Infrastructure Victoria

Second Container Port Advice

Estimated Capacity of the Port of Melbourne

May 2017

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1. Introduction

1.1 Background

The Victorian Special Minister of State has asked Infrastructure Victoria (IV) to provide advice on the future capacity of Victoria's ports, focusing on the need for, timing and location of a second container port.

Currently all container shipping into Victoria is through the Port of Melbourne, which is Australia's largest container port. The Infrastructure Victoria Study is preparing advice on the ultimate capacity of the Port of Melbourne, when the port will reach capacity and when a second container port will be required.

The Special Minister of State has also asked Infrastructure Victoria to assess two possible sites for the second container port, one at Hastings in Western Port and one at Bay West in Port Phillip Bay.

GHD have been appointed by Infrastructure Victoria (IV) to assist with the preparation of this Ports Advice for the Victorian Government, being engaged to provide advice on the Container Handling Capacity of the Port of Melbourne.

1.2 Purpose of this report

This report provides estimates of when the port of Melbourne will reach capacity, helping Infrastructure Victoria answer the (timing) 'when' section of the advice.

This report provides an estimate of the capacity of the Port of Melbourne in its current condition, and provides a cost estimate for a selection of development scenarios that could be considered to enhance its capacity in the longer term.

The report collates work from GHD, Jacobs and AECOM to consider:

- Berth, yard and gate capacity
- Road network capacity
- Rail network capacity; and
- Limitations imposed by navigational infrastructure

Based on the information presented in this report IV will determine what investments and capacity enhancements are considered appropriate to form part of the final IV advice to Government.

1.3 Report structure

This report is structured as follows:

Section 1 – (this section) – study scope, limitations and key assumptions.

Section 2 – to define the factors and terms that apply to the determination of port capacity.

Section 3 – to outline the characteristics of shipping and container trade at the Port of Melbourne. This section should be read in conjunction with Section 9 (shipping fleet characteristics)

Section 4 –Describes the key precincts at the Port of Melbourne.

Section 5 – focusses on the berth yard and gate capacity limits of Swanson Dock. This considers the 'as is' (current) situation and explores a number of capacity

enhancement options to identify what the maximum capacity and limiting components might be. This section does not address road, rail and channel constraints.

Section 6 – focusses on the berth yard and gate capacity limits of Webb Dock. This considers the 'as is' (current) situation and explores a number of capacity enhancement options to identify what the maximum capacity and limiting components might be. This section does not address road, rail and channel constraints

Section 7 – looks at the local road network capacity at Swanson dock and Webb Dock through modelling of the intersection capacities at peak and off-peak periods. This work being undertaken by Jacobs.

Section 8 – looks at the rail network capacity and the benefits this may on terminal capacity at Swanson Dock and Webb Dock

Section 9 – looks at the container fleet spectrum and Port Phillip channel capacity to what limitations may be imposed by navigational infrastructure over time. The channel capacity work has been undertaken by AECOM.

Section 10 – brings the capacity assessment findings together to consider the effective capacity of the Port of Melbourne as a consequence of individual components combined. The section explores plausible development paths to maximum capacity and effective capacity needs driven by the fleet spectrum impacts on container share between Swanson Dock and Webb Dock.

Section 11 – highlights key factors and risks that could affect the successful implementation of capacity enhancement at Port of Melbourne.

Section 12 – provides a summary of the cost estimates considered as part of the capacity enhancement study.

1.4 Study scope and limitations

1.4.1 General

This report provides input to the timing of the need for a second container port in Victoria.

The assessment of the port capacity has been undertaken only for this purpose. To explore broad timelines and capacity range estimates. The analysis has been undertaken using static models and assumptions made by GHD, Jacobs and AECOM as appropriate. GHD does not warrant or guarantee that the estimated capacity can or will be achieved, as many other factors and variables can affect port capacity.

1.4.2 Cost estimate

This document presents a Cost Estimate for a number of capacity enhancing initiatives identified in the analysis. The Cost Estimate includes an estimate of CAPEX for the core infrastructure to be required under each scenario. The estimates are intended to reflect an accuracy of +60 / -40% in line with Victoria's high value high risk (HVHR) framework.

The achievement of this accuracy is impacted by the adequacy of information. Where this is deemed insufficient, this is noted and risk-adjustments have been incorporated.

The Cost Estimate has been prepared to provide an order of magnitude costs for enhancing container capacity and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only, based on basic concepts and assumptions. Actual prices, costs and other variables may be different to those used to prepare the Cost

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Estimate and should be expected to change. GHD does not represent, warrant or guarantee that the proposed development at either site can or will be undertaken at a cost which is the same or less than the Cost Estimate.

1.4.3 Limitations and validation

This report has been prepared by GHD for Infrastructure Victoria and may only be used and relied on by Infrastructure Victoria for the purpose agreed between GHD and Infrastructure Victoria as set out in section 1.2.

GHD otherwise disclaims responsibility to any person other than Infrastructure Victoria arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the limitations set out in the report and other referenced documentation.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report or as otherwise agreed with Infrastructure Victoria. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Infrastructure Victoria and others who provided information to GHD (including some other Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.5 Assumptions

Table 1 lists the assumptions and criteria that have been adopted in the study to determine the existing berth capacity at the Port of Melbourne:

A Glossary of terms is provided in Appendix A.

Table 1 Assumptions for existing berth performance of the Port of Melbourne

	Swanson Dock West	Swanson Dock East	Webb Dock
Berth length (m)	944	884	660
Berth (no)	3	3	2
Lease area (Ha)	44	38	35
Yard area (Ha)[1]	23	28	27
Ship to Shore Cranes (STSC) (No)	8	7	6
Largest vessel	320 x 45 m beam[2] (7,500 TEU)		335 x 48 m beam[3]

1 GHD estimates

2 Restricted by basin width, cannot be accommodated on all berths

3 Up to 10,000 TEU

Ship productivity (mph)	60 - 100	60 - 100	120
STSC availability (%)	95%	95%	95%
STSC utilisation (%)	52%	52%	52%
Berth occupancy (%)	60%	60%	75%[4]
TEU Factor	1.5	1.5	1.5
Containers per move	1.2	1.2	1.2
Vessel spacing (% LOA)	10%	10%	10%
Working days	360 days x 24/7 working is assumed		

Table 2 lists the assumptions and criteria have been adopted in the study to determine the future berth capacity at the Port of Melbourne:

Table 2 Assumptions regarding the future berth performance

	Swanson Dock West	Swanson Dock East	Webb Dock (E)
Berth length (m)	1000	1000	≥750
Berth (no)	3	3	≥ 2
Leased area (Ha)	44	38	35
STSC cranes (No)	10	10	7
Largest vessel	320 x 43 m beam (7,500 TEU)		335 x 48 m beam (10,000 TEU)
Crane productivity (mph)	35	35	35
Ship productivity (mph)	100 – 120	100 - 120	120
Crane availability (%)	95%	95%	95%
TEU Crane utilisation (%)	52%	52%	52%
Berth occupancy (%)	60 – 75%	60 – 75%	75%
TEU Factor	1.5 – 1.6	1.5 – 1.6	1.5 – 1.6
Containers per move	1.2	1.2	1.2
Vessel spacing on berth (% LOA)	10%	10%	10%
Working days	360 days x 24/7 working is assumed		

4 VICT target

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Table 3 lists the assumptions and criteria that have been used to determine yard capacity.

Table 3 Benchmark slots per hectare for alternative equipment types

Equipment type	Slots per Hectare
TL / Reach Stacker	1148
ECH	1722
SC	574
RTG	1455
RMG Europe	1360
RMG Asia	2849
ASC	1310

Table 4 lists the assumptions and criteria that have been used to determine gate capacity.

Table 4 Assumed criteria for gate capacity analysis

Parameter	Value range
Gate peak	1.1 - 1.44
Containers/truck	1.75 - 2.5
Operating hours	14 - 24
Gate processing time (minutes)	1 to 3

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2. Port Capacity Factors

2.1 General

This section identifies the port capacity factors, measures and benchmarks that are relevant to the Port of Melbourne Capacity estimate.

2.2 Nameplate and effective capacity

For the purposes of this report, **nameplate capacity** is defined as the full theoretical load sustainable throughput of a port in TEU per annum. This assumes that the limiting port component is running at its peak for 365 days per year with no variation for seasonality.

For port planning purposes the **effective capacity** is the nameplate capacity reduced to a level that ensures competitive tension can exist between the stevedores within a single port to ensure competitive service levels are maintained. The effective capacity is usually defined as a percentage of nameplate capacity that gives competitive service levels. Additional port capacity should be scheduled before the annual throughput reaches the effective capacity. Throughput and operations up to effective capacity are not expected to be impacted by unacceptable performance, delays or congestion. Effective capacity as a percentage of nameplate capacity is will vary between different sized ports and number of berths. This is discussed further in Section 2.12.

Port capacity can also be divided into two further realms: **operational capacity** and **infrastructure capacity**. Operational capacity can be increased relatively easily by the application of more labour or more equipment. Increased infrastructure capacity on the other hand requires long term investment in critical infrastructure, which includes expensive berth structures, channels, container yards, and associated transport infrastructure which typically require long planning, separate funding and construction lead times.

2.3 Influencing factors

Each port system is unique – whether it is an existing port that has grown and adapted to changes in trade or urban growth or a brand new greenfield port, the nature of the container trade in terms of the surrounding environment, seasonality, container types, acceptable dwell times and operations will vary from one port to another, with implications for capacity.

The myriad of factors that influence the efficiency and ultimately the capacity of a container port can broadly be categorised into external market factors, infrastructure limits within the control of the port manager or landlord and productivity factors that are within the control of the stevedore. The following sections discuss some of the key factors and how they may affect marine side aspects (channels, berths, ship size, access to the berth), port/terminal (berth, yard, gate) and landside factors (road and rail networks).

2.3.1 External factors

The key factors that are outside the control of either the port landlord or the stevedore include:

- **Adequacy of landside transport infrastructure** – the capacity and/or congestion existing on road and rail networks connected to a port are critical to the performance of the port. The ability to get cargo in and out of the port gate on time, without delay will define supply chain economics container dwell periods and shape port capacity.Local road and rail network capacity is also critical in this area.

- **Peaking** – demand for both import and export containers varies over the week primarily due to work-day practices and supply chains, and throughout the year due to consumer patterns and agricultural production.
- **Fleet spectrum** – the number and dimensions of the vessels that call at the port. Smaller vessels with irregular dimensions are harder to plan for and create higher congestion within the approach channels and at the berth due to rules of separation and fixed non-working time at berth for all vessels irrespective of size.
- **Vessel stowage patterns** – how containers are stowed within a vessel affects the number of cranes that can be applied to that vessel – this factor is linked to the TEU exchange per vessel. Most vessels calling at the Port of Melbourne have containers stowed within particular holds dedicated to Melbourne, with other holds for other Australian ports.
- **TEU exchange per vessel** – the number of containers lifted off and onto each vessel expressed as a ratio of the vessel's total capacity. A full vessel unload and load would be 200%. The historic average TEU exchange per vessel for Melbourne over the past decade is 50 - 60% (i.e approximately a third of the vessels capacity is removed and a third is loaded) depending on the trade.
- **TEU Factor - Ratio of 20-foot to 40-foot containers** – A TEU factor of 1.5 indicates there is one 20ft container to each 40 ft container. As 50% of lifts in the terminal will be for one TEU and 50% for two TEU the average TEU for each lift is equal to 1.5 TEU
- The TEU factor determines the actual number of lifts required for the forecast TEUs as container cranes can transfer 40-foot containers at the same rate as 20-foot containers. This proportion is driven by the demands of freight forwarders and receivers for packaging of goods in particular container types and by rail and road mass limitations.

  New crane technology allows some cranes to lift two 40-foot containers (4 TEU) or two 20-foot containers(2 TEU) together as a 'twin lift' (2 x 20ft end to end) or run two sets of hoists with twin lifting capacity (tandem lifting- 2 x 20 ft or 2 x 40ft side by side), which results in significant improvements in productivity (TEU's handles per move). The success of this however, depends on the stowage of the ship, capacity of the quay and the adequacy of the onshore operation. At present in Melbourne, the great majority of containers are lifted individually. The industry is predicting that new ports with suitable cranes will average 2 or more TEU per lift by 2020.
- **Truck utilisation and fleet mix** these factors influence the number of trucks through the port gate and ultimately the time taken to transfer each container. All Australian ports have seen a gradual decline in truck turnaround times over the past decade, with the Port of Melbourne averaging 30.6 minutes over the last quarter. With an average TEU per truck call of 2.4, this equates to 12.75 minutes per TEU.

  The truck fleet mix (numbers of semis, B-Doubles and Super B-Doubles or HPFVs) servicing a port is related to the capacity of the road network linking the port with its hinterland. As axle load limits and permitted routes increase, the proportion of larger capacity trucks will likewise increase.

2.3.2 Factors within control of the port manager

In most landlord port models, the port owner or manager is responsible for the provision of the fixed infrastructure including the channels and wharfs.

- **Quay length** – increasing quay length has two impacts on port capacity. Longer quays obviously enable more vessels to berth simultaneously, additionally, as the ratio of

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average vessel LOA to total berth length decreases, the stevedore has a greater flexibility to optimise berthing arrangements and consequently berth utilisation. Similarly, the configuration of the berths will have an impact – a single facetted berth face will have greater flexibility than a quay line with breaks. It is usual to have around 10% of the quay length unused between berthed vessels.

