LNG such as tug boats for example. Another shipping segment in which LNG is becoming popular is Cruise shipping. Carnival Corporation awaits four LNG powered cruise ships to be delivered 2019 onwards.

Industry experts expects that on the East West routes mainly Singapore and Rotterdam/Zeebrugge will play a major role as there are located at the beginning or end of trades. Port of Colombo is however also strategically positioned along the route and may be able to play a role in this new market. The markets can be further expanded when also the local ad coastal markets around the Indian Ocean adopt the new IMO regulations tis is however expected to take some time.
18.3 Pre-Feasibility

18.3.1 Introduction
The business case for the jetty structure to house the LNG floating storage and regasification units is relatively straightforward as SLPA will not be responsible for the management of the vessel or the operations. This is to be provided and operated by the government selected entity. SLPA should be compensated for its CAPEX investments.

It is to be noted that upon construction of extend break water of south harbour, the LNG unit will need to be relocated. The costs association with this movement is not incorporated in this analysis.

18.3.2 Project Scope
To set up this business case the project case and non-project case are identified as:
- **Non-project Case** – This would be the current situation where no LNG imports take place.
- **Project Case** – SLPA constructs the jetty infrastructure and walkway. The FSRU vessels investments are done by the government selected entity.

<table>
<thead>
<tr>
<th></th>
<th>Project Case</th>
<th>Non-project Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Starts in 2019</td>
<td>-</td>
</tr>
<tr>
<td>Operations</td>
<td>Starts in 2020</td>
<td>-</td>
</tr>
<tr>
<td>Terminal estimated lifespan</td>
<td>Until 2050</td>
<td>-</td>
</tr>
<tr>
<td>Throughputs</td>
<td>Per requirement of the power plant.</td>
<td>-</td>
</tr>
</tbody>
</table>

18.3.3 Financial Pre-feasibility

Forecast
The LNG import terminal in the South Port break water will cater to the first imports of LNG in 2019 after which a ramp-up is expected of the production in Colombo. The forecast is based on a national energy generation of LNG of which a share of LNG generation is expected. Under current assumptions Hambantota will have a LNG power plant running as of 2025.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG Forecast Project Case '000 Tons</td>
<td>-</td>
<td>-</td>
<td>32</td>
<td>343</td>
<td>545</td>
<td>767</td>
<td>1,009</td>
<td>1,273</td>
<td>781</td>
<td>995</td>
<td>1,508</td>
<td>1,994</td>
</tr>
<tr>
<td>LNG Forecast Non-Project Case '000 Tons</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Incremental Volumes</td>
<td>-</td>
<td>-</td>
<td>32</td>
<td>343</td>
<td>545</td>
<td>767</td>
<td>1,009</td>
<td>1,273</td>
<td>781</td>
<td>995</td>
<td>1,508</td>
<td>1,994</td>
</tr>
</tbody>
</table>

Revenue Estimations
This project is estimated to be budget neutral for SLPA, which means the net present value of the project should be equal to zero. To achieve this SLPA should receive a concession fee, either a fixed annual fee or variable fee based on tonnage. These fees are thus a minimum to make the project feasible:
- Fixed annual concession fee for project life time: 2.3 M USD.
- Variable concession for project life time: 2.6 USD per ton LNG imported.

**OPEX Estimations**  
Maintenance and repair costs for the platform, dolphins, bridge and catwalks are estimated at 1.0% of the initial investment of 20.8 M USD. The costs total at 208 thousand USD annually.

**CAPEX Estimations**  
The CAPEX estimations as seen in paragraphs 18.2.5 consists of:  
- Platform structure – 6.0 M USD  
- Eight Dolphins to moore the FSRU – 8.0 M USD  
- Bridge and catwalks – 2.0 M USD

The total investment is 20.8 M USD including site installation costs, planning and design and contingencies.

**Results**  
As mentioned, the business case for the LNG structure is set to break-even to recover the costs made by SLPA. Based on this structure the project is financially feasible.

<table>
<thead>
<tr>
<th>Output</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV - Free Cash Flow</td>
<td>0</td>
<td>USD</td>
</tr>
<tr>
<td>IRR</td>
<td>10.0%</td>
<td>%</td>
</tr>
<tr>
<td>Payback Period</td>
<td>10</td>
<td>Years</td>
</tr>
<tr>
<td>Concession Fee Annual*</td>
<td>2,321,022</td>
<td>USD</td>
</tr>
<tr>
<td>or Variable Concession Fee*</td>
<td>2.62</td>
<td>USD / Ton</td>
</tr>
</tbody>
</table>

*Either the fixed annual concession fee or the variable concession fee is to be applied; both have approximately the same impact on the business case. For this example, the fixed annual concession fee is applied.

<table>
<thead>
<tr>
<th>'000 USD</th>
<th>Assumption</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental Revenues</td>
<td>2.3 M USD</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
</tr>
<tr>
<td>Incremental OPEX</td>
<td>1% of CAPEX</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
</tr>
<tr>
<td>Platform</td>
<td>(6,000)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dolphins</td>
<td>(8,000)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bridge and catwalks</td>
<td>(2,000)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Design &amp; Installation</td>
<td>(2,400)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Contingencies</td>
<td>(2,400)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAPEX - Total</td>
<td>(20,800)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Free Cash Flow</td>
<td>(18,815)</td>
<td>1,985</td>
<td>1,985</td>
<td>1,985</td>
<td>1,985</td>
<td>1,985</td>
<td>1,985</td>
<td>1,985</td>
<td>1,985</td>
<td>1,985</td>
</tr>
</tbody>
</table>
18.3.4 Economic Feasibility

The conversion of financial cash flows to economic cash flows a conversion factor is used of 1.0 for all cash flows. The tax expense is exempt in the calculation as it is a benefit to the nations. Additionally, by providing the jetty the Sri Lanka is able to generate power from LNG instead of coal. This has a significant economic benefit which can be attributed to this project. Without these added benefits the business case is already economically feasible.

Emission Cost Savings

The following assumptions underline the economic costs savings related to switching from coal fired power plant to a gas fired power plant:

- CO\textsubscript{2} emission per to LNG: 2.81 ton
- CO\textsubscript{2} emission per to coal: 2.54 ton
- Cost of ton CO\textsubscript{2} emission per ADB guidelines: 36 USD.

The savings as indicated in the table below are significant due to the difference in emission of coal and gas. Inclusion of these numbers in the economic business case significantly increase the benefits.