- **Wharf structural capacity** – the structural capacity limits the capacity of cranes that can be deployed at the port terminal, as cranes with longer outreach and twin and tandem lift capabilities are generally heavier and will require a wider rail gauge and heavier wheel loads. A greenfield port such as Hastings or Bay West will generally be designed to match the wharf structural capacity with the planned STSC operating mass and dimensions. New wharf added to existing wharf structures, whilst adding length, will still be restricted by the crane gauge, as cranes need to be able to traverse the entire quay length.
- **1-way/2-way channel configuration** – full 2-way channel systems minimise or eliminate most channel delays due to occupancy. This is particularly important for long channel systems.

2.3.3 Factors within control of the stevedore

Factors within the control of the stevedore are generally related to the terminal operating systems, number and arrangement of Ground Slots and the numbers and characteristics of equipment applied to the terminal operation. On the berth, key factors include:

- **Number of shifts** – Most Australia ports either already run 3 shifts of 8 hours at least six days per week. The period of handover can impact on efficiency.
- **Crane rates** – the rate at which Ship to Shore cranes can transfer containers between the ship and the wharf. The standard measures of crane rate are:
  - **Gross Crane Rate (GCR)** is the average number of cranes' moves per hour for a crane over a year taking into account downtime for maintenance
  - **Net Crane Rate (NCR)** is the average number of container lifts per hour for a crane whilst it is working
  - **Ship Productivity** is a measure of the average container crane moves per hour per ship.
- **Available cranes** – as the number of cranes on each quay is increased each vessel is more likely to receive its optimum number of cranes resulting in a more rapid exchange of **containers, thus reducing the Time at Berth (TAB).**
- **Container dwell times** – If the capacity of the yard limits the terminal throughput, reducing the average dwell time directly increases the maximum achievable. The adequacy of connecting road and rail infrastructure can influence these aspects.

2.4 Quayline as the limiting component

As noted above, the infrastructure capacity of a port may be limited by any of the components that comprise the port system, from the approach channels through the berth, container yard and into the landside transport interface. Of these, the highest profile items are the:

- depth, width, length and 1-way/2-way configuration of the approach channels and basin accommodating the vessels
- length and structural capacity of the quayline

- area and orientation of the container yard and the capacity of the handling system used behind the quay
- the adequacy of transport infrastructure serving the port

For many European, Asian and Australian ports, the quayline is often the dominant limiting infrastructure component – port managers and operators have greater flexibility in tightening shipping schedules, or intensifying container stacking than they do in increasing throughput across the quayline. Conversely, in North America where container ports employ chassis operations (where containers are lifted directly on to wheeled trailers rather than stacked under ASCs or similar) it tends to be the yard area that limits capacity.

2.5 Performance measures

Large container ships are very expensive to run, making any delays costly and thus reducing economies of scale benefits that would otherwise result from running a large container ship. Consequently, shipping lines demand minimal turnaround times for the volume of cargo transferred at the port.

2.5.1 Berth utilisation defined

Berth utilisation is defined as the percentage of time the berth is occupied by vessels. The time on the berth is referred to as the service time and includes berthing, mooring, documentation checks, unloading/loading, letting go lines and de-berthing.

Berth utilisation is calculated by multiplying the cumulative length of vessels that call within a period of time (i.e. the total length of the vessels lined up end to end), by the sum of their times at berth and then dividing this figure by the total berth length multiplied by the period of time for which utilisation is being measured.

$$Utilisation = \frac{\sum LOA \times \sum TimeAtBerth}{Berth\ length\ \times Time}$$

2.5.2 Waiting time to service time ratio

The optimum limit of berth utilisation is determined by reference to the wait time/service time ratio. This is a major factor considered by shipping lines as a measure of the level of service provided by a terminal – as average berth utilisation increases, delays to shipping lines due to the unavailability of berths and channel congestion will also increase adding cost to shipping operations.

Most container ports seek to keep waiting time to service time ratios well below 20%, and the target understood to be adopted by the PoMC following the Channel Deepening Project is 10%. Globally the major ports achieve better service time ratios, particularly for services with slot bookings and good service reliability. For initial planning purposes, it is considered that the target upper limit of wait time/service time ratio for new ports in Victoria should be in the order of 10%.

2.5.3 Target berth utilisation

Average berth utilisation and the corresponding waiting time to service time ratios are generally forecast using Discrete Event Simulation (DES) to account for the complexity of the port system. However, for high level port planning, queuing theory[5] can be used. Queuing theory is a branch of mathematics used to predict waiting times and service levels and is applied across many industries, but was developed in response to the advent of telephone exchanges by Erlang.

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[5] Agner Krarup Erlang, Erlang is the international unit of telephone traffic

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Table 5 Recommended berth utilisation

Number of Berths	Utilisation (%)
2	45
3	60
4	65
5	70
Greater than 5	75%

Adopting a 10% wait time/service time ratio and applying queuing theory allowing for semi random ship arrivals, the optimum berth utilisation can be determined for a varying number of berths as follows:

A commonly quoted benchmark for berth utilisation for major container terminals with multiple berths is 60-65%, this aligns with a 4 berth facility presented in Table 5, although this figure will vary, depending on the number of berths available.

The major shipping lines usually have fixed schedules and expect the berth to be available, with a low tolerance for any delays. Section 2.9 provides further discussion regarding the impact of scheduling on berth utilisation, and the rapid decay of service levels as berth utilisation increases.

While 65% utilisation at first sight may appear to be relatively low, there are other factors in play which are not captured within the above definition of berth utilisation. These factors vary from terminal to terminal.

2.5.4 Berth occupancy

Whilst berth utilisation deals with the time the vessel is alongside, the actual time that a berth is available for another vessel arrival is significantly less when allowance is made for the following factors:

- arrival and departure time tolerances
- swinging on arrival or departure depending on the configuration of the swing basin
- vessel transits in one-way channel sections

These factors will all reduce target berth utilisation for a particular port.

2.5.5 Ship scheduling

An additional factor limiting berth utilisation is the uneven vessel arrival pattern at Australian ports. All terminals experience “bunching” of arrivals during the week that is high demand for berth windows interspersed with days of no arrivals. In addition to potential waiting time for a berth to become available, vessel delays can also be incurred while waiting for a pilot or tugs, and while waiting for channel access. Channel access delays may be due to weather, under keel clearance, or channel occupancy. These delays are generally included in the assessment of the wait time/service time ratio, hence berth waiting time needs to be kept low

While queuing theory suggests that increasing the number of berths permits a higher average berth utilisation for the adopted level of service, this does not apply where there are multiple terminal operators in competition; for example, two terminals, each having three berths, would still require an average berth utilisation around 60% to achieve an acceptable wait time/service time ratio. A single terminal with 6 berths could achieve a higher utilisation, (around 75%) with the same wait time/service time ratio. This can lift capacity.

2.6 Ship to shore transfers

2.6.1 Berth capacity

For the stevedore, the key consideration for capacity is the berth capacity – the maximum annual container throughput that can be handled over the berth without the vessel service level (measured by the wait time/service time ratio) falling below an acceptable level.

2.6.2 Berth throughput

The standard measure of berth throughput is TEU throughput per berth metre per year. Berth throughput can be improved through improved stevedoring productivity; however, it is limited by the following factors:

- crane intensity: the number of cranes that can be applied to each vessel depending on the vessels length and stowage pattern
- crane density: the number of cranes available on the berth accounting for minimum crane spacing, and target crane utilisation
- crane capacity: twin lift and tandem lift cranes can handle more containers per lift than conventional STSCs
- ratio of 20-foot to 40-foot containers: this in turn impacts the number of lifts required per TEU
- typical TEU exchange rates and stowage patterns: this in turn impacts crane intensity
- the ability of the yard handling system to keep up with the STSCs. As STSCs are the most expensive equipment within the port, and they have a direct impact on the ship service time it is important to ensure they are never delayed by the unavailability of transfer equipment between the stacks and the berth

The world record for a single lift crane is 75 container moves in an hour for a single crane and 793 moves in one hour for a set of cranes working on a large ship. However, these records are set under artificial conditions and are not applicable as part of a benchmarking system. The typical upper-end productivity for a single lift crane is recognised as 35 moves per hour. BITRE statistics for Melbourne indicate a current average rate of 30.9 moves per hour.

Figure 1 highlights historical crane rate benchmarks for Australia’s top 5 ports over 15 years. This shows a trending increase in productivity, which is attributable to technological advancement, new investment, etc. Note that these figures reflect an average TEU/ hour which is the crane rate x the TEU factor that may typically be around 1.5.

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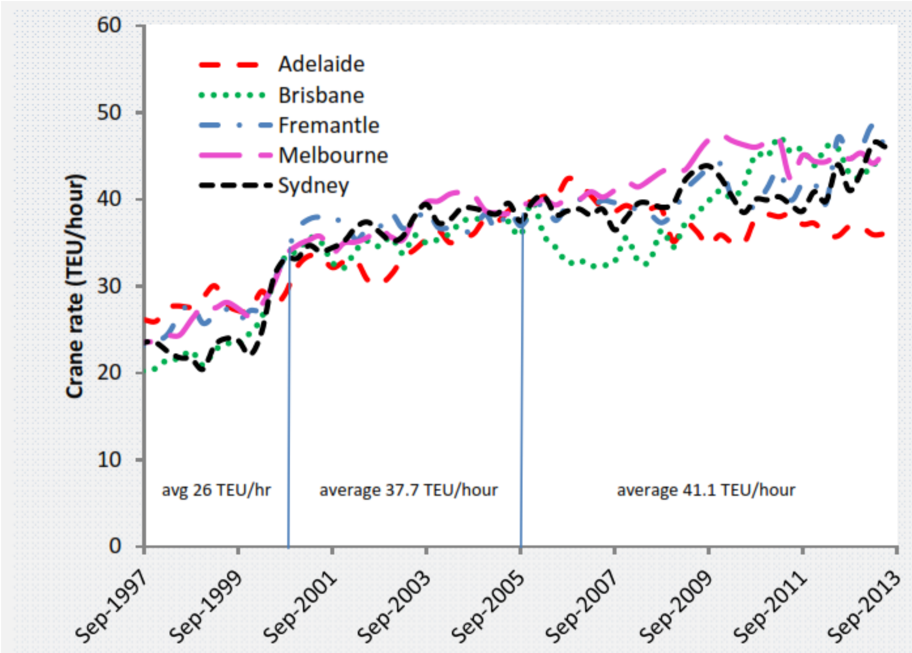

Figure 1 Historical crane rates at Australian ports (Source BITRE Information Sheet 55)

2.7 Container yard

Container yard capacity is measured in TEU throughput per gross hectare. The key factors influencing this measure include:

- The area available.
- The distance the stacks are from the ship – longer distances, mean equipment has to travel further, which reduces the number of containers that can be handled in a unit time period.
- The manoeuvring requirements for terminal stacking equipment and density in which containers can be stacked: straddle carriers result in lower densities than Rubber tyred Gantry cranes or Automatic Stacking Cranes. Small terminals using reach stackers or chassis operations give the lowest densities of all.
- average container dwell times for imports and exports, the longer a container resides in a port, the longer that slot is occupied, and this reduces the number of times it can be re-filled in a year.
- average stack heights

2.8 Landside interface

The landside interface is important in two aspects. Truck turnaround (container exchange) in the terminal and the capacity of the local road network to handle the truck movements in and out of the terminal.

2.8.1 Truck turnaround

A common measurement of the terminal's service quality to road transport operators are truck turnaround time (TTT) and the container exchange slot availability. TTT is the time between the vehicle's arrival at the terminal entrance gate and its departure from the terminal exit gate.

The TTT is driven by the performance of the terminal yard equipment in conjunction with the trends on containers per truck, together with the number and location of truck exchange grids.

These factors directly affect the number of moves (lifts) and distance that terminal equipment needs to travel over during the delivery and collection of containers. As yard equipment numbers are finite, if port equipment is dedicated to the unloading of a ship, then the servicing of road trucks can be impacted, which can result in queuing and congestion outside the terminal. These factors are under the control of the Stevedore.

The overall performance is affected by the terminal configuration and choice in terminal yard equipment. A key requirement is to have sufficient manoeuvring areas for larger trucks and truck loading or unloading zones in optimal locations etc.

Trucks enter and depart the terminal via a 'gate', which is typically a booth that provides an administrative function to confirm paperwork and the details of the container collection or delivery are in order. In modern terminals this function is an 'unmanned' operation, using RFID and Optical Character Recognition (OCR) technology employed to confirm truck particulars etc. Smaller terminal utilise manual processes, comprising administrative staff and a window.

The terminal gate requires a sufficient number of 'windows', truck lanes and parking areas to handle truck arrivals, such that queuing is tolerable even at peaks. These factors are also controlled by vehicle booking systems that can smooth out the flow to set times and capacity. The number of lanes, being driven by the **processing time** will also include an allowance for a peaking factor recognising peak flows and gate capacity which should not become an impediment to TTT.

2.8.2 Road network

The capacity of the local road network needs to match terminal truck movement characteristics. Local road junctions and intersections should not impede the flow of trucks arriving and departing the terminal. This again is important at peak times.

The characteristics of other traffic flows becomes important, and it is desirable to be able to service the port 24 hours a day 365 days per year, as opposed to just daytime working periods.

2.9 Congestion, queuing and charges

In a commercially competitive port, there is a link between capacity, congestion and the fees and charges that operators can command – as capacity is approached, stevedores are able to charge higher fees for the same level of service. A key concern for port planners, is when does congestion begin to become an issue, how rapidly does it grow and how does it drive higher port charges?

2.9.1 Cost of the delays

Figure 2 illustrates the general relationship between the provision of additional berths, the increased cost for the capital investment in the berth, and the reduction in costs due to the reduced delays to shipping. It can be seen that there is a point where the capital and operational costs are balanced.

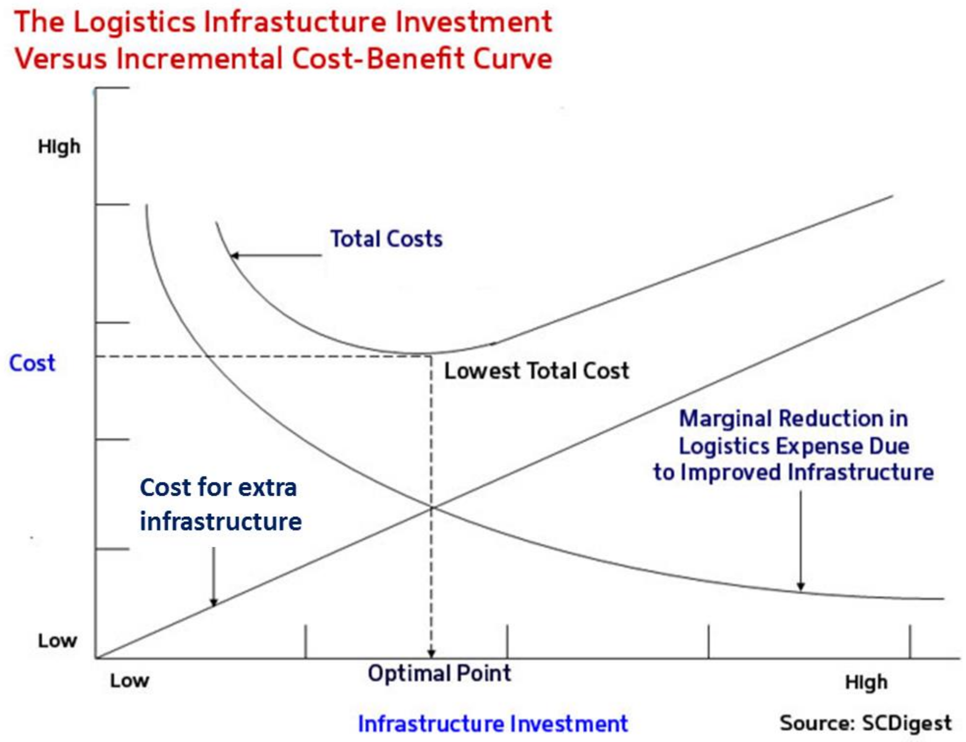

Figure 2 Relationship between total port costs and the costs of infrastructure and delays (Source: Supply Chain Digest, 2009)

2.10 Capacity buffers

2.10.1 Seasonality and market volatility

Container demand through any port will display some seasonality throughout the year. In Australia, where the container trade is dominated by imports of manufactured products, the peak demand is generally from late September through to December driven by retail importers stocking up inventory prior to the Christmas shopping season. By contrast, container ports in New Zealand are dominated by agricultural exports, in particular processed dairy products and their seasonal peaks are generally in the late summer months from February to April.

Over the past decade the Port of Melbourne's annual peak volumes have been up to 15% - 20% above than the annual monthly average. It is probable that this trend will continue for the foreseeable future.

Generally, if the peak demand is relatively acute then the port system will adapt to cope for the short duration of the peak period, either through the application of more labour, equipment and additional shifts or through port users and ultimately Beneficial Cargo Owners (BCOs) accepting temporarily diminished service levels. Consequently, seasonality under these circumstances is not factored into nameplate or effective port capacity considerations.

2.10.2 Competitive environment

Landlord ports with multiple stevedores endeavour to ensure competitive tension is maintained between each of the stevedores. Competition is recognised as the most effective means of improving productivity and driving efficient investment in new capacity.

By ensuring residual capacity exists within the port or a terminal, shipping lines have the ability to move their service contracts between stevedores. This in turn provides an incentive for stevedores to offer existing and potential customers their most competitive terms and

conditions. Conversely, when the nameplate capacity of the port (or terminal) is approached, shipping lines and other port users do not have the flexibility of choice.

The Port of Melbourne appears to have historically operated at an effective capacity of around 80 - 85% of the nameplate capacity. This figure has been derived from an assessment of the relative market shares of the shipping lines calling at Melbourne – essentially if throughput is less than 85%, then a medium sized shipping line can choose to change their stevedore contract. If the liner industry continues to consolidate or form larger alliances, then this factor uy

may decrease (to account for the size of an average shipping line service transferring between stevedores) or may simply not be applicable any longer.

2.10.3 Maintenance and industrial downtime

Terminals invariably have periods where they cannot operate at full capacity due to maintenance of equipment including STSCs and ASCs, as well as maintenance of fixed infrastructure including maintenance dredging, wharf repairs and other civil infrastructure maintenance. These downtime periods are generally scheduled well in advance and generally do not impact the capacity of the port. Similarly, large developments, in particular capacity expansion projects can be planned and scheduled to not impact port capacity.

Industrial relations generally impact individual stevedores rather than the port as a whole, and furthermore it is very difficult to forecast and make allowance for downtime due to industrial action.

Whilst both maintenance and industrial downtime impact port throughput, it is rare that they will ever significantly impact capacity, and no allowance is made for these factors in port planning.

2.11 Benchmarks

Benchmarking operating ports is very difficult due to the market conditions relevant to each port; moreover, for capacity considerations, infrastructure developments are often staged to provide considerable over capacity for a medium to long term duration rather as required. Consequently, there are very few relevant examples of ports actually operating at or near capacity.

Appropriate benchmarks for a future Port of Melbourne are presented in Table 6.

Table 6 Recognised benchmarks to be considered in planning new Ports

Factor	Threshold or Target
Waiting time to service time ratio	10% (maximum average annual)
Berth utilisation	65% to 75% (target range)
Berth throughput	2200 - 2400 TEU/m/year
Truck turnaround time	30 mins (maximum)
Cranes moves per hour	35 (currently recorded as 30.9)

2.12 Berth capacity and ship queuing

Ship waiting time is impacted by the average service times and number of berths available. Whilst Discrete Event Simulation is the most appropriate tool for modelling the relationship between fleet spectra, ship arrival patterns, available berths and vessel service time, the typical delays (and likely performance) can be modelled using standard queuing theory techniques.

Figure 3 below shows how delays (or waiting time) increase as berth occupancy increases, for an operation that is intended to run to a pre-defined schedule (as opposed to random arrivals). The chart highlights that the number of berths can significantly reduce the waiting time factor.

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In this regard, and in order to reduce delays, the stevedore can attempt to reduce the service time at berth through driving productivity in equipment and labour, or the port owner can invest in increasing the number of berths available.

In reading Figure 3, it should be noted that while nearly all container shipping operates to fixed berthing windows and, to that extent, could be said to be fully 'scheduled', the reality is that a high percentage of vessels arrive either early or late for their windows. This tends to result in a slightly more random arrival pattern, which can exacerbate delays for the same occupancies.

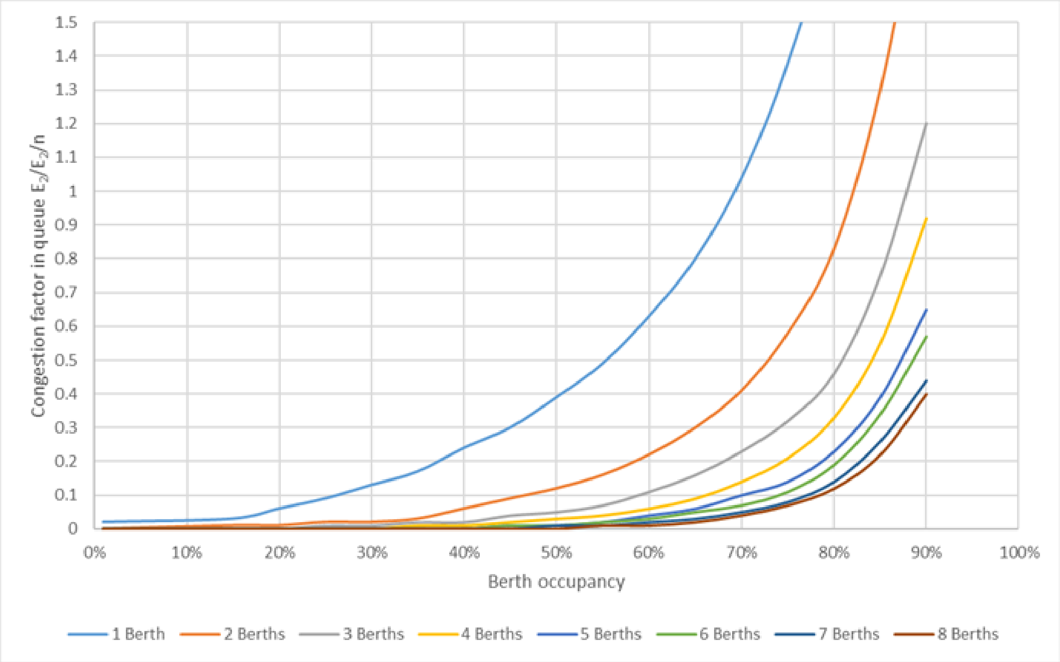

Figure 3 Target Berth Occupancy Factors E2 / E2 / n - container terminals, Source: 'Planning & Design of Ports & Marine Terminals', 2nd Edition. (Source: GHD)

3. Port of Melbourne, shipping and container trade characteristics

3.1 Introduction

This section describes the current situation and history of the Port of Melbourne's container trade and shipping visiting the port. The long-term future situation, in terms of possible scenarios for ship sizes, number of ship calls and the utilisation of port container capacity, is presented in Section 9.

3.2 Port of Melbourne as Australia's premier container port

3.2.1 Overview

The Port of Melbourne is Australia's number one capital-city container port in terms of container throughput handling a total of 2.64 million TEU in FY 2015-16[6], followed closely by Sydney (Botany Bay), then by Brisbane, Perth (Fremantle) and Adelaide.

The containerisation of overseas cargo commenced at the Port of Melbourne 50 years ago in 1969 with the opening of the dedicated Swanson Dock container precinct (construction commenced in 1966). The first overseas container ship to visit Melbourne's Swanson Dock in March 1969 was OCL's "Encounter Bay" with a container capacity of around 1,600 TEU deployed with other sister-ships on the UK/Europe-Australia trade route also calling at Sydney and other Australian ports. The first full year of container shipments at Australian ports (1969-70) involved the ports of Melbourne and Sydney handling around 120,000 TEU each.

In January 2017, the Port of Melbourne will have a second overseas container precinct operating at Webb Dock East as part of providing increased port capacity for expected future international container trade growth.

Figure 4 OCL's Encounter Bay - The first overseas container ship to visit Melbourne's Swanson Dock

3.3 Container shipping trends

3.3.1 Shipping lines and port calling patterns (container services)

The container shipping industry (also known as the 'liner' shipping industry) is global in terms of the shipping lines involved, the fleets of ships they operate, and the international trade routes

[6] Port of Melbourne Corporation – container trade statistics, 2016.

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covered by container shipping services (i.e. sets of deployed vessels sailing on fixed port rotations and schedules).

The exception to this concerns domestic container trades, where the liner shipping industry tends to be more localised particularly for regional domestic trades – for example the Bass Strait trade between Melbourne and Tasmania. However, the mainland coastal trade between Melbourne and other capital-city main ports is still serviced by internationally operating container shipping lines as legs on their vessels deployed on international routes.

The supply-demand balance of shipping capacity and trade demand in the container shipping industry is relatively dynamic and capital intensive with repeating periods of severe capacity over-supply leading to financial losses for shipping lines. In response, this has led to the liner shipping industry adopting a number of mitigating strategies:

- cost-reductions through increasing ship sizes to secure economies of operating scale
- increased scrapping of old and uneconomic vessels
- market consolidation (rationalisation) through company acquisitions and the merging of container services through vessel operating alliances, and
- withdrawal from some severely loss-making markets (i.e. some North-South, East-West or intra regional trades), or even complete withdrawal from the industry (including due to financial insolvency).

As of mid-2016, the top-ten shipping lines operate 71% of the global container shipping fleet[7]. The majority of the international shipping lines serving Australia and the Port of Melbourne are global top-ten shipping lines with others being niche regional Asian or Pacific Ocean players.

From the very beginning of containerisation (almost 50 years ago), the Australian international container trades have been served by series of scheduled vessels (‘strings’ or ‘services’) calling on the same voyage directly at a number of main ports along the Australian coast, including the Port of Melbourne. These often weekly ‘multi-port calling’ container services are considered by shipping lines to be the most economic network solution for the Australian market as opposed to series of single-port calling international services, or moving cargo long distances interstate by land, or ‘hubbing’ at a single Australian cargo-consolidation port.

Currently, Victoria’s international container imports and exports are serviced by 24 separate multi-port calling container services (vessel strings)[8] on five distinct end-to-end shipping routes:

- North East Asia (Hong Kong to Korea/Japan)
- South East Asia (Malaysia to Vietnam/Indonesia)
- Europe (via South Asia / Indian Ocean / Middle East / Suez Canal)
- North America (West Coast separate, and East Coast via Panama Canal with alternative service extension to Europe), and
- Oceania (New Zealand / South Pacific Islands / PNG).

Many of the shipping services also carry non-Australian cargo on legs within the shipping route (i.e. New Zealand-Americas or Europe-Africa & Americas cargoes) to improve the economics of the services. Some ports called at in Asia and North America by direct Australian services are also used to tranship and connect with other inter-regional services.

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7 Clarksons SIN – Container Intelligence Quarterly, 3Q 2016 – statistics as at July 2016.

8 GHD analysis of shipping lines web-published sailing schedules, Nov. 2016. Note: Two of the services effectively involve one fleet of vessels operating on two inter-connected loops.