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombo LNG</td>
<td>32</td>
<td>343</td>
<td>545</td>
<td>767</td>
<td>1,009</td>
<td>1,273</td>
<td>781</td>
<td>995</td>
<td>1,508</td>
<td>1,994</td>
</tr>
<tr>
<td>Forecast Tons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent Coal</td>
<td>97</td>
<td>1,033</td>
<td>1,641</td>
<td>2,307</td>
<td>3,036</td>
<td>3,832</td>
<td>2,350</td>
<td>2,996</td>
<td>4,539</td>
<td>6,001</td>
</tr>
<tr>
<td>Forecast Tons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission LNG</td>
<td>90</td>
<td>964</td>
<td>1,532</td>
<td>2,154</td>
<td>2,834</td>
<td>3,577</td>
<td>2,194</td>
<td>2,797</td>
<td>4,237</td>
<td>5,603</td>
</tr>
<tr>
<td>Forecast Tons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission Equivalent Coal</td>
<td>246</td>
<td>2,623</td>
<td>4,168</td>
<td>5,861</td>
<td>7,712</td>
<td>9,733</td>
<td>5,969</td>
<td>7,610</td>
<td>11,528</td>
<td>15,243</td>
</tr>
<tr>
<td>Forecast Tons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic CO\textsubscript{2} Savings</td>
<td>5,639</td>
<td>60,210</td>
<td>95,690</td>
<td>134,548</td>
<td>177,046</td>
<td>223,445</td>
<td>137,030</td>
<td>174,710</td>
<td>264,664</td>
<td>349,958</td>
</tr>
<tr>
<td>USD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results

The business case is strongly economically viable based on these results:

- ENPV (@ 7.83%): USD 1.8 B USD
- ERR: 529%
### Economic Benefits

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental Concession Fee</td>
<td>-</td>
<td>-</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td>2,321</td>
<td></td>
</tr>
<tr>
<td>CO2 Savings</td>
<td>5,639</td>
<td>60,210</td>
<td>95,690</td>
<td>134,548</td>
<td>177,046</td>
<td>223,445</td>
<td>137,030</td>
<td>174,710</td>
<td>264,664</td>
<td>349,958</td>
</tr>
</tbody>
</table>

### Economic Costs

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental OPEX</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
<td>(208)</td>
</tr>
<tr>
<td>Incremental CAPEX</td>
<td>(20,800)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Economic Free Cash Flows

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Free Cash Flows</td>
<td>(13,048)</td>
<td>62,323</td>
<td>97,803</td>
<td>136,662</td>
<td>179,159</td>
<td>225,558</td>
<td>139,143</td>
<td>176,823</td>
<td>266,777</td>
<td>352,071</td>
</tr>
</tbody>
</table>

#### 18.3.5 Potential for Private Financing and PPP

Volumes for an LNG import terminal are typically well defined and guaranteed through offtake agreements, as the gas-fired power plant that uses the LNG as inputs has a long-term stable LNG requirement. Due to this volume security, such LNG import terminals are suitable for private investments. In this pre-feasibility study, it is assumed that the construction/procurement and operations of the LNG vessels are thus carried out by a private party.

However, the platform, mooring dolphins, and bridge and catwalk investments required to moor the LNG vessel are assumed to be carried out by the SLPA in this pre-feasibility study. Such marine infrastructure investments are typically allocated to the (landlord) port authority; hence, private sector investments are not considered likely for these project components.
18.4 Environmental Impact Assessment

Environmental Risks
The operation of a LNG handling and storage facility inherently is associated with a number of risks, of which the most important one is the risk of accidental fire and explosions. Other issues concern:

- Hazardous material management
- Wastewater discharges
- Air emissions
- Waste management
- Noise generation
- LNG transport related issues & LNG fuelling related issues

Mitigation Measures

- EIA to be carried out for LNG floating terminal; this activity is mandatory as per the ADB Environmental Safeguard Policy Statements and CEA regulations. This study could in general address all adverse impacts in detail. This EIA basically covers all possible construction and operation impacts on environment, as well as contingency plan will be prepared in order to manage a catastrophic situation that could arise at any moment of the time.

- A buffer zone to be maintained; it is usual that a buffer zone be maintained in the case of a fire in the proposed development. However, Sri Lanka does not have a guideline on the selection of a particular distance for the buffer zone. But for the LNG facilities located in Hambantota port, it was decided to be 100 m because strong wind could blow, which would trigger the fire towards downwind directions. Hence, decision on the buffer zone distance is crucial for the management authorities and accordingly the buffer zone area must be kept devoid of any development activities.

- Fire control unit is to be established nearby; when a fire breaks up it is difficult to bring in fire brigade vehicles and gear from other part of the port. Hence, it is advisable to have established a unit within the same area so that it can mobilize as early as possible to minimize the devastations that are very likely from a LNG plant.

- For the workshop to be established, end of pipe treatment facilities to be provided; As mentioned earlier for the modernization of JCT, this facility should also be provided with the end of pipe treatment to avoid any deterioration of water quality.
19 BQ Warehousing Relocation

19.1 Background to the Project

Due to the construction of the passenger terminal on the Bandaranaike Quay (BQ) in the port of Colombo per 2019 the warehouses need to be replaced. The capacities of the warehouses total 20,000 m². SLPA is opting to have the new facilities built in a PPP structure, essentially letting private parties handle the current activities. The choice for private warehouse operators will most likely increase efficiency of the warehouse, increasing the capacity as compared to the current BQ use.

Figure 19-1: BQ Warehouses

<table>
<thead>
<tr>
<th>Description</th>
<th>Type of Cargo</th>
<th>Capacity (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BQ1</td>
<td>General non-dangerous cargo</td>
<td>5,000</td>
</tr>
<tr>
<td>BQ2</td>
<td>Local cargo/Transhipment/Dangerous cargo</td>
<td>5,000</td>
</tr>
<tr>
<td>BQ3</td>
<td>General non-dangerous cargo</td>
<td>5,000</td>
</tr>
<tr>
<td>BQ4</td>
<td>Transhipment/MCC cargo</td>
<td>5,000</td>
</tr>
</tbody>
</table>
19.2 Supporting Analyses

19.2.1 Relocation Options

Three locations are considered when replacing the warehousing activities for SLPA:

- **South Port** - The corner between CICT future west container terminal could be used for warehousing activities. This valuable port land however and costs of landfill would need to be included in the business case. These costs are estimated at 18 M USD. This is too large of an expense for warehousing activities.

- **“Triangle”** – The area below CICT is currently unused. However setting up warehousing facilities on this piece of land is challenging as there are no expansion options. The elevated highway access ramps are also planned in this area.

- **Bloumendhal Hill** - This area is designated as warehousing location for SLPA. The main challenge however are the soil improvement costs as this area used to be a garbage dump site. This location is the most feasible for SLPA as expansion options are necessary to for long-term development of warehousing facilities.

The most feasible option for SLPA would be development on Bloumendhal Hill. The costs of soil improvements though are not considered in the business case as this is a one-time costs and these should not be attributed to the operations.

![Table 19-1: MCA warehouse location](image)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>South Port</th>
<th>Triangle</th>
<th>Bloumendhal Hill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of area</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Accessibility</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>LCL bonded transport</td>
<td>++</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>PPP possibilities</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Potential for future expansion</td>
<td>-</td>
<td>-</td>
<td>+++</td>
</tr>
<tr>
<td>Costs</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
</tbody>
</table>

19.2.2 Warehouse Facility

The new warehouse facility is designed at Bloumendhal Hill with a surface of 8,000 m². It is noted that the land area required for a warehouse is development is approximately 1.5 – 2.0 times the size of the warehouse; hence, a land area requirement of 1.2ha to 1.6ha is foreseen. Loading bays will facilitate efficient transfer of goods from truck to warehouse where goods can be stored in pallet racks of approximately 7 m high.
<table>
<thead>
<tr>
<th>HP</th>
<th>PO</th>
<th>UP</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate (USD)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07</td>
<td>New CFS-warehouse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Buildings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Cargo shed 100x80m (Inc. Loading bays)</td>
<td>m²</td>
<td>8,000</td>
<td>1,200.00</td>
<td>9,600,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Restroom etc. 400m²</td>
<td>m²</td>
<td>400</td>
<td>1,500.00</td>
<td>600,000.00</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Loading Bays (reception)</td>
<td>#</td>
<td>10</td>
<td>15,000</td>
<td>150,000.00</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Loading Bays (delivery)</td>
<td>#</td>
<td>10</td>
<td>15,000</td>
<td>150,000.00</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Pallet Racks</td>
<td>m</td>
<td>1,872</td>
<td>125</td>
<td>234,000.00</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Sewage, lights, fencing</td>
<td>m²</td>
<td>8,000</td>
<td>12</td>
<td>96,000.00</td>
<td></td>
</tr>
</tbody>
</table>

| 03 | Subtotal | | | | 10,830,000.00 |
| 04 | Site installation costs | 10% | | | 1,083,000.00 |
| 05 | Planning and design | 5% | | | 541,500.00 |
| 06 | Contingencies | 20% | | | 1,624,500.00 |

| 07 | New CFS-warehouse | | | | 14,079,000.00 |

To operate the warehouse pallet trucks and reach trucks are necessary. A warehouse OS combined with bar scanning handhelds should ensure efficient operations.