The weekly Melbourne/Asia container services typically involve fleets of five to six vessels operating on 35 to 42 day roundtrips. The longest routes to/from Europe (via Suez) typically involve fleets of 13 vessels (for weekly services) on 91 day roundtrips.

The weekly (or fortnightly) container services calling at the Australian main ports (including Melbourne) are scheduled to arrive and depart on fixed days of the week and at fixed times necessitating the need for ‘all-tides’ 24/7 port access and specific “time-slots” at the container terminals operated by stevedores.

The Bass Strait (Tasmania-Melbourne) domestic route is served by two dedicated, container roll-on/roll-off freight services each operating six sailings per week from the Port of Melbourne’s Webb Dock (Eastside, two north-end terminals). The Tasmania-Melbourne passenger ferry daily service operating from the Port of Melbourne’s Station Pier also carries unitised Bass Strait freight (containers and trailers).

3.3.2 Vessel fleet and size development

The global container ship fleet (excluding orders) currently numbers 5,221 fully-cellular vessels totalling around 20 million TEU slot capacity[9]. The ownership of the fleet is split into two parts – around half owned and operated by shipping lines, and the other half chartered to shipping lines by independent shipowners.

The global fleet has a number of distinct size segments reflecting geographical deployment opportunities according to sizes of particular markets (trades), distances, and shipping route constraints. Vessels greater than 6,000 TEU currently number 1,092 with 53% share of the total global fleet slot capacity. Vessels greater than 12,000 TEU currently number 254 with 18% share of the total global fleet slot capacity. The global order-book currently amounts to an additional 423 vessels with total 3.4 million TEU slot capacity, or 17% of the currently delivered fleet slot capacity. Out of the 423 vessels, 131 are sized greater than 12,000 TEU with a 66% share of the total slot capacity on order.

One particular shipping route constraint, the Panama Canal locks, has historically led to a class of container ships (Panamax) designed to the maximum size to fit through the locks (beam of 32 metres and capacity of around 4,000 TEU). In 2016, new, wider locks have been opened resulting in a new Panamax class with a maximum ship size of around 13,000 TEU.

The high volume, long distance East-West container trades (i.e. Asia/Europe and Asia/North America) have been the drivers behind increasing ship sizes over the last twenty years. At the start of containerisation in the early 1970s, maximum ship sizes were less than 2,000 TEU. This gradually increased to around 4,000 TEU by around mid-1990s. The first Post-Panamax vessels appeared in 1996 with 9,000 TEU vessels delivered in 1997. Ten years later, in 2006, the largest vessels increased to 15,000 TEU followed by 18,000 TEU vessels in 2013. Current ships on order include vessels of 20,000-21,000 TEU – these vessels are generally regarded by the industry as the maximum sizes for the Asia/Europe trade due to ship design and infrastructure constraints (i.e. Suez Canal and Malacca Straits) as well as the high cost of replacing port equipment (gantry cranes).

Currently, these East-West trades see the deployment of the large- and ultra- size container ships of 12,000 to 19,000 TEU with the ‘thinner’ typically North-South container shipping routes utilising 3,000 to 12,000 TEU size vessels. Typically, the shorter length intra-regional, coastal and feeder shipping routes use vessels in the 1,000 to 3,000 TEU size range.

Given that container ships have traditionally had an economic (usable) life of around 20 years, this has meant that vessels displaced on the East-West trades by larger vessels have had to

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9 Clarksons SIN – Container Intelligence Quarterly, 3Q 2016 – statistics as at July 2016.

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find deployment in other trades – an effect known as "vessel cascading". The result has been pressure put on ports and terminal operators by shipping lines to increase access for larger vessels across all trades globally (including Australia).

The container ship fleet currently deployed on the Australian (Melbourne-calling) international container trades numbers 141 vessels with an average ship size of 4,252 TEU, and age of 10 years[10]. Given a current Melbourne ship size constraint factor caused by access to Swanson Dock, a significant part of the shipping fleet deployed on the Australian trades remains constant often being the final 'thin' trade for these vessels (i.e. 4,000 to 6,500 TEU size vessels). Some are younger more specialised vessels with relatively high refrigerated container capacity – a cargo need of many Australian and New Zealand containerised agricultural/food exports.

The Australia-Asia and Europe-Australia (via Suez) shipping routes have the largest vessels deployed 5,000-7,500 TEU, with the Oceania shipping routes using the smallest vessels of 800-1,600 TEU. The three vessels of 7,000-7,500 TEU on the Europe-Australia (via Suez) route currently calling Melbourne are nearing the limits of access for Swanson Dock with two vessels of length 304 m x beam 40 m (7,000 TEU) and one vessel of length 320 m length x beam 43 m (7,500 TEU).

In late 2016, Sydney (Port Botany) and Brisbane set a record of the largest vessels to call the Australian East Coast to date. The 'ad-hoc' calls, mainly for the evacuation of empty containers, were by the containership "Seroja Enam" of 8,110 TEU (316 m length x 46 m beam and 14.5 m maximum draught) which called Port Botany, and the "Lloyd Don Carlos" of 8,200 TEU (334 m length x 43 m beam and 14.5 m maximum draught) which called Brisbane. This size class of vessel will only be able to call at Melbourne once Webb Dock international terminal opens in January 2017.

The Port of Melbourne also has calling a fleet of four domestic Bass Strait container roll-on/roll-off vessels deployed on two services. The vessels range in size from 260-340 to 600 TEU with one operator introducing a new vessel of 450 TEU (replacing its 260 TEU vessel) at the end of 2016. The other operator has plans to replace their two existing 600 TEU vessels with larger 700 TEU ships in late 2018.

3.4 Victorian container trade developments

The Port of Melbourne's current container trade comprises a number of sectors, which are handled at various precincts and terminals. Each sector involves the handling of both loaded and empty containers of two sizes – 20ft and 40ft length containers – and two main types of container – dry (ambient) and refrigerated.

The largest sector, around 84% of total containers handled, is currently international (or overseas) direct container imports and exports of over 2 million TEU per year handled at Swanson Dock by two stevedores.

Domestic Bass Strait (Tasmanian) import and export containers currently amount to over 300,000 TEU per year (including some trailer freight), or around 13% of total containers handled. Over 200,000 TEU per year of Bass Strait trade is handled at two terminals at Webb Dock with the remaining Bass Strait trade (including trailer freight) handled by the Tasmania-Melbourne ferry operation at Station Pier.

The remainder of Melbourne's container trade (around 3% of the total) comprises mainland coastal and transhipment containers. This volume is currently shipped by international calling vessels and is handled at Swanson Dock along with the direct international containers.

10 GHD analysis of shipping line published schedules and vessel particulars from Clarksons SIN ship database – Nov. 2016. Includes proposed new Australia-New Zealand direct end-to-end weekly service to deploy 3 vessels.

Further details of Victorian historic and future container trade developments are discussed in the accompanying Deloitte report "IV Port Strategy – Container Trade Forecasts for Victoria".

3.4.1 International

The Port of Melbourne's international container trade is currently handled by shipping services operating on specific shipping routes. Not all overseas origin and destinations countries are directly called at by Melbourne shipping services with transhipment/connections occurring at various overseas ports.

Currently, over 70% of the Port of Melbourne's international container trade is with Asia, followed by 9% with the South Pacific region (incl. New Zealand), 9% with Europe, and 7% with North America.

Typically, loaded international import containers are household goods for Victorian household consumption or inputs for local manufacturing, while loaded international exports containers generally consist of Victorian (and some inter-state) regional agricultural, food and forestry products, as well as waste materials.

3.4.2 Inland origin and destination patterns

The inland origins and destinations of containers moving through the Port of Melbourne are typically close to the port and within the metropolitan area.

This is particularly the case for loaded (non-Tasmania) import containers with around 87% transported and unpacked in locations in metropolitan Melbourne. In terms of road-trips, 91% of these containers are destined for locations within 50 km of the port[11]. The returned empty containers generally move to empty container depots (or yards) within a few kilometres of the port.

Loaded (non-Tasmania) export containers have a significant share from non-metropolitan Melbourne areas (i.e. 23% from regional Victoria and a further 23% inter-state). Many of the metropolitan Melbourne loaded export containers are packed close to the port with regional products such that around 66% of loaded (non-Tasmania) export containers transported by road originate within 50 km of the port[12].

In terms of loaded container movements around metropolitan Melbourne, around 39% of total metropolitan Melbourne (non-Tasmania) imports are to the Outer Eastern/SouthEast area and 30% to the Outer Western area[13]. For loaded (non-Tasmania) metropolitan Melbourne exports, around 14% of total metropolitan Melbourne (non-Tasmania) imports are from the Outer Eastern/SouthEast area and 48% from the Outer Western area.

Currently, the use of road transport depots ('breaking' or 'staging' the road movement) is important in the distribution of loaded containers to/from the Port of Melbourne. Only 29% of loaded import containers are directly delivered from the port to the unpack location (i.e. 71% are staged via a road depot), while 46% of loaded export containers are directly delivered to the port from the pack location (i.e. 54% are staged via a road depot)[14].

3.4.3 Empty containers

The Port of Melbourne's container trade is imbalanced in terms of loaded import and export containers with the dominant direction being loaded imports (i.e. loaded imports represent around 60% of total loaded overseas containers). This generates a significant share of empty

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11 Port of Melbourne Corporation – 2009 Container Logistics Chain Study.

12 Port of Melbourne Corporation – 2009 Container Logistics Chain Study.

13 Port of Melbourne Corporation – 2009 Container Logistics Chain Study.

14 Port of Melbourne Corporation – 2009 Container Logistics Chain Study.

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container exports as returns to overseas deficit areas such as Asia and New Zealand. Some empty containers, typically refrigerated and 20ft dry, are also imported as required for certain export commodities.

Typically, around a third of Port of Melbourne's overseas container exports are empties, compared with 5% of overseas container imports as empties.

Nearly all loaded import containers are returned to empty container depots around Melbourne as empty containers, where they are either later exported as empties through the port, or are picked-up for export packing and then exported as loaded containers through the port.

3.4.4 Dwell times and seasonality

The time that a container spends inside the container terminal at the port (i.e. discharged from the ship to exiting the gate, or from gate in to loading on board the ship) is known as 'dwell time', i.e. storage and handling time at the terminal. There is no public information available on average dwell times at the Port of Melbourne as this is operational (commercial) data of the stevedores.

However, typical industry benchmarks suggest that average import loaded container dwell times at the Port of Melbourne are likely to be around 2 to 3 days, and longer average export loaded container dwell times of 3 to 4 days with a typical maximum interval between shipping line sailings of 7 days. Empty containers tend to remain longer (albeit with more variability) with average dwell times of up to 14 days including time at empty container parks close to the port.

Dwell times have a direct impact on the capacity of the container yard and terminal to handle container throughput, i.e. the greater the velocity of containers through the port, the greater the availability of port capacity given no other constraints.

The Port of Melbourne, like other Australian main capital-city ports, also experiences container trade seasonality or a 'busy (peak)' operating period driven by imports. This typically occurs in the period September to December, when the peak monthly throughput in overseas trade is around 15-20% higher than the quietest months in the year. The implication of this seasonality (peaking) is that the port always requires 'buffer' capacity to handle the peak in trade. The most efficient use of capacity would occur if, hypothetically, all monthly trade volumes were at the same level.

3.4.5 Ratio of 20' to 40' containers

Historically, the ratio of 20ft to 40ft containers moving through the Port of Melbourne has been gradually declining in favour of more 40ft containers reflecting the increasing share of more volumetric household import goods. However, Victoria, as a key Australian port of containerised export goods, still requires 20ft containers for the relatively heavy agricultural commodities.

Currently, the container-to-TEU ratio for the Port of Melbourne is around 1.5, which means that around 50% of all containers handled are 40ft.

The container size ratio has both operational and commercial implications for in particular the stevedores. Since most terminal handling operations are based on a 'lift', a 40ft-lift is generally twice as productive as a 20ft-lift in terms of TEU terminal productivity.

3.4.6 Modal trends

The Port of Melbourne currently has a landside transport modal share for containers moving through the port of 12% by rail (including via the Dynon rail precinct) and 88% by road[15]. All of the containers moved by rail are currently linked to the export of regional agricultural/forestry

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15 BITRE – Waterline number 58, Nov. 2016.

products with no metropolitan containerised freight moved by rail. Over 60% of the loaded export containers transported to the port by rail, originate more than 600 km from the Port of Melbourne[16].

There are plans by various proponents, including Victorian government policy, to introduce port rail shuttles to/from a number of proposed metropolitan intermodal container terminals located around Melbourne.

In comparison with other capital-city container ports, Melbourne currently has a relatively low landside rail transport mode share, i.e. Sydney's container rail mode share is 17% and increasing[17].

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16 Port of Melbourne Corporation – 2009 Container Logistics Chain Study.

17 BITRE – Waterline number 58, Nov. 2016.

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4. Port of Melbourne (Key Precincts)

4.1 Precinct plan

Figure 5 provides an overview of the Port of Melbourne precincts and berths referred to in subsequent sections.

Table 7 summarises the cargo that is handled at each precinct.