<table>
<thead>
<tr>
<th>HP</th>
<th>PO</th>
<th>UP</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate (USD)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07</td>
<td>New CFS-warehouse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Pallet trucks</td>
<td>#</td>
<td>20</td>
<td>8,500</td>
<td>170,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Reach trucks</td>
<td>#</td>
<td>12</td>
<td>28,000</td>
<td>336,000.00</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Warehouse OS</td>
<td>#</td>
<td>1</td>
<td>150,000</td>
<td>150,000.00</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Bar scanning handhelds</td>
<td>#</td>
<td>20</td>
<td>1,500</td>
<td>30,000.00</td>
<td></td>
</tr>
</tbody>
</table>

| 03 | Subtotal | | | | 686,000.00 |
| 06 | Contingencies | 15% | | | 102,900.00 |

| 07 | New CFS-warehouse | | | | 788,900.00 |
19.3 Pre-Feasibility

19.3.1 Introduction
The pre-feasibility of the warehousing relocation is based only on LCL cargo as MCC cargo will remain in the bounded port area in the to be constructed UCT warehouse. The costs of soil improvements are also excluded from the business case as it is unclear whether SLPA, UDA or the government will incur the costs of such operations.

19.3.2 Project Scope
To set up this business case the project case and non-project case are identified as:
- **Non-project Case** – Warehousing is not relocated. Under capacity will be created in port.
- **Project Case** – A 8,000 m² warehouse is constructed at the the Bloumendhal area, on a land plot of approximately 1.2 – 1.6 ha.

<table>
<thead>
<tr>
<th></th>
<th>Project Case</th>
<th>Non-project Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Starts in 2018</td>
<td>-</td>
</tr>
<tr>
<td>Operations</td>
<td>Starts in 2019</td>
<td>-</td>
</tr>
<tr>
<td>Terminal estimated lifespan</td>
<td>Until 2050</td>
<td>-</td>
</tr>
<tr>
<td>Throughputs</td>
<td>LCL Cargo will be handled at facility</td>
<td>Capacity shortage for handling LCL cargo in port.</td>
</tr>
</tbody>
</table>

19.3.3 Financial Pre-feasibility

Forecast
The forecast for the warehouse is based on the Colombo Base Case gateway cargo forecast. The following assumptions are applied:
- It is assumed that the LCL stream that will be handled at warehousing facilities is equal to 2.31% of the gateway container volumes, based on average LCL container volumes handled at Peliyagoda, Pettah, CFS I, CFS II, BQ I, BQ III between 2012 and 2016.
- Currently, nearly all of the LCL containers are handled by SLPA; it is assumed that all SLPA LCL handling will be relocated to the warehouse at Bloumendhal Hill to achieve economies of scale and optimally utilize the new and technologically advanced warehouse facility. However, it is noted that the market has been liberalised, enabling private parties to set up LCL facilities; it is thus assumed that the market share of the Bloumendhal Hill facility will decrease from 90% in 2019 to 50% in 2050.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombo Gateway TEU Forecast</td>
<td>'000 TEU</td>
<td>1,552</td>
<td>1,643</td>
<td>1,749</td>
<td>1,855</td>
<td>1,959</td>
<td>2,058</td>
<td>2,153</td>
<td>2,498</td>
<td>3,026</td>
<td>3,289</td>
</tr>
<tr>
<td>Market Share Bloumendhal</td>
<td>%</td>
<td>90%</td>
<td>89%</td>
<td>87%</td>
<td>86%</td>
<td>85%</td>
<td>84%</td>
<td>82%</td>
<td>76%</td>
<td>63%</td>
<td>50%</td>
</tr>
<tr>
<td>LCL Volume Bloumendhal</td>
<td>'000 TEU</td>
<td>32</td>
<td>34</td>
<td>35</td>
<td>37</td>
<td>38</td>
<td>40</td>
<td>41</td>
<td>44</td>
<td>44</td>
<td>38</td>
</tr>
</tbody>
</table>
Revenue Estimations

Revenues are derived from the SLPA tariff book. The main revenue generators are stuffing and destuffing activities of the LCL boxes. The main revenue assumptions are:

- Stuffing and Destuffing Rate 20ft (50% of 20ft) - 22 USD
- Stuffing and Destuffing Rate 40ft (50% of 40ft) - 33 USD
- Stuffing and Destuffing Rate 20ft - Full service (50% of 20ft) 100 USD
- Stuffing and Destuffing Rate 40ft - Full service (50% of 40ft) 150 USD
- Additional revenues including box handling and administrative charges total at 30% of handling revenues.

The projected revenues are presented in the table below.

<table>
<thead>
<tr>
<th>('000 USD)</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stuffing and Destuffing Rate 20ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box</td>
<td>22 USD</td>
<td>118</td>
<td>123</td>
<td>129</td>
<td>135</td>
<td>141</td>
<td>146</td>
<td>150</td>
<td>160</td>
<td>161</td>
</tr>
<tr>
<td>Stuffing and Destuffing Rate 40ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOX</td>
<td>33 USD</td>
<td>177</td>
<td>185</td>
<td>194</td>
<td>203</td>
<td>211</td>
<td>218</td>
<td>225</td>
<td>241</td>
<td>242</td>
</tr>
<tr>
<td>Stuffing and Destuffing Rate 20ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Full service Box</td>
<td>100 USD</td>
<td>538</td>
<td>561</td>
<td>589</td>
<td>615</td>
<td>640</td>
<td>662</td>
<td>682</td>
<td>729</td>
<td>733</td>
</tr>
<tr>
<td>Stuffing and Destuffing Rate 40ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Full service Box</td>
<td>150 USD</td>
<td>1,613</td>
<td>1,683</td>
<td>1,766</td>
<td>1,846</td>
<td>1,919</td>
<td>1,986</td>
<td>2,045</td>
<td>2,187</td>
<td>2,198</td>
</tr>
<tr>
<td>Revenue Container Handling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Revenues Containers</td>
<td>30% of total</td>
<td>734</td>
<td>766</td>
<td>803</td>
<td>840</td>
<td>873</td>
<td>903</td>
<td>930</td>
<td>995</td>
<td>1,000</td>
</tr>
<tr>
<td>Total Revenues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,180</td>
<td>3,319</td>
<td>3,481</td>
<td>3,639</td>
<td>3,784</td>
<td>3,915</td>
<td>4,032</td>
<td>4,312</td>
<td>4,334</td>
<td>3,744</td>
</tr>
</tbody>
</table>

OPEX Estimations

OPEX are estimated at 45% of revenue per MTBS benchmark with a following breakdown of elements:

<table>
<thead>
<tr>
<th>Share of OPEX</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour cost</td>
<td>50%</td>
<td>(715)</td>
<td>(747)</td>
<td>(783)</td>
<td>(819)</td>
<td>(851)</td>
<td>(881)</td>
<td>(907)</td>
<td>(970)</td>
<td>(975)</td>
</tr>
<tr>
<td>Capital</td>
<td>20%</td>
<td>(286)</td>
<td>(299)</td>
<td>(313)</td>
<td>(327)</td>
<td>(341)</td>
<td>(352)</td>
<td>(363)</td>
<td>(388)</td>
<td>(390)</td>
</tr>
<tr>
<td>(facility, equipment, systems)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running cost</td>
<td>15%</td>
<td>(215)</td>
<td>(224)</td>
<td>(235)</td>
<td>(246)</td>
<td>(255)</td>
<td>(264)</td>
<td>(272)</td>
<td>(291)</td>
<td>(293)</td>
</tr>
</tbody>
</table>
The CAPEX estimations as seen in paragraphs 19.2.2 consists of:
- Warehouse infrastructure – 14.1 M USD
- Equipment and OS – 0.8 M USD

The total investment is 14.9 M USD including site installation costs, planning and design and contingencies.

Results
The business case for the BQ relocated warehouse is financially feasible with a financial IRR of 11.2%, just above the required rate of 10%. It is to be noted that if a PPP option is selected further changes in revenues can be made to deviate from the SLPA tariff book.
19.3.4 Economic Feasibility

For the conversion of financial cash flows to economic cash flows, the following conversion factors are applied:

- Tax - As the tax cash flows flow to the country, it is not considered a cost in the economic business case; as such, a conversion factor of 0.00 is applied.
- Labour costs – A factor of 0.85 is applied, in order to reflect the average income tax of approximately 15% on salaries.
- Revenues – A factor of 0.80 is applied to reflect that some of the revenues could be generated in the remaining old warehouses in the port in the no-project case.
- CAPEX – A conversion factor of 0.90 is applied to reflect some benefits to the economy resulting from the construction, such as sourcing of local materials.
- For all other cash flows, a conversion factor of 1.00 is applied.

Results

The business case is considered economically viable based on these results:

- ENPV (@ 7.83%): USD 4.6 M USD
- ERR: 11.4%

<table>
<thead>
<tr>
<th>'000 USD</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental Revenues</td>
<td>-2,544</td>
<td>2,655</td>
<td>2,785</td>
<td>2,911</td>
<td>3,027</td>
<td>3,132</td>
<td>3,226</td>
<td>3,450</td>
<td>3,468</td>
<td>2,995</td>
<td></td>
</tr>
<tr>
<td>Incremental OPEX</td>
<td>(1,324)</td>
<td>(1,382)</td>
<td>(1,449)</td>
<td>(1,515)</td>
<td>(1,575)</td>
<td>(1,630)</td>
<td>(1,678)</td>
<td>(1,795)</td>
<td>(1,804)</td>
<td>(1,559)</td>
<td></td>
</tr>
<tr>
<td>Incremental CAPEX</td>
<td>(12,671)</td>
<td>1,220</td>
<td>1,274</td>
<td>1,336</td>
<td>1,396</td>
<td>1,452</td>
<td>1,502</td>
<td>1,547</td>
<td>1,655</td>
<td>1,663</td>
<td>1,437</td>
</tr>
</tbody>
</table>

Economic Free Cash Flows

19.3.5 Potential for Private Financing and PPP

Warehouse operations are considered suitable for private sector involvement:

- Fully private – If the development is not on SLPA lands, a private operator may fully invest in and develop the warehouse and operate it.
- PPP – If the warehouse is developed on SLPA lands, the SLPA may act as a landlord authority. In this case, the SLPA will provide basic infrastructure (i.e., the land) and the private operator will invest in superstructure and equipment. In this structure, the private operator will typically pay a land lease fee to the port authority.
19.4 Environmental Impact Assessment

Environmental Risks
- Risk of demolishing archaeological interesting structures (national heritage)
- Risks associated with the demolition of structures on, and infrastructure of the quay; emissions (Noise, dust, gaseous), unprofessional handling and indiscriminate disposal of hazardous waste (asbestos, polluted soil). Same as for JCT Modernisation.
- Risks related to dredging (similar to JCT modernisation Plan)
- Occupational health risk associated with demolition and construction works.

Mitigation Measures
- Archaeological Impact Assessment to be done with Archaeological Department (AD). As per the Antiquity Ordinance of Sri Lanka, it is essential to get the clearance from the AD in order to ensure that no heritage building, or archaeological artefact be destroyed or disturbed. This department will usually decide whether to sacrifice or preserve such an artefact if found.
- As mentioned for the JCT modernization plan, demolition plan needs to be worked out and approval from CEA will have to be obtained prior to the demolition work begins.
- Material transfer plan for hazardous material to be prepared and approval to be obtained from CEA; this could be taken to be a part of demolition plan as well. All adverse impacts that are very likely need to be addressed.
- Dredging plan and dredge material disposal to be done as per USEPA protocol; this is the same as for the JCT modernization.
- Safety plan for demolition work to be prepared; as explained for JCT modernization health and safety plan needs to be worked out.
- EIA/IEE or environmental clearance is to be prepared for the relocation and environmental clearance for the new location to be obtained; it is not yet clear whether either IEE or EIA is required for this activity; it is decided based on the anticipated impacts and their magnitudes as well.
20 PVQ Upgrade Plan

20.1 Background to the Project

The current users of the Prince Vijaya Quay (PVQ) have indicated the need for an upgrade of the berth due to:

- Water depth constraints;
- High berth utilisation; and
- Low discharge rates

A possible solution to be provided by SLPA is the upgrading of the quay to allow for deeper draft vessels up to 13m. A possible solution can be found in the placing an existing quay front of the old one as analyses show. The business case for SLPA is deemed financially and economically not feasible.

Figure 20-1: PVQ & North Pier

20.2 Supporting Analyses

20.2.1 Infrastructure Development

Existing Infrastructure

The Prince Vijaya Quay is constructed as a marginal quay along the combined grain/cement-pier which is located at the north perimeter of Colombo Port. The northern side of the pier is constructed with wave protection for waves from north. The length of the quay is 378m and the design water depth is CD -10m with actual vessel draughts allowable upto 9.4m

There are several structures (silos, warehouses etc.) situated on the central part of the pier; furthermore, two rail-mounted unloading units are operating on the quay apron in the full length of the pier.
The quay is designed as a gravity structure based on mass concrete blocks. They are founded on an approximately 5m thick rubble base which is assumed to reach solid ground of firm clay/rock. The figure below presents a cross section of the quay wall.

Observations
At the site visit the quay structure appeared rather old with many signs of wear and tear. However, no misalignment or apparent depressions in the quay apron were observed - this suggests that the basic quay structure may be in a reasonably good condition.
The road behind the buildings (in front of the shore protection) was not visited, but is reportedly in rather poor condition.

**Proposed Development**

In the port planning an upgrading of the quay is considered a possibility with the objective to prepare the quay for accommodation of larger bulk-carriers than today bulk carriers up to LOA 170 with draughts of 9.4. With a deeper water depth up to CD -14m, allowable vessel draughts may increase to 13m. This would boost vessel sizes from Handysize/Handymax up to 40,000 DWT to Panamax sizes of up to around 80,000 DWT.