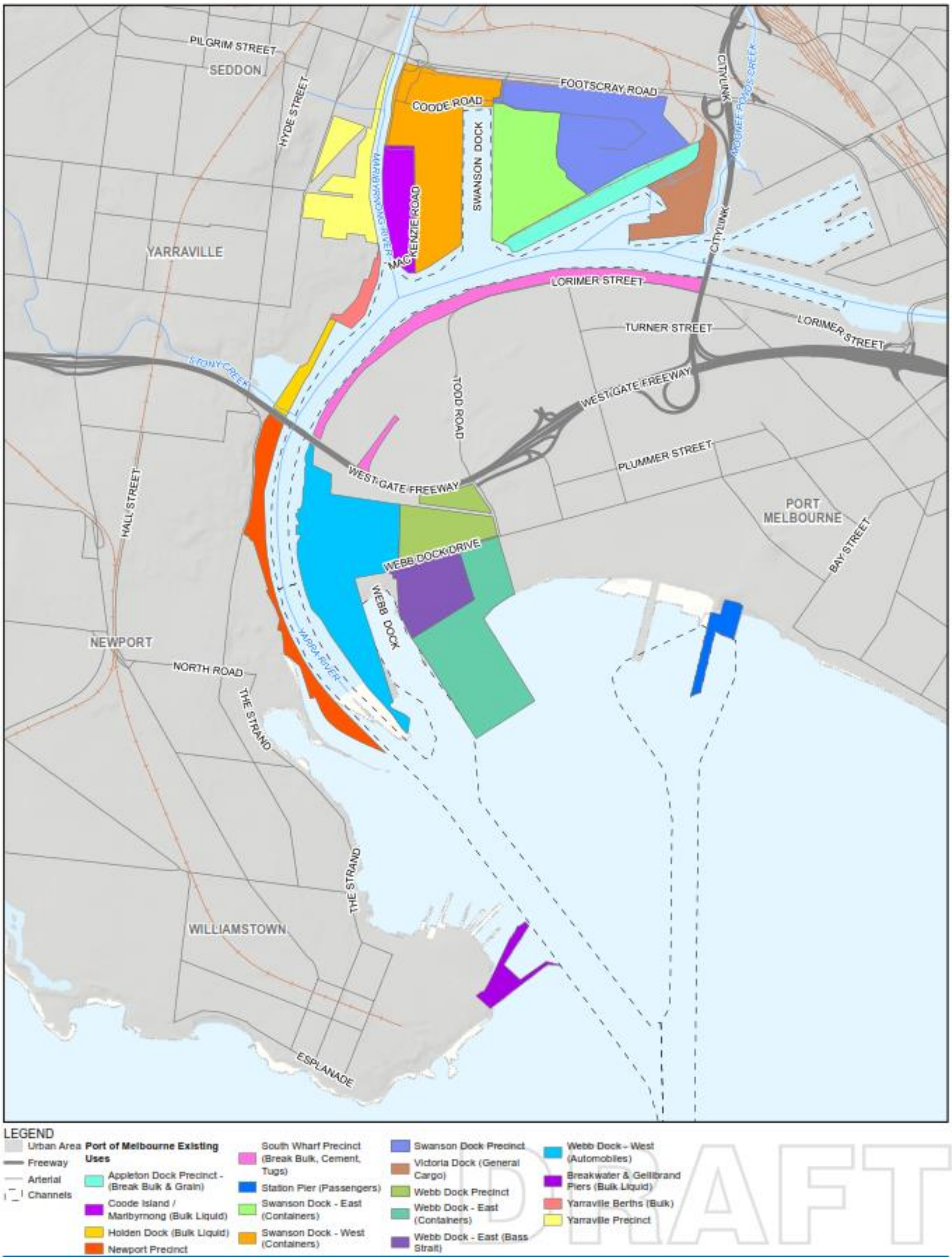

Figure 5 Key precincts at the Port of Melbourne

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Table 7 Primary cargo operations at each precinct

Precinct	Cargo / operations
Appleton Dock Precinct	Timber, pulp & waste-paper Automotive Transport and agricultural equipment Iron and steel
Coode Island Precinct	Vegetable oils and tallow Petrochemical liquids Lubricating oils Molasses
Holden Dock Precinct	Petroleum products (refined fuels/oils) Lubricating oils
South Wharf Precinct	Cement Gypsum Fertiliser minerals, blast furnace slag and fly-ash
Station Pier Precinct	Tasmania ferry (Spirit of Tasmania), cruise-ship berth, Royal Australian Navy berth
Swanson East	International Containers
Swanson West	International Containers
Victoria Dock Precinct	General cargo
Webb Dock - East	Containerised trade General Cargo Tasmanian coastal trade
Webb Dock - West	Automotive
Williamstown Precinct	Oil and petrochemical Storage and mooring of marine equipment and plant
Yarraville Berths	Sugar Gypsum Fertiliser (and bone-meals)
Newport Precinct	Westgate punt Ferry services Public accessible jetties
Swanson/Appleton/Victoria Dock Precinct	Patrick Port Logistics Cold storage Empty container park Freight forwarding Customs Rail terminal
Webb Dock Precinct	Automotive trade
Yarraville Precinct	Murrays (Bus charter) CC containers (empty container park) Yarraville wharves

5. Swanson Dock

5.1 Overview

5.1.1 Background

Swanson Dock is exclusively international container terminals and it serves 42 container shipping lines. Approximately 2.3 million international and other TEU passed through Swanson Dock in FY 2015-16 (remainder of FY 2015-16 volumes being through Webb Dock). Swanson Dock is broken into two terminals around a single basin, Swanson Dock East (SDE) and Swanson Dock West (SDW).

5.1.2 Infrastructure

The characteristics of infrastructure at Swanson Dock are shown in Table 8.

Table 8 Swanson Dock infrastructure summary

Factor	SDW	SDE
Berth No's	3	3
Berth length (m)	944	884
STSC (No)	8	7
Vessel Draught (m)	14	14
Leased area (Ha)	44	53
Existing Yard area (Ha) and TEU Ground Slots[18] (TGS)	23 (5279 TGS)	28 (6112 TGS)
Largest vessel	320 x 45 m beam[19] (7,500 TEU)	
Airdraught limit (m)	50.1 m (aligns to a 9,000 TEU vessel)	
Rail	Dual gauge connections exist	
Road	Accepts 68 tonne Super B Doubles	

18 Estimated by GHD
19 Restricted by basin width, cannot be accommodated on all berths

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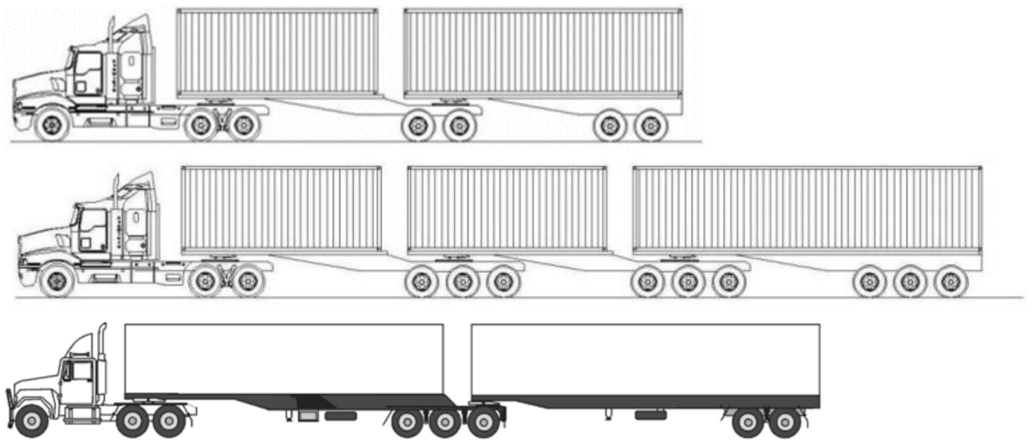


Figure 6 Examples of truck sizes

Swanson Dock was upgraded in 2006 for a 30-year design life. Swanson Dock East and West have provision for eight quay cranes each, three of which are post-Panamax.

Swanson Dock has good road connectivity to the major transport logistics areas in Melbourne's west, north and south-east via Footscray Road and CityLink. However, urban encroachment has led to conflict on the road networks through the immediate inner west suburbs of Footscray and Yarraville.

Rail connectivity includes a dual gauge rail loop and a 590 m long siding along the Footscray road side of West Swanson Dock servicing DP World facilities, seven dual gauge sidings in the Appleton Dock area and a further dual gauge siding which splits into three sidings servicing Qube Logistics facilities at Victoria Dock. The Appleton Dock dual gauge sidings provide two tracks for Emerald Grain unloading, three common user sidings over 900 m long and two sidings in the former Patricks facility which is now to become a common access terminal. The common user tracks also lead to a single wharf siding in the Patrick stevedoring lease area.

5.1.3 Leaseholders

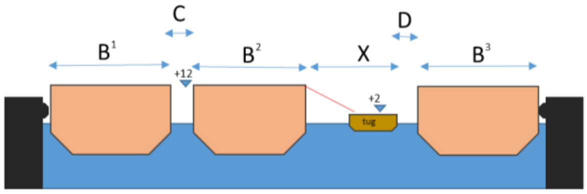
Patrick holds the lease for SDE and DP World holds the lease for SDW.

5.1.4 Constraints

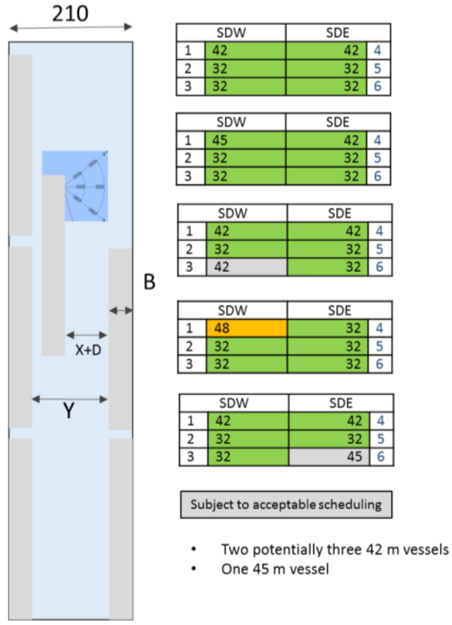
Notable constraints at Swanson Dock include:

- The air-draught under the Westgate Bridge. This limits vessels to around 9,000 TEU capacity (refer Section 9) .
- The turning basin at the entrance to Swanson Dock limits the length of vessel that can enter the dock to 320 m LOA.
- Coode Rd and Dock Link Rd currently restrict access for port (yard) equipment to the rail tracks that run parallel to Footscray Rd at the North of the precinct.
- The maximum gross vehicle mass (GVM) along both Coode Rd and Mackenzie Rd is 109t, while the maximum GVM on Footscray Rd is 77t..
- The existing quay line length is not able to accommodate three 300 m vessels together.
- The width of the channel in the Yarra River constrains the maximum size vessel that can safely access Swanson Dock. Vessels with beam greater than 42 m can create unsatisfactory water level variations at other berths and infrastructure along the river. The width and radius of the channel also impacts the navigability of vessels.

- The 210 m width of the basin restricts the maximum beam of vessel that can be berthed together. The constraint is illustrated indicatively in Figure 7. Based on a minimum passing clearance of 20 m between vessels[20], the basin can only accept one 45 m beam vessel and two 42 m beam vessels in conjunction with others.



Basin	Beam (B¹)	Beam (B²)	Beam (B³)	Dim (C)	Dim (Y)	Dim (X)	Surplus (D)
210	32	42	32	20	146	60	24
210	32	45	32	20	146	60	21
210	32	48	32	20	146	60	18
210	42	42	32	20	136	60	14
210	42	45	32	20	136	60	11
210	42	48	32	20	136	60	8
210	42	42	42	20	126	60	4
210	42	45	42	20	126	60	1
210	42	48	42	20	126	60	-
210	45	45	32	20	133	60	8



X =60m (30m line + 30m tug) + min clearance = 20 m

Figure 7 indicative vessel beam limits applicable to Swanson Dock basin

5.1.5 Opportunities

Notable opportunities include:

- The wharf structure is able to accommodate Super Post Panamax cranes capable of lifting two 20 foot containers simultaneously. Such cranes have a waterside outreach of around 50 metres, rail gauge of 25.3 metres and a landside back reach of 20 metres. The Safe Working Load is 65 tonnes under twin lift spreader with a lift height of 38 metres.
- Each terminal lease area isn't currently fully utilised for container stacking operations.
- The arrangement of the basin at the northern end, provides opportunity to extend the quay line on SDE and SDW up to 100m (each).
  - A 50 m extension of quay line up to the edge of Coode Rd, would involve some dredging and excavation and a new edge structure along the end of the basin.
  - A 100 m extension, would involve dredging, excavation, the removal of parts of Coode Rd and a new edge structure along the end of the basin.

5.2 Berth capacity

5.2.1 Existing situation

The berth capacity of SDE and SDW has been calculated based on the estimated number of Ship to Shore Cranes (STSC's) existing currently in combination with the stated berth lengths and operating assumptions.

The resulting berth capacity is estimated at around 3.47 million TEU, as indicated in Table 9.