### Table 20-1 Dry Bulk Vessel Classes

<table>
<thead>
<tr>
<th>Dry bulk vessels</th>
<th>DWT (tons)</th>
<th>LOA (m)</th>
<th>Beam (m)</th>
<th>Draught (m)</th>
<th>Able to call old basin?</th>
<th>Future at PVQ*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handysize</td>
<td>10,000 - 40,000</td>
<td>140 - 180m</td>
<td>22 - 28m</td>
<td>8 - 10.5m</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Handymax (supramax)</td>
<td>40,000 - 65,000</td>
<td>169 - 200m</td>
<td>31 - 32.4m</td>
<td>9.8 - 12.3m</td>
<td>Partly</td>
<td>YES</td>
</tr>
<tr>
<td>Panamax (incl. new)</td>
<td>67,000 - 99,000</td>
<td>223 - 233m</td>
<td>32 - 48m</td>
<td>13.2 - 14.1m</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Capesize</td>
<td>100,000 - 200,000</td>
<td>250 - 300m</td>
<td>43 - 50m</td>
<td>14.2 - 18.5m</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Ultra Large cape</td>
<td>250,000 - 320,000 +</td>
<td>300 - 360m</td>
<td>50 - 64m</td>
<td>18 - 24m</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

Source: Clarksons; MTBS

*Assuming that the PVQ quay wall is renewed and deepened.

A future water depth of 14m has been proposed at quay side. According to the sea chart this water depth is already available in the basin close to the end of the PVQ Jetty.

Due to the mode of foundation of the existing block wall a future water depth of 14m will be difficult to achieve without advancing the quay front to a safe distance from the footing of the block wall. An advance with approximately 9 m compared to the existing alignment is considered necessary. Furthermore, this extension of the quay apron will provide additional space for traffic in front of the buildings.

To close the gap, it is proposed to install a new RC deck slab which shall be partly seated on the existing block wall and partly supported on a row of new piles in front of the block wall. Piles shall be driven or drilled (depending on soil conditions) to a depth which ascertains sufficient bearing capacity. The existing rail track for unloading equipment shall be relocated accordingly to an appropriate distance from the new quay front. Furthermore, the slab and the piles shall be designed for loads from mobile crane pads (Liebherr MHC 420 or equivalent).
Potentially, the volume between the pile row and the existing block wall may be partly filled with rock/gravel material – depending on the actual conditions of block wall.

The horizontal stability of the combined quay structure may potentially be strengthened by installation of ground anchors under 45° under the existing buildings.

**Cost Estimates**
The table below provides an overview of estimated costs for the improvement works to the PVQ quay, as identified and detailed in the preceding sections.

Table 20-2 PVQ Upgrade - Cost Estimate

<table>
<thead>
<tr>
<th>HP</th>
<th>PO</th>
<th>UP</th>
<th>Unit</th>
<th>Quantity</th>
<th>Rate (USD)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>PVQ Upgrading to -14m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Quay Wall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Structural works</td>
<td>m</td>
<td>370</td>
<td>18,000.00</td>
<td>6,660,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Quay equipment</td>
<td>m</td>
<td>370</td>
<td>1,500.00</td>
<td>555,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Quay Apron</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Rails relocation</td>
<td>m</td>
<td>370</td>
<td>1,800.00</td>
<td>666,000.00</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Pavement upgrading</td>
<td>m</td>
<td>370</td>
<td>400.00</td>
<td>148,000.00</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Utilities refurbishment</td>
<td>m</td>
<td>370</td>
<td>250.00</td>
<td>92,500.00</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Dredging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Operational Analysis

In terms of cargo handling operations, no operational adjustments are foreseen for the improvement plan. However, to efficiently serve the larger vessels that are expected to berth at the terminal once the deepening is completed, an improvement of the loading/discharging equipment can be further investigated.

In terms of navigability, the envisaged new quay wall, which is to be constructed in front of the existing quay wall, limits the space available for navigating and manoeuvring. As the PVQ already has limited manoeuvring space, the envisaged quay wall improvement may result in issues related to navigation.
20.3 Pre-Feasibility

20.3.1 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 constructs the quay wall infrastructure and dredges the PVQ berth pockets, resulting in larger vessels and volume capacity at PVQ.
- **Non-project Case** – No new quay wall structure is placed, thus limiting the vessel size and volume capacity at PVQ.

The table below describes the elements of the cases further:

<table>
<thead>
<tr>
<th>Table 20-3 PVQ - Project Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Case</strong></td>
</tr>
<tr>
<td>Construction</td>
</tr>
<tr>
<td>Operations</td>
</tr>
<tr>
<td>Service Level</td>
</tr>
<tr>
<td>Business Scope</td>
</tr>
<tr>
<td>Throughputs</td>
</tr>
</tbody>
</table>

*Water depth of CD -14m enables berthing of medium-sized or not fully loaded Panamax vessels. However, the limited width of the berth/channel may result in navigational issues, especially as the new quay wall is positioned in front of the old quay wall.

The project scope and investment divisions are as follows:

<table>
<thead>
<tr>
<th>Table 20-4 PVQ - Cash Flow Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Revenues</td>
</tr>
<tr>
<td>Regular fees and charges per tariff book</td>
</tr>
<tr>
<td>Item</td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Concession fee / royalty charges</td>
</tr>
<tr>
<td>Business operations revenues</td>
</tr>
<tr>
<td><strong>PVQ Quay Wall Improvement CAPEX</strong></td>
</tr>
<tr>
<td>Quay Wall</td>
</tr>
<tr>
<td>Dredging</td>
</tr>
<tr>
<td><strong>Operational Expenses</strong></td>
</tr>
<tr>
<td>Maintenance and repair quay wall and dredging</td>
</tr>
</tbody>
</table>

### 20.3.2 Forecast

The tables below present the vessel and volume forecasts for (i) the project case; (ii) the non-project case; and (iii) the difference between the two cases.

**Table 20-5 PVQ - Forecasts**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volumes*</td>
<td>M Tons</td>
<td>2.45</td>
<td>2.64</td>
<td>2.13</td>
<td>3.08</td>
<td>3.13</td>
<td>2.86</td>
<td>3.16</td>
<td>2.68</td>
</tr>
<tr>
<td>Average DWT per Vessel*</td>
<td>DWT</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>23,333</td>
<td>26,667</td>
<td>33,333</td>
<td>40,000</td>
</tr>
<tr>
<td>Vessels*</td>
<td>Vessels</td>
<td>122</td>
<td>132</td>
<td>106</td>
<td>154</td>
<td>134</td>
<td>107</td>
<td>95</td>
<td>67</td>
</tr>
<tr>
<td>Average GT per Vessel*</td>
<td>GT</td>
<td>11,765</td>
<td>11,765</td>
<td>11,765</td>
<td>11,765</td>
<td>13,725</td>
<td>15,686</td>
<td>19,608</td>
<td>23,529</td>
</tr>
<tr>
<td><strong>Non-Project Case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volumes*</td>
<td>M Tons</td>
<td>2.45</td>
<td>2.64</td>
<td>2.83</td>
<td>3.08</td>
<td>3.13</td>
<td>2.86</td>
<td>3.16</td>
<td>2.68</td>
</tr>
<tr>
<td>Average DWT per Vessel*</td>
<td>DWT</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Vessels*</td>
<td>Vessels</td>
<td>122</td>
<td>132</td>
<td>142</td>
<td>154</td>
<td>156</td>
<td>143</td>
<td>158</td>
<td>134</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incremental Volumes*</td>
<td>M Tons</td>
<td>-</td>
<td>-</td>
<td>(0.71)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Incremental Vessels*</td>
<td>Vessels</td>
<td>-</td>
<td>-</td>
<td>(35)</td>
<td>-</td>
<td>(22)</td>
<td>(36)</td>
<td>(63)</td>
<td>(67)</td>
</tr>
</tbody>
</table>

*Vessels and volumes presented are for the grains and cement handled at both the PVQ and New North Pier.*
20.3.3 Financial Feasibility

The sections below present the estimated financial cash flows related to the PVQ quay improvement project. First, the estimated revenues, OPEX, and CAPEX are assessed individually; subsequently, overall key financial indicators are presented for the envisaged project.

Revenues

From the perspective of the SLPA, revenues from the grain and cement trades in Colombo port comprise (i) port dues and (ii) concession fees.

Port Dues

The table below presents the assumptions for the port dues revenues.

Table 20-6 PVQ – Port Due Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariffs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Dues</td>
<td>4.00</td>
<td>USD / 100 GT</td>
</tr>
<tr>
<td>Entering Dues</td>
<td>5.00</td>
<td>USD / 100 GT</td>
</tr>
<tr>
<td>Pilotage Fee</td>
<td>5.00</td>
<td>USD / 100 GT</td>
</tr>
<tr>
<td>Pilot Fee</td>
<td>32.00</td>
<td>USD / Move</td>
</tr>
<tr>
<td>Tug Fee</td>
<td>350.00</td>
<td>USD / Tug / Hour</td>
</tr>
<tr>
<td>Dockage Fee</td>
<td>0.22</td>
<td>USD / 100 GT</td>
</tr>
<tr>
<td>Landing &amp; Delivery Fee</td>
<td>0.22</td>
<td>USD / Ton</td>
</tr>
</tbody>
</table>

*Operations*

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot Moves per Vessel</td>
<td>2</td>
<td>Moves</td>
</tr>
<tr>
<td>Tug Moves per Vessel</td>
<td>2</td>
<td>Moves</td>
</tr>
<tr>
<td>Tugs per Vessel</td>
<td>3</td>
<td>Tugs</td>
</tr>
</tbody>
</table>

Subsequently, the table below summarizes the port dues revenues for (i) the project case; (ii) the non-project case; and (iii) the difference between the two cases. It can be observed that the revenues from port dues are estimated to be lower in the project case, despite the fact that the volumes remain constant between the two cases. This is due to the fact that the higher fees paid by larger vessels do not fully compensate for the decreased number of vessels estimated to be handled at the PVQ and New North Pier.

Table 20-7 PVQ - Port Due Revenues

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Dues</td>
<td>M USD</td>
<td>1.01</td>
<td>1.09</td>
<td>0.88</td>
<td>1.27</td>
<td>1.24</td>
<td>1.10</td>
<td>1.17</td>
<td>0.96</td>
</tr>
<tr>
<td>Non-Project Case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Dues</td>
<td>M USD</td>
<td>1.01</td>
<td>1.09</td>
<td>1.17</td>
<td>1.27</td>
<td>1.29</td>
<td>1.18</td>
<td>1.30</td>
<td>1.10</td>
</tr>
</tbody>
</table>
It is assumed that the incremental annual concession fee is set at a specific tariff to cover for SLPA’s:

- decreased operational profit (incremental port dues – incremental OPEX); and
- incremental CAPEX.

As such, the concession fee is calculated after assessment of the OPEX and CAPEX.

**OPEX**

The OPEX related to the PVQ improvement project comprise (i) labour and fuel costs for the marine services and (ii) maintenance for the additional infrastructure.

**Labour and Fuel Costs for Marine Services**

It is expected that SLPA’s labour and fuel OPEX related to the marine services are equal to 50% of the marine services revenues, as presented in Table 20-7. The table below summarizes the OPEX related to the marine services.

**Table 20-8 PVQ - Port Due OPEX**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine Services OPEX</td>
<td>M USD</td>
<td>0.50</td>
<td>0.54</td>
<td>0.44</td>
<td>0.63</td>
<td>0.62</td>
<td>0.55</td>
<td>0.58</td>
<td>0.48</td>
</tr>
<tr>
<td>Non-Project Case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine Services OPEX</td>
<td>M USD</td>
<td>0.50</td>
<td>0.54</td>
<td>0.58</td>
<td>0.63</td>
<td>0.64</td>
<td>0.59</td>
<td>0.65</td>
<td>0.55</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine Services OPEX</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(0.15)</td>
<td>-</td>
<td>(0.02)</td>
<td>(0.04)</td>
<td>(0.07)</td>
<td>(0.07)</td>
</tr>
</tbody>
</table>

**Maintenance OPEX**

Besides operational costs related to providing marine services, the development of additional infrastructure will result in increased maintenance costs. The table below presents the maintenance costs for the new infrastructure, based on a benchmark of 1% of CAPEX per annum.

**Table 20-9 PVQ - Maintenance OPEX**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infra Maintenance Costs</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td>Non-Project Case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It is noted that the actual incremental maintenance costs may be lower, as the new infrastructure may reduce the need for maintaining the old infrastructure; hence, the maintenance costs of the new infrastructure may (partially) substitute maintenance costs of the old infrastructure, rather than being fully complimentary. However, the full maintenance costs are considered to arrive at a conservative estimate.

**CAPEX**

The table below summarizes the CAPEX for the PVQ development, based on the CAPEX items identified in Table 20-2.

**Table 20-10 PVQ - CAPEX**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infra CAPEX Costs</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>13.16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Non-Project Case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infra CAPEX Costs</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infra CAPEX Costs</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>13.16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Feasibility**

The feasibility is based on the incremental cash flows, to provide insight in the value that is created by improving the PVQ.

**Without Incremental Concession Fee**

The table below summarizes the financial results before considering an incremental concession fee from the grain and cement companies to the SLPA. The presented cash flows result in the following financial performance indicators:

- NPV (10% WACC): USD -11.15 M
- Payback period: N/A
- IRR: N/A

It is concluded that, without considering an incremental concession fee, the project is not financially feasible.
Table 20-11 PVQ - Financial Feasibility without Concession Fee

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(0.29)</td>
<td>-</td>
<td>(0.05)</td>
<td>(0.08)</td>
<td>(0.14)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>OPEX</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(0.15)</td>
<td>0.13</td>
<td>0.11</td>
<td>0.09</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Operational Cash Flow</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(0.15)</td>
<td>(0.13)</td>
<td>(0.16)</td>
<td>(0.17)</td>
<td>(0.20)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>CAPEX</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(13.16)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Investment Cash Flow</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(13.16)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pre-Tax Free Cash Flow</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(13.30)</td>
<td>(0.13)</td>
<td>(0.16)</td>
<td>(0.17)</td>
<td>(0.20)</td>
<td>(0.20)</td>
</tr>
</tbody>
</table>

With Incremental Concession Fee
However, as the grain and cement companies can realize (i) reduced costs from marine services fees and (ii) transport cost savings by transporting the grains and cement in larger vessels.

**Reduced Marine Services Costs**
The reduced costs from marine services paid by the grain and cement companies are equal to the reduction in marine services revenues for SLPA, as calculated in Table 20-7.

**Transport Cost Savings**
From market consultations, it has been identified that cement is mainly sourced from Pakistan, Indonesia, and Vietnam. The table below presents the calculation for the average shipping distance between Colombo and these three destinations, assuming an equal distribution of cargoes between the three destinations.