[20] Guidance from VPC(M) Harbour Master

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Table 9 Berth capacity estimate for SDE and SDW

Factor	SDW	SDE
STSC (No)	8	7
Berth length (m)	944	884
STSC gross rate (mvs)	32	32
Availability (%)	95%	95%
Peaking factor (%)	20%	20%
STSC utilisation (%)	52%	52%
STSC moves per yr (mvs)	133,721	133,721
Containers per move	1.2	1.2
TEU factor	1.5	1.5
TEU per yr per STSC	230,737	230,737
TEU per yr	1.85 M	1.62 M

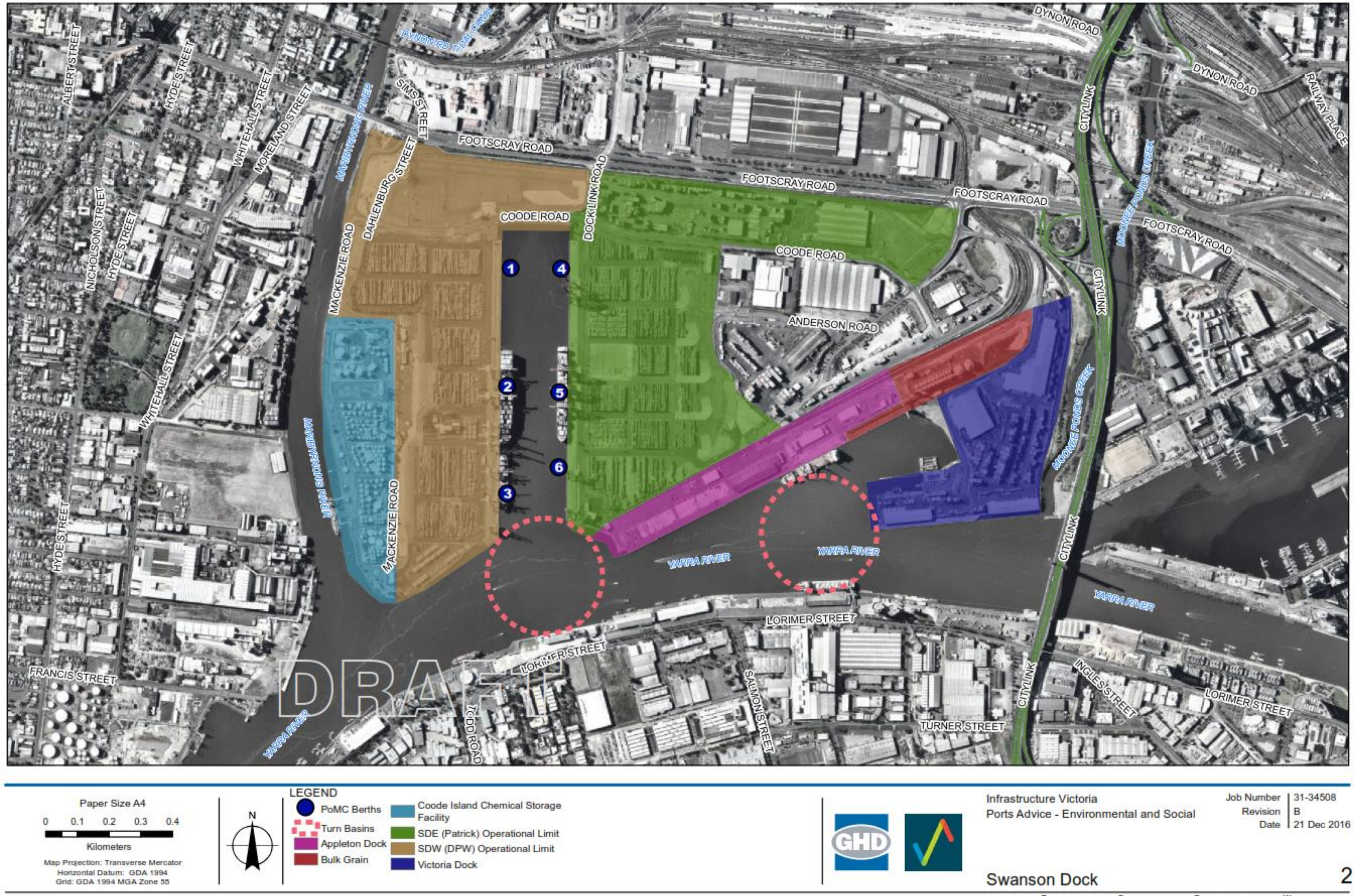

Figure 8 General arrangement of Swanson Dock & the adjacent Appleton precinct

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5.2.2 Berth capacity enhancement initiatives

Berth capacity can be increased through either:

1. Operational efficiency gains, i.e. an improvement in the productivity of a STSC over time though better performance / reliability of the terminal equipment handling containers and favourable changes in the 40' ratio of containers handled. (See C, E, F & J in Table 10)
2. The provision of extra Ship to Shore Cranes (STSCs) so that the intensity of cranes servicing a vessel can be increased, subject to their being able to access a ship. (See D, E, H & J in Table 10)
3. The provision of longer berths in conjunction with extra STSC's. (See I & J in Table 10)
4. The provision of a wider basin and longer berths with / without extra STSC's – allowing a greater number of larger vessels to access the terminal. This has the benefit of allowing more containers through the terminal for the same number of vessel calls. (G & H)
5. A move to receiving dedicated calls – i.e. the handling of greater container volumes per vessel call (increasing container exchange). (See F in Table 10)
6. To increase berth occupancy without detriment to waiting time. A set of six berths under the control of one stevedore will allow higher berth occupancy than two sets of three berths for the same level of waiting time (congestion) – refer Figure 3. (See B in Table 10)
7. Changes arising from an increase in the TEU factor or call exchange patterns, this is outside the Stevedores control, but does result in an effective TEU capacity gain. (see A)

To consider options for Swanson Dock, ten (10) enhancement scenarios (A to J) have been developed considering a mix of the above initiatives, as presented in Table 10. The results are presented in Table 11. The Dock modification scenarios (G to J) are indicated in Figure 9.

Table 10 Swanson Dock berth capacity enhancement scenarios

ID	Scenario	STSC (no.)	Berth (m)	Exchange[21] %	Berth occ.%	TEU Factor	STSC mph
A	As is (TEU > 1.6)	15	944 + 884	60%	60%	1.6	31
B	As is, but with 1 stevedore	15	944 + 884	60%	75%	1.5	31
C	As is, + productivity gain (improved)	15	944 + 884	60%	60%	1.5	35
D	As is + 3 STSC	18	944 + 884	60%	60%	1.5	31
E	Improved + 3 STSC	18	944 + 884	60%	60%	1.5	35
F	Improved + full ship exchange	15	944 + 884	200%	60%	1.5	35
G	Widened basin	16	944 + 884	60%	60%	1.5	31
H	Widened basin + STSC's	18	944 + 884	60%	60%	1.5	31
I	Extended quay line	20	1000 + 975	60%	60%	1.5	31
J	Improved STSC + Extended quay line	20	1000 + 975	60%	60%	1.5	35

Note: shaded cells indicate adjustment from 'as is'. 'Improved' = STSC productivity gain.

[21] 200% = full vessel unload and load

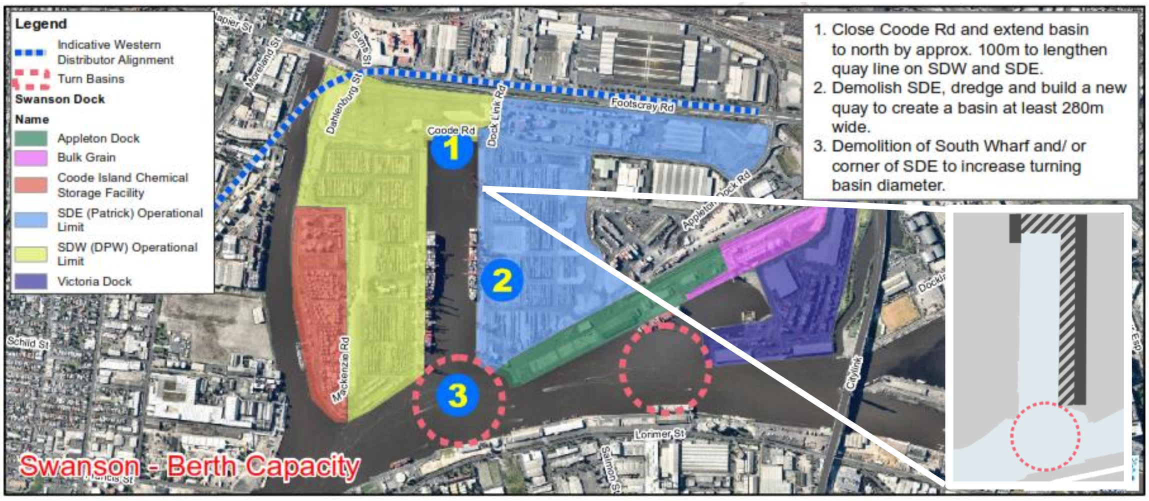

Figure 9 Possible modifications to Swanson Dock to enhance berth capacity

The scenario results are presented in Table 11. Cost estimates are presented in Table 12.

Table 11 Swanson Dock berth capacity enhancement option estimates

ID	Scenario	Capacity (TEU)	% increase on A
0	status quo (2 stevedores)	3,461,065	-
A	As is (TEU > 1.6)	3,691,803	7%
B	As is but with 1 stevedore (75% occ.)	3,993,537	15%
C	As is, improved	3,920,300	13%
D	As is + 3 extra STSC	4,153,278	20%
E	Improved + 3 STSC	4,704,360	36%
F	Improved + (dedicated calls)	5,490,060	59%
G	Widened + 1 STSC	3,843,933	11%
H	Widened + 3 STCS	4,605,794	33%
I	Extended quay line + 5 STSC	4,614,753	33%
J	Improved + extended + 5 STSC	5,227,067	51%

5.2.3 Cost estimates

Capital cost estimates associated with the modification of Swanson Dock under scenarios G/H and I/J are presented in Table 12. Further details are provided in Section 12.

Table 12 Capital cost estimate for the modification of Swanson Dock

	100 m Basin extension & quay length added	70 m Dock widening
Capital cost estimate[22]	$165 M	$597 M

22 Excludes, services / utility costs and equipment needs

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5.2.4 Key messages

- Options exist to increase berth capacity at Swanson Dock, capacity increase ranges vary between 7% and 51% of existing.
- Excluding dedicated calls, and based on the stated assumptions, a berth capacity of between 3.5 and 5.2 M TEU could be considered for Swanson Dock.
- The trend in increasing 40' share is estimated to increase capacity by 7%, and requires no capital investment. Other options require significant capital investment in either quayside equipment or quayside infrastructure. (Scenario A).
- A move to a dedicated call (F) would increase capacity to an estimated 5.49 M TEU
- A move to a single stevedore would result in an estimated 15% gain to 3.99M TEU (B)
- Considering factors under the stevedores control, the maximum capacity at Swanson Dock arising from the use of the existing berth length is estimated at 4.7 M TEU (E).
- If 3 STSC's are added and the basin widened the capacity may increase to 4.6 M TEU, which is expected to be comparable to that achieved through extension of the quay line and the addition of 2 extra STSC. (Scenarios H & I), but for much lower capital cost.
- Productivity gains together with extension of the berth length may increase capacity to 5.2 M TEU (scenario J)
- Investment in new STSC and extension of the berth appear to be provide effective capacity enhancement solutions. Operational improvement and changes in the TEU factor will improve capacity limits further over time.

5.3 Swanson Dock yard capacity

The yard capacity of SDE and SDW has been derived based on an estimate of ground slots existing currently and the assumptions provided below and in Section 1.5. The yard areas that are considered are indicated in Figure 10 (23 Ha and 28 Ha respectively).

The combined yard capacity is estimated to be 3.0 M TEU p.a. as indicated in Table 13.

Table 13 Yard capacity estimate for SDE and SDW

Factor	SDW	SDE
Yard area (Ha)	23	28
Ground slots	5279	6112
Average dwell (days)	2.9	2.9
Yard utilisation (%)	83%	83%
Peaking provision (%)	20%	20%
Maximum stack height	3	3
Estimated yard capacity	1.4 M TEU	1.6 M TEU
Combined yard capacity	3.0 M TEU (p.a.)	

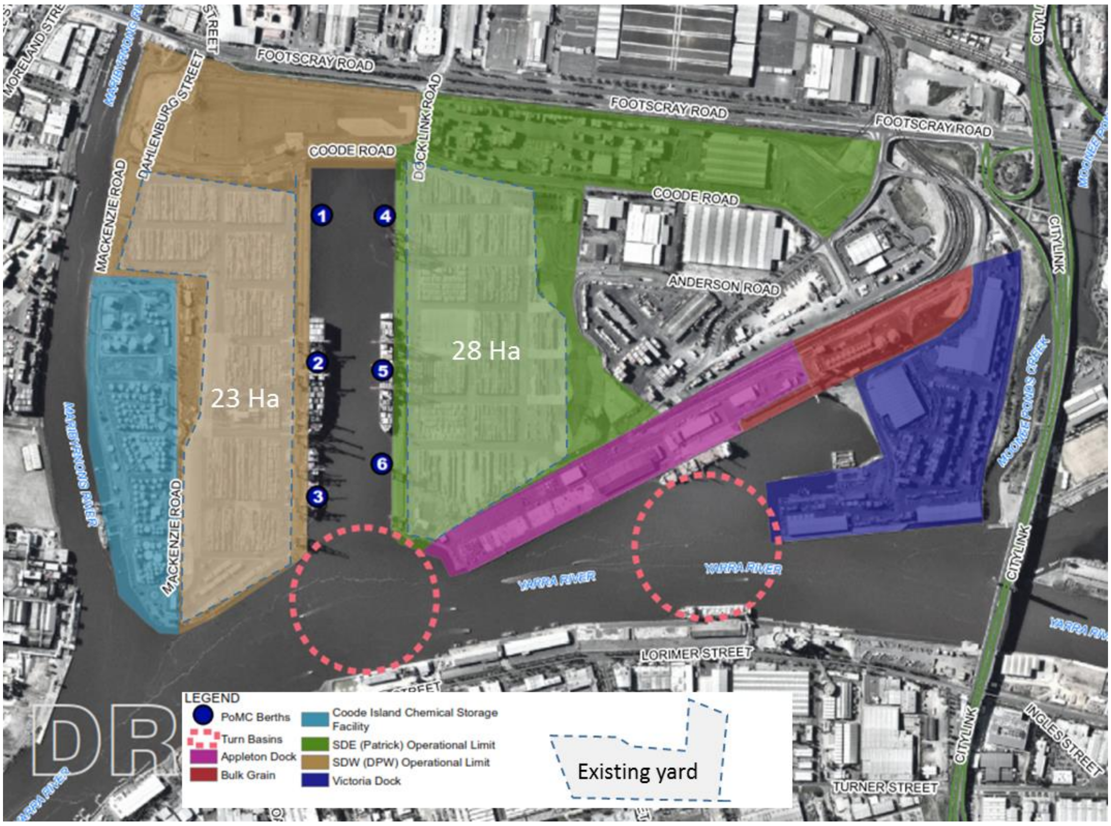

Figure 10 Assumed extent of existing yard areas within the SDW and SDE lease areas.