Table 20-12 PVQ - Transport Cost Savings - Distances

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karachi, Pakistan</td>
<td>Colombo, Sri Lanka</td>
<td>Nautical Miles</td>
</tr>
<tr>
<td>Tanjung Priok, Indonesia</td>
<td>Colombo, Sri Lanka</td>
<td>Nautical Miles</td>
</tr>
<tr>
<td>Saigon, Vietnam</td>
<td>Colombo, Sri Lanka</td>
<td>Nautical Miles</td>
</tr>
<tr>
<td><strong>Average Distance</strong></td>
<td></td>
<td>Nautical Miles</td>
</tr>
</tbody>
</table>

According to Clarkson's Research, the transport cost savings between a Panamax vessel and Handymax vessel are estimated at approximately USD 1.00 per 1,000 tons of cargo per mile. The table below presents the estimated shift from Handysize vessels to Panamax vessels; it is noted that the share of cargoes transported by Panamax vessels is not expected to exceed 50% of the total volumes, as the total volumes also comprise volumes handled at New North Pier, which is not suited to handle Panamax vessels.
Table 20-13 PVQ - Transport Cost Savings - Vessel Shift

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumes by Panamax</td>
<td>%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8.33%</td>
<td>16.67%</td>
<td>33.33%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Volumes by Panamax</td>
<td>M Tons</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.26</td>
<td>0.48</td>
<td>1.05</td>
<td>1.34</td>
</tr>
</tbody>
</table>

Subsequently, the table below presents the estimated transport cost savings, given (i) the estimated USD 1.00 saving per 1,000 tons per mile; (ii) the transport distances; and (iii) the volumes transported by Panamax volumes.

Table 20-14 PVQ - Transport Cost Savings

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg Transport Distance</td>
<td>NM</td>
<td>1,799</td>
<td>1,799</td>
<td>1,799</td>
<td>1,799</td>
<td>1,799</td>
<td>1,799</td>
<td>1,799</td>
<td>1,799</td>
</tr>
<tr>
<td>Volumes by Panamax</td>
<td>M Tons</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.26</td>
<td>0.48</td>
<td>1.05</td>
<td>1.34</td>
</tr>
<tr>
<td>Savings per 1,000 ton</td>
<td>USD / NM</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Transport Cost Savings</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.47</td>
<td>0.86</td>
<td>1.90</td>
<td>2.41</td>
</tr>
</tbody>
</table>

Total Savings Private Parties

The table below summarizes the total savings that are realized by the private parties due to the envisaged PVQ improvement.

Table 20-15 PVQ - Total Cost Savings Private Parties

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Services Costs</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>0.29</td>
<td>-</td>
<td>0.05</td>
<td>0.08</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport Cost Savings</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.47</td>
<td>0.86</td>
<td>1.90</td>
<td>2.41</td>
</tr>
<tr>
<td>Total Cost Savings</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>0.29</td>
<td>-</td>
<td>0.52</td>
<td>0.94</td>
<td>2.03</td>
<td>2.55</td>
</tr>
</tbody>
</table>

The table below summarizes the financial results for the SLPA, if the cost savings of the private parties fully flow to the SLPA through concession fees or royalties. The presented cash flows result in the following financial performance indicators:

- **NPV (10% WACC):** USD -5.15 M
- **Payback period:** 19 Years
- **IRR:** 5.51%

It is concluded that, despite a substantial improvement of the financial performance caused by the concession fees, the project is not financially feasible.
Table 20-16 PVQ - Financial Feasibility with Concession Fee

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues Incl Cost Savings</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.47</td>
<td>0.86</td>
<td>1.90</td>
<td>2.41</td>
</tr>
<tr>
<td>OPEX</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.13</td>
<td>0.11</td>
<td>0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>Operational Cash Flow</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>0.15</td>
<td>(0.13)</td>
<td>0.36</td>
<td>0.77</td>
<td>1.83</td>
<td>2.35</td>
</tr>
<tr>
<td>CAPEX</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(13.16)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Investment Cash Flow</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(13.16)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Pre-Tax Free Cash Flow</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(13.01)</td>
<td>(0.13)</td>
<td>0.36</td>
<td>0.77</td>
<td>1.83</td>
<td>2.35</td>
</tr>
</tbody>
</table>

20.3.4 Economic Feasibility

For the PVQ improvement project, the following economic benefits and costs are foreseen:

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

It can be noted that the economic cash flows for the PVQ improvement project are similar to the financial cash flows; however, 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 20-17 PVQ - Economic Conversion Factors

<table>
<thead>
<tr>
<th>Item</th>
<th>Conversion Factor</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental CAPEX</td>
<td>0.9</td>
<td>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.</td>
</tr>
<tr>
<td>Incremental OPEX</td>
<td>1.0</td>
<td>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.</td>
</tr>
<tr>
<td>Incremental Revenues*</td>
<td>1.0</td>
<td>No market distortions are apparent.</td>
</tr>
<tr>
<td>Transport Savings Cost</td>
<td>1.0</td>
<td>No market distortions are apparent.</td>
</tr>
</tbody>
</table>
*Incremental revenues do not include the concession fees / royalties that are paid by the client due to the transport cost savings, as the transport cost savings are already included separately. Also including the concession fees / royalties would result in double-counting of benefits.

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 -2.38 M
- ERR: 6.11%

Hence, it is concluded that the project is not economically viable.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incremental Revenues*</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(0.29)</td>
<td>-</td>
<td>(0.05)</td>
<td>(0.08)</td>
<td>(0.14)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>Cost Savings</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>0.29</td>
<td>-</td>
<td>0.52</td>
<td>0.94</td>
<td>2.03</td>
<td>2.55</td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incremental CAPEX</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(11.84)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Incremental OPEX</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(0.15)</td>
<td>0.13</td>
<td>0.11</td>
<td>0.09</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Pre-Tax Free Cash Flow</td>
<td>M USD</td>
<td>-</td>
<td>-</td>
<td>(11.70)</td>
<td>(0.13)</td>
<td>0.36</td>
<td>0.77</td>
<td>1.83</td>
<td>2.35</td>
</tr>
</tbody>
</table>

*Incremental revenues do not include the concession fees / royalties that are paid by the client due to the transport cost savings, as the transport cost savings are already included separately. Also including the concession fees / royalties would result in double-counting of benefits.

20.3.5 Potential for Private Financing and PPP

Currently, SLPA is a landlord authority for the activities at PVQ; SLPA is the owner of the PVQ infrastructure, while operations and superstructure investments are carried out by private parties.

The investments envisaged under the PVQ upgrade plan comprise dredging and quay wall construction works. These investments are typically allocated to the (landlord) port authority. However, as these investments benefit the private operators, concession fees paid by the operators may be increased; in this pre-feasibility, it is assumed that the private operators increase the concession fee payments with the level of their cost savings from the increased water depth.
20.4 Environmental Impact Assessment

Potential impacts are identical as those listed for the BQ Warehousing Relocation Plan.

Environmental Risks

- Risk of demolishing archaeological interesting structures (national heritage)
- Risks associated with the demolition of structures on, and infrastructure of the quay; emissions (Noise, dust, gaseous), unprofessional handling and indiscriminate disposal of hazardous waste (asbestos, polluted soil). Same as for JCT Modernisation.
- Risks related to dredging (similar to JCT modernisation Plan)
- Occupational health risk associated with demolition and construction works.