5.3.1 Yard capacity enhancement opportunities

Swanson Dock currently employs straddle carriers (SC) in the yard areas across 23 Ha and 28 Ha of the respective SDW and SDE lease areas. Yard capacity at Swanson can be increased through yard expansion and the use of an alternative yard stacking system.

To consider capacity benefits, the following five (5) enhancement scenarios have been considered:

a. The implications of the basin widening considered in the berth capacity scenarios.

b. The expansion of the current yard system (straddle carriers) to a greater operational area.

c. The use of a Rubber Tyred Gantry (RTG) based system on the existing yard areas of both SDE and SDW. RTG systems can offer storage density increases over straddle systems of in excess of 20%.

d. The use of existing yard areas for an RTG based system on SDW and an Automtaed Stacking Crane (ASC) based system on SDE. An ASC system has marginal storage density improvements over RTG systems with the added benefit of automation. The provision of a perpendicular ASC system on SDW is not considered feasible due to the terminal depth dimensions being less than optimal.

e. Scenario (d) across an expanded operational area(s).

The expansion options are indicatively presented in Figure 11, expansion of operations is assumed to apply to the boundary of the operational limits indicated.

The findings of the capacity enhancement testing are presented alongside the 'as is' estimate in Table 14.

Figure 11 Swanson Dock Yard capacity enhancement options

Table 14 Swanson Dock Yard capacity enhancement estimates

System	SDW (TEU)	SDE (TEU)	Total p.a. (TEU)	Increase %
SC (as is)	1.4	1.6	3.0	-
Widened basin	1.4	1.3	2.7	-10%
RTG	1.6	2.3	4.0	33%
RTG/ASC	1.6	2.6	4.3	43%
Expanded SC system	2.3	2.6	4.9	64%
Expanded RTG/ASC	3.7	7.4	11.1	273%

5.3.2 Feasibility comment

- Widening the basin reduces available yard space and will significantly impact ongoing operations during implementation.
- The modification of yard areas to accept alternative systems will reduce operational capacity as yard areas are cleared during the implementation works. Full capacity benefits may be deferred by several years and works need to start before limits are reached.
- Expansion of the Straddle Carrier system will benefit from the closure of Coode Rd.

5.3.3 Key observations on yard capacity options testing

- If Straddle Carriers are expanded out to fill the entire lease areas (ie. Assuming the removal of Coode Road in these areas) the yard capacity is estimated to increase to a maximum 64% to around 4.9 M TEU p.a. this is reasonable close to the upper estimates of berth capacity achievable at Swanson Dock.
- If RTG and RTG/ASC systems are used on the existing yard areas, yard capacity is estimated to increase by 33% and 43% to between 4.0 M TEU and 4.3 M TEU.
- If RTG and RTG/ASC systems are expanded out to fill the entire lease areas, yard capacity is estimated to increase by up to 273% to between 11.1 M TEU annually that is significantly beyond maximum berth capacity estimates.

- The use of an RTG system increases yard capacity beyond the existing berth capacity estimate of 3.5 M TEU, but remains under the estimated potential maximum berth capacity that can be achieved by using the existing berth length (4.7 M TEU).
- The mix of RTG on SDW and ASC's on SDE is envisaged to provide a yard capacity that aligns well the upper estimates of berth capacity achievable at Swanson Dock, where berth extension is not undertaken.
- Yard capacity does not appear to be a constraining component of capacity for Swanson Dock.

Figure 12 shows the outcomes of the yard capacity enhancement testing for the 'existing' and 'expanded' yard development scenarios.

The enhancement potential of on-dock rail also benefits yard capacity and is complementary to the above options. This is discussed further in Section 8 and Section 10.3.5.

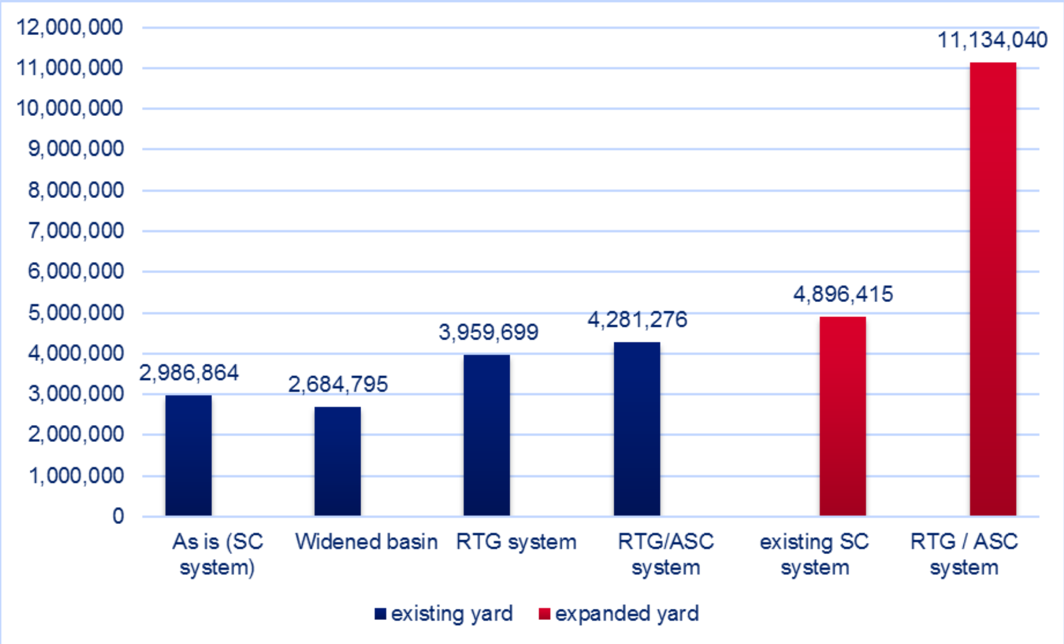

Figure 12 Swanson yard capacity for alternative scenarios on existing and expanded yard areas

5.4 Swanson Dock gate capacity

5.4.1 Existing capacity

The gate capacity has been estimated based on the current number of truck lanes together with the stated operating assumptions. The gate capacity is estimated to be 3.5 M TEU p.a, as indicated in Table 15. The capacity of the road network is covered separately in Section 7.

Table 15 Existing gate capacity for Swanson Dock

Factor	SDW	SDE
Gate Lanes	5	2
Process period (mins)	3	1
Peaking provision (%)	44%	44%
Estimated gate capacity	1.6 M TEU	1.9 M TEU

`

5.4.2 Gate capacity enhancement opportunities

Gate capacity at Swanson can be increased through improvement in the productivity of truck calls, better management of peaking, extra gate lanes and improvement in gate processing times. Benefits may also result, from a natural increase in the TEU factor over time.

Table 16 presents the findings of the following five (5) scenarios that have been considered:

i) Improving gate process times.

ii) Increase in the TEU factor from 1.5 to 1.6

iii) Reducing peak movements, to no more than 10%. Expected to be achieved through shifting more truck movements to off-peak periods + better scheduling of truck moves.

iv) Improving the truck exchange productivity to 2.5 per call

v) Combining the peak management solution and truck exchange productivity increase

vi) The impacts of exchanging containers during off-peak periods, over 14 hours in 24 hours.

Table 16 Swanson Dock gate capacity enhancement estimates

System	SDW (TEU)	SDE (TEU)	Total p.a. (TEU)	Increase %
As is	1.5	1.9	3.5	-
Improved gate processing times	4.7	1.9	6.6	91%
As is TEU factor (1.5 => 1.6)	1.7	2.0	3.7	7%
Levelling out peak (1.1)	2.0	2.5	4.5	31%
Increase containers/truck (2.5 TEU/call tested)	2.2	2.7	5.0	43%
Combine peak & containers/truck	2.9	3.5	6.5	87%
Off peak use only (14 hours)	0.9	1.1	2.0	-42%

5.4.3 Key observations

- There is insufficient capacity in the existing Swanson gate system to allow container exchanges to occur in only off peak periods (14 hours). The capacity is estimated at 2 M TEU.
- Management of the peaking and improvements in truck productivity would allow the gate capacity to exceed all of the estimated effective berth and yard capacity enhancement scenarios (estimated at 6.5 M TEU).
- Improvements in gate processing times at DPW would allow capacity to match berth and yard capacity estimates, and hence is not considered to be limiting. The addition of extra lanes at SDE would lift the combined capacity further.
- Without improvements in the management and productivity of truck arrival / departure processes, the gate processes will limit capacity.
- There seems to be sufficient options available to ensure gate capacity does not limit capacity of Swanson Dock.

5.5 Limiting capacity profiles for Swanson Dock berth & terminal (excluding road connections)

5.5.1 The 'as is' situation at Swanson Dock (excluding road factors)

Figure 13 shows the estimated limiting capacity profile for the Swanson Dock berth and terminal in its current configuration and with the current yard system expanded to a maximal area.

This indicates that the yard with its current arrangement of ground slots is expected to limit capacity to around 3.0 M TEU annually, but there is scope to lift this through expansion, which could increase capacity to a maximum of 4.9 M TEU annually.

Berth capacity is the next component limiting capacity at around 3.5 M TEU, which can be lifted most economically by adding STSC's, improving productivity and extending the quay length.

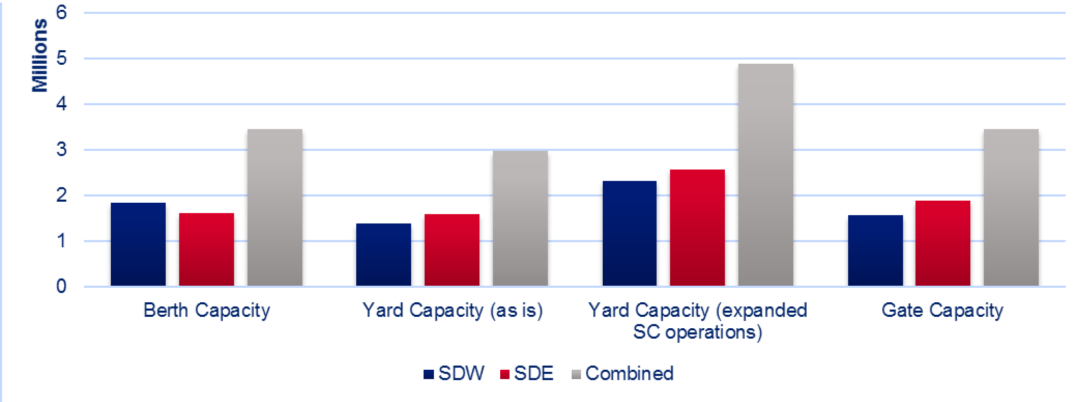

Figure 13 Estimated capacity profile for Swanson Dock in its current configuration and existing equipment choices

5.5.2 Infrastructure components limiting capacity enhancement

Table 17 summarises the capacity profile for Swanson Dock under each of the 'enhancement' scenarios' outlined earlier. This highlights that berth capacity enhancements are expected to be the limiting 'capacity' component at the port when road and rail connections are excluded.

The implications of other infrastructure capacity estimates (road, rail and channel) and 'plausible' enhancement steps for Swanson Dock are discussed further in Section 10.2.

Table 17 Summary of the terminal capacity enhancement analysis (M TEU)

	As is	As is with expansion on operational areas	As is with operational improvement (productivity gains)	As is with investment in additional /alternative equipment	expanded berth / yard + new equipment	Other - out of Stevedore control
Berth	3.5	3.5	3.9	4.7	5.2	5.5[23]
Yard	3.0	4.9	4.9	4.3	11.1	-
Gate	3.5	3.5	4.5	6.6+	-	6.5
Limiting	**Yard**	**Berth**	**Berth**	**Yard**	**Berth**	**Berth**
Capacity	3.0	3.5	3.9	4.3	5.2	5.5

23 Arises from a dedicated call scenario (full ship exchange on every visit)

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6. Webb Dock

6.1 Overview

6.1.1 Background

Webb Dock is currently configured with three terminals around a single basin. These include Bass Strait operations, International Containers (VICT) and an Automotive terminal. The automotive terminal is located across the entire western side of the basin. The WDE berth numbers and arrangement is shown in Figure 14 over the page.

The international container terminal is currently under construction and the automotive terminal has recently been opened as part of the recent Port Capacity Project. A Pre-Delivery Inspection (PDI) hub for automotive imports has also been constructed immediately to the north of Webb Dock West. The northeastern area of the Webb Dock precinct has been developed as an empty container park, but this may not be utilised in this mode in the longer term.

6.1.2 Infrastructure

The assumed characteristics of existing infrastructure at Webb Dock are shown in Table 18.

Table 18 Webb Dock infrastructure summary (Source VICT)

Berth(s)	East 1,2,3	East 4,5	West 1,2,3
Trade(s)	Container Ro-Ro	Container	Automotive
Commodity	Tasmanian/Coastal	International Container	Automotive
Beth length (m)	200	660	950
Terminal area (ha)[24]	24	35[25]	70[26]
Draught (m)	9.0	14.5	14
LOA (m)	185	335	300
Beam (m)	32	48	42
Air draught (m)	N/A		
Road	77 tonne Super B-Double (68.5t on the Westgate Bridge)		
Rail	None		

Webb Dock has good road connectivity to the major transport logistics areas in Melbourne's west, north and south-east via Footscray Road and CityLink. However, recent restrictions on the mass of vessels allowed to traffic the Westgate Bridge has been reduced to 68.5 tonnes.