Mitigation Measures

- Archaeological Impact Assessment to be done with Archaeological Department (AD). As per the Antiquity Ordinance of Sri Lanka, it is essential to get the clearance from the AD in order to ensure that no heritage building, or archaeological artefact be destroyed or disturbed. This department will usually decide whether to sacrifice or preserve such an artefact if found.
- As mentioned for the JCT modernization plan, demolition plan needs to be worked out and approval from CEA will have to be obtained prior to the demolition work begins.
- Material transfer plan for hazardous material to be prepared and approval to be obtained from CEA; this could be taken to be a part of demolition plan as well. All adverse impacts that are very likely need to be addressed.
- Dredging plan and dredge material disposal to be done as per USEPA protocol; this is the same as for the JCT modernization.
- Safety plan for demolition work to be prepared; as explained for JCT modernization health and safety plan needs to be worked out.
- EIA/IEE or environmental clearance is to be prepared for the relocation and environmental clearance for the new location to be obtained; it is not yet clear whether either IEE or EIA is required for this activity; it is decided based on the anticipated impacts and their magnitudes as well.
Appendix I  Detailed Forecasts of Commodities

General
This section contains the detailed forecasts for Colombo port for the period 2016 – 2050. Each Colombo port forecast is derived from a national forecast, the details of which and the assumptions can be reviewed in the National Port Directions document. The forecasts table contain:

- Colombo share – The Colombo share is the percentage of national throughput flowing through Colombo port. This share is based on national allocation assumptions. The Colombo share for gateway containers for example, sees a decrease to 88% on the basis that Hambantota and Trincomalee will see some container throughputs.
- High, base and low scenarios – These are derived from the national high base and low scenarios differing by economic assumptions multiplied by the Colombo Share.
- Difference 2016 – 2050 – This is the absolute difference between the 2016 historic throughput and the 2050 forecast.
- CAGR – Average growth rate for the years 2016 – 2050.

Summary Colombo Forecasts

<table>
<thead>
<tr>
<th></th>
<th>Demand 2016</th>
<th>Demand 2020</th>
<th>Demand 2025</th>
<th>Demand 2030</th>
<th>Demand 2050</th>
<th>Difference 2016 - 2050</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway Containers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombo Share</td>
<td>100.0%</td>
<td>99.0%</td>
<td>98.0%</td>
<td>95.0%</td>
<td>88.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1,300</td>
<td>1,643</td>
<td>2,207</td>
<td>2,713</td>
<td>4,003</td>
<td>2,703</td>
<td>3.36%</td>
</tr>
<tr>
<td>Base</td>
<td>1,300</td>
<td>1,643</td>
<td>2,153</td>
<td>2,498</td>
<td>3,289</td>
<td>1,989</td>
<td>2.77%</td>
</tr>
<tr>
<td>Low</td>
<td>1,300</td>
<td>1,643</td>
<td>2,098</td>
<td>2,283</td>
<td>2,585</td>
<td>1,286</td>
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<tr>
<td>Transhipment Containers</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombo Share</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>4,355</td>
<td>5,775</td>
<td>5,873</td>
<td>6,433</td>
<td>12,671</td>
<td>8,316</td>
<td>3.19%</td>
</tr>
<tr>
<td>High</td>
<td>4,355</td>
<td>6,304</td>
<td>7,311</td>
<td>8,473</td>
<td>20,996</td>
<td>16,641</td>
<td>4.74%</td>
</tr>
<tr>
<td>Wheat / Maize / Corn</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombo Share</td>
<td>18.0%</td>
<td>16.7%</td>
<td>15.0%</td>
<td>15.0%</td>
<td>15.0%</td>
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</tr>
<tr>
<td>High</td>
<td>2,179</td>
<td>3,057</td>
<td>3,279</td>
<td>3,070</td>
<td>2,968</td>
<td>789</td>
<td>0.91%</td>
</tr>
<tr>
<td>Base</td>
<td>2,179</td>
<td>2,866</td>
<td>2,871</td>
<td>2,560</td>
<td>2,334</td>
<td>156</td>
<td>0.20%</td>
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<tr>
<td>Low</td>
<td>2,179</td>
<td>2,675</td>
<td>2,463</td>
<td>2,049</td>
<td>1,701</td>
<td>(477)</td>
<td>-0.72%</td>
</tr>
<tr>
<td>Cement / Clinker / Gypsum</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombo Share</td>
<td>56.0%</td>
<td>53.3%</td>
<td>50.0%</td>
<td>40.0%</td>
<td>30.0%</td>
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<td></td>
</tr>
<tr>
<td>High</td>
<td>190</td>
<td>211</td>
<td>257</td>
<td>315</td>
<td>380</td>
<td>190</td>
<td>2.06%</td>
</tr>
<tr>
<td></td>
<td>Demand 2016</td>
<td>Demand 2020</td>
<td>Demand 2025</td>
<td>Demand 2030</td>
<td>Demand 2050</td>
<td>Difference 2016 - 2050</td>
<td>CAGR</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------</td>
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<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Base</td>
<td>190</td>
<td>211</td>
<td>257</td>
<td>302</td>
<td>342</td>
<td>152</td>
<td>1.74%</td>
</tr>
<tr>
<td>Low</td>
<td>190</td>
<td>211</td>
<td>257</td>
<td>289</td>
<td>304</td>
<td>114</td>
<td>1.39%</td>
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**Fertilizer**

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<tbody>
<tr>
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<td>100.0%</td>
<td>55.6%</td>
</tr>
<tr>
<td>High</td>
<td>314</td>
<td>314</td>
</tr>
<tr>
<td>Base</td>
<td>314</td>
<td>314</td>
</tr>
<tr>
<td>Low</td>
<td>314</td>
<td>314</td>
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</tbody>
</table>

**Crude Oil**

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Low</th>
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<tbody>
<tr>
<td>Colombo Share</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>High</td>
<td>1,685</td>
<td>359</td>
</tr>
<tr>
<td>Base</td>
<td>1,685</td>
<td>343</td>
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<tr>
<td>Low</td>
<td>1,685</td>
<td>333</td>
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**Refined Oil**

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<thead>
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<th></th>
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<tbody>
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<td>Colombo Share</td>
<td>90.3%</td>
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<tr>
<td>High</td>
<td>2,778</td>
<td>359</td>
</tr>
<tr>
<td>Base</td>
<td>2,778</td>
<td>343</td>
</tr>
<tr>
<td>Low</td>
<td>2,778</td>
<td>333</td>
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**LNG**

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</tr>
<tr>
<td>High</td>
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<td>343</td>
</tr>
<tr>
<td>Low</td>
<td>-</td>
<td>333</td>
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</table>

**Non-containerised General Cargo**

<table>
<thead>
<tr>
<th></th>
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<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombo Share</td>
<td>66.5%</td>
<td>63.6%</td>
</tr>
<tr>
<td>High</td>
<td>855</td>
<td>949</td>
</tr>
<tr>
<td>Base</td>
<td>855</td>
<td>949</td>
</tr>
<tr>
<td>Low</td>
<td>855</td>
<td>949</td>
</tr>
</tbody>
</table>

**RoRo Domestic**

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombo Share</td>
<td>50.3%</td>
<td>50.3%</td>
</tr>
<tr>
<td>High</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Base</td>
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<td>32</td>
</tr>
<tr>
<td>Low</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Demand 2016</td>
<td>Demand 2020</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Colombo Share</td>
<td>-</td>
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</tr>
<tr>
<td>High</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Base</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Low</td>
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<td>-</td>
</tr>
</tbody>
</table>