Webb Dock does not currently have a rail connection. It is understood that the investigations of options for rail connections have been completed for Government, but none have been approved.

24 GHD estimates
25 Excludes empty container park
26 Includes PDI area to north of Webb Dock

Figure 14 Webb Dock precinct plan

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6.1.3 Leaseholders

- Berth East 1: Toll Shipping (Ro-Ro operations)
- Berth East 2: SeaRoad Shipping (Ro-Ro operations)
- Berth 4 / 5: International Container Terminal Services (ICTS) is the leaseholder. This will operate as the Victorian International Container Terminal (VICT)
- WD West: The automotive terminal is operated by MIRRAT, a subsidiary of Wallenius Wilhelmsen Logistics (WWL). The PDI hub is operated by Patrick Autocare and Prixcar.

6.1.4 Observed constraints

Observed constraints at Webb Dock include:

- There is currently no rail connection to the terminal. All containers have to be transported on road. Gross mass limits on the Westgate Bridge limit trucks to 68.5 tonnes. This requires trucks 77 t trucks to route through Wurundjeri Way if they are heading West.
- The 660 m berth length provided as part of the Port Capacity Project does not allow two 8500 TEU size of vessels to be accommodated simultaneously on the quay.
- The alongside depth on WDE berths 1 to 3 is insufficient for international container operations and the geometry of the northern end of the basin would constrain container vessels accessing Webb Dock West.

6.1.5 Opportunities

- The northern areas of the Webb Dock precinct are large enough to accommodate a rail terminal if an appropriate network link could be provided
- The Bass Strait and Automotive terminals could provide additional international container capacity in Webb Dock if existing trades were relocated.

6.2 Berth capacity

6.2.1 Existing situation (as is)

The capacity for Webb Dock (VICT) ‘as is’ is estimated at 1.4 M TEU, as indicated in Table 19.

Table 19 Berth capacity estimate for Webb Dock (VICT)

Factor	SDW
STSC (No)	6
Berth length (m)	660
STSC gross rate (mvs)	35
STSC Availability (%)	95%
Peaking factor (%)	20%
STSC utilisation (%)	52%
Containers per move / TEU factor	1.2 / 1.5
TEU per yr	1.4 M

6.2.2 Berth capacity enhancement initiatives at Webb Dock

Initiatives for enhancing berth capacity at Webb Dock include:

1. Operational efficiency gains, i.e. an improvement in the productivity of a STSC over time though increased performance of the terminal equipment collecting containers.
2. Increasing berth occupancy through strict management of ship schedules.
3. The provision of a longer berth in conjunction with an extra STSC's on the existing VICT terminal so that two large vessels can be accommodated simultaneously.
4. A move to receiving dedicated calls – i.e. the handling of greater container volumes per vessel call (increasing container exchange). Although this is outside the stevedores control.
5. Changes arising from an increase in the TEU factor or call exchange patterns, this again, is outside the Stevedores control, but does result in an effective TEU capacity gain.
6. The provision of additional berths with STSC's. Figure 15 outlines what is considered under this scenario.

Twelve (12) enhancement scenarios (A to L) have been developed that reflect the some of the above initiatives, as presented in Table 20. The results are presented in Table 21 over the page.

Table 20 Webb Dock berth capacity enhancement scenarios

ID	Scenario	STSC (no.)	Berth (m)	Exchange[27] %	Berth occ.%	TEU Factor	STSC mph
A	As is (TEU > 1.6)	6	660	60%	60%	1.6	31
B	As is - but berth occ. at 75% (high)	6	660	60%	75%	1.5	31
C	As is, improved	6	660	60%	60%	1.5	35
D	extended + 1 STSC	7	750	60%	60%	1.5	31
E	Extended + improved + 1 STSC	7	750	60%	60%	1.5	35
F	Improved + full exchange	6	660	200%	60%	1.5	35
New Terminal Scenarios (refer Figure 15)							
G	New berth (Bass Strait terminal)	7	750	60%	75%	1.5	31
H	BS + improved	7	750	60%	75%	1.5	35
I	Webb Dock South	7	750	60%	75%	1.5	31
J	WDS + Improved	7	750	60%	75%	1.5	35
K	Webb Dock West	10	1100	60%	75%	1.5	31
L	WDW + Improved	10	1100	60%	75%	1.5	35

Note shaded cells indicate adjustments from the 'as is' situation.

27 200% = full vessel unload and load

Table 21 shows the results of the berth enhancement scenarios applicable to the existing VICT.

Table 21 VICT berth capacity enhancement scenario estimates

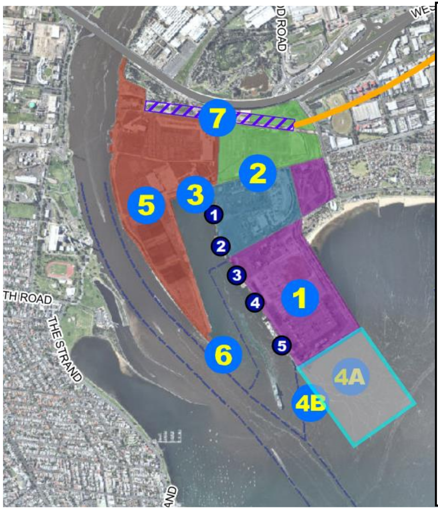
ID	Scenario	Capacity (M TEU)	% increase on 0
0	Existing situation (as is)	1.38[28]	-
A	As is (TEU > 1.6)	1.48	7%
B	As is - but berth occ. at 75% (high)	1.38	0%
C	As is, improved	1.57	13%
D	Extended + 1 STSC	1.62	17%
E	Extended + improved + 1 STSC	1.83	32%
F	Improved + full exchange	1.82	31%

6.2.3 New terminal scenarios

Table 22 shows the estimates of berth capacity provided by new terminals at the locations indicated in Figure 15.

Table 22 New terminal berth capacity scenario estimates

ID	Scenario	Capacity (M TEU)	% addition to 0
G	New berth on the Bass Strait area (BS)	1.9	133%
H	BS + improved STSC	2.1	151%
I	Webb Dock South (WDS) extension	1.9	133%
J	WDS + Improved STSC	2.1	151%
K	Webb Dock West (WDW) (extended)	2.3	167%
L	WDW + Improved	2.6	189%



New terminal options at Webb Dock

(1) 90 m extension of VICT berth northwards to create 750 m quay line (scenario D and E)

(2) New terminal on the Bass Strait precinct with 750 m quay line & terminal area behind (G/H)

(3) Extension of WD basin northwards by 150 m to facilitate 750 m quay line (G/H and K/L)

(4) Webb Dock South extension to create 750 m new quay line & terminal area behind (I/J)

(5) Extension of WDW to create 1100 m quay line with conversion of the automotive terminal to container operations. (K/L). Remove entrance constraint (6)

Figure 15 New terminal options at Webb Dock

28 Based on 75% berth occupancy. At 45%, capacity is estimated at 1.0 M TEU annually

6.2.4 Cost estimates

Capital cost estimates associated with the modification of Webb Dock under scenarios D/E, G, H, I, J K and L are presented in Table 23. Further details are provided in Section 12.

Table 23 Capital cost estimate for the modification of Webb Dock

Option	Capital Cost ($ AUD)[29]
Extend VICT by 90 m	$44.5 M
Convert WDW to Container, extend basin to north by 150m & remove the basin entrance constraint	$270 M
Convert WDE (berth 1,2,3) to a 2 berth (750 m) container terminal	$620 M
Expand WDE to the South to create a new 2 berth terminal	$1,310 M

6.2.5 Key observations (berth capacity)

- Numerous options exist to increase the VICT berth capacity at Webb Dock, capacity increase ranges vary between 7% and 32% of existing.
- Excluding new terminal development options, an effective berth capacity of between 1.4 and 1.8 M TEU is estimated to for VICT.
- The trend in increasing 40’ share is estimated to increase capacity by 7%, and requires no capital investment. Other options require capital investment in either quayside equipment or quayside infrastructure.
- A move to a dedicated call would increase capacity to an estimated 1.8 M TEU annually.
- Considering factors under the stevedores control, the maximum capacity at VICT in Webb Dock arising from the use of the existing berth length is estimated at 1.6 to 1.8 M TEU.
- Extending the berth length may increase capacity to 1.8 M TEU annually.
- The new terminal development scenarios each offer significant capacity increases that are comparable to 130% to 190% of the existing VICT.
  - Collectively, they offer a potential capacity of some 7.8 M to 8.6 M TEU annually for the Webb Dock precinct.
  - Without extension to the precinct (excluding Webb Dock South), they offer a potential capacity of some 6.0 M to 6.5 M TEU annually for the Webb Dock precinct

The feasibility of these options is discussed further in Section 10.4.

Figure 16 shows the estimated collective capacity that would result if a mix of the new terminal options were developed at Webb Dock considering both ‘with’ and ‘without productivity gain.

[29] Excludes services & utility costs and equipment

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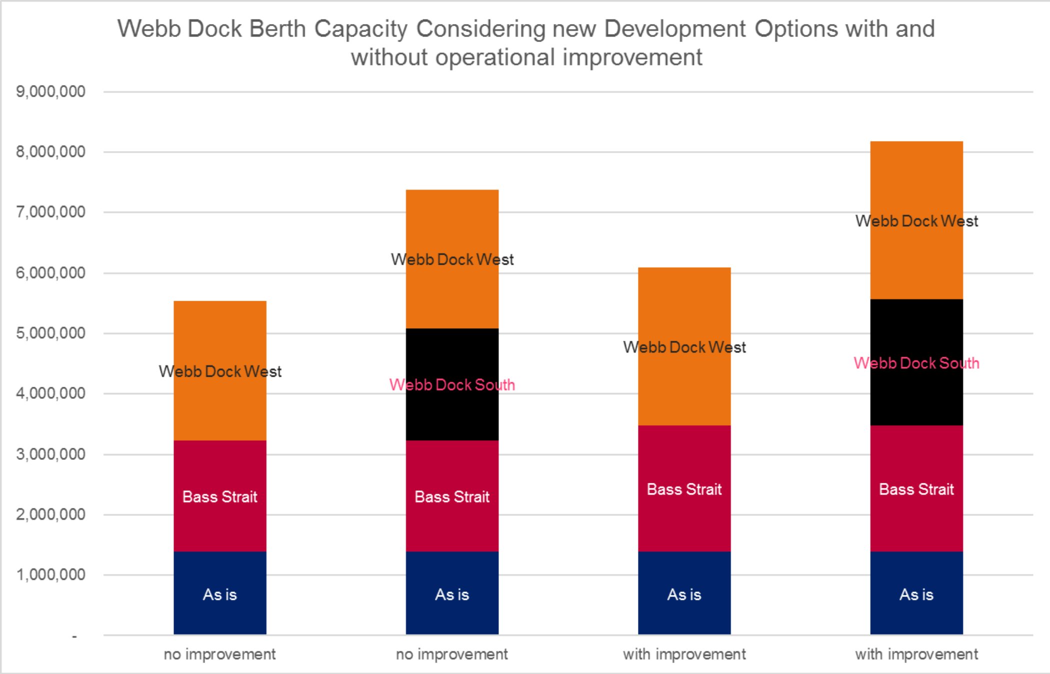

Figure 16 Webb Dock capacity considering new development options with and without operational productivity gain

6.3 Yard Capacity

6.3.1 Existing

The yard capacity of VICT has been estimated based on the application of recognised performance benchmarks for twin crane ASC systems on the assumed yard areas. Figure 17 shows the assumed yard area at VICT in the currently planned configuration.

The yard capacity is estimated to be 1.8 M TEU annually, as indicated in Table 24.

Table 24 Yard capacity estimate for VICT in WDE

Factor	WDE
Yard area (Ha)	27
Terminal System	ASC's
Average dwell (days)	2.9
Yard utilisation (%)	83%
Peaking provision (%)	20%
Maximum stacking height	5
Estimated yard capacity (TEU)	1.8 M

Figure 17 Existing yard area assumed for VICT

6.3.2 Webb Dock yard capacity enhancement options

Yard capacity enhancement options for Webb Dock are presented in Figure 18 and are referenced by the following annotations:

1. Demolish WDE berth 3 and locally extend the VICT quayline northwards (Approx 90 m) to create a 750 m long two berth (large ship) facility and expand the yard accordingly.
2. Relocate Bass Strait operators. Demolish WDE, (berth 1/2) and build 750m of quayline parallel to WDW to form a basin at least 300 m wide. Develop the existing yard to create a terminal of around 35 Ha, in close proximity to a future rail terminal (7).
3. Extend basin to north and install spending beach / revetment along shoreline. This enables options (2) and (5), and helps mitigate wave agitation in the basin.
4. Expand Webb dock into Hobsons Bay to create a 750 m quayline (two berths) and associated yard through land reclamation (4a). Dredge a new berth pocket and turning area (4b).
5. Relocate the Automotive terminal and extend the WDW berth to north to create a three berth facility with 1100 m quay line. Develop the yard area to west and north accordingly for container operations. Yard is in proximity to a future rail terminal (7).
6. Remove land at southern end of WDW to improve vessel access into the basin.
7. Future rail terminal with a dedicated link to the freight rail infrastructure located at Swanson Dock. The benefits and implications of a rail terminal are discussed in Section 8.8 and Section 10.4.

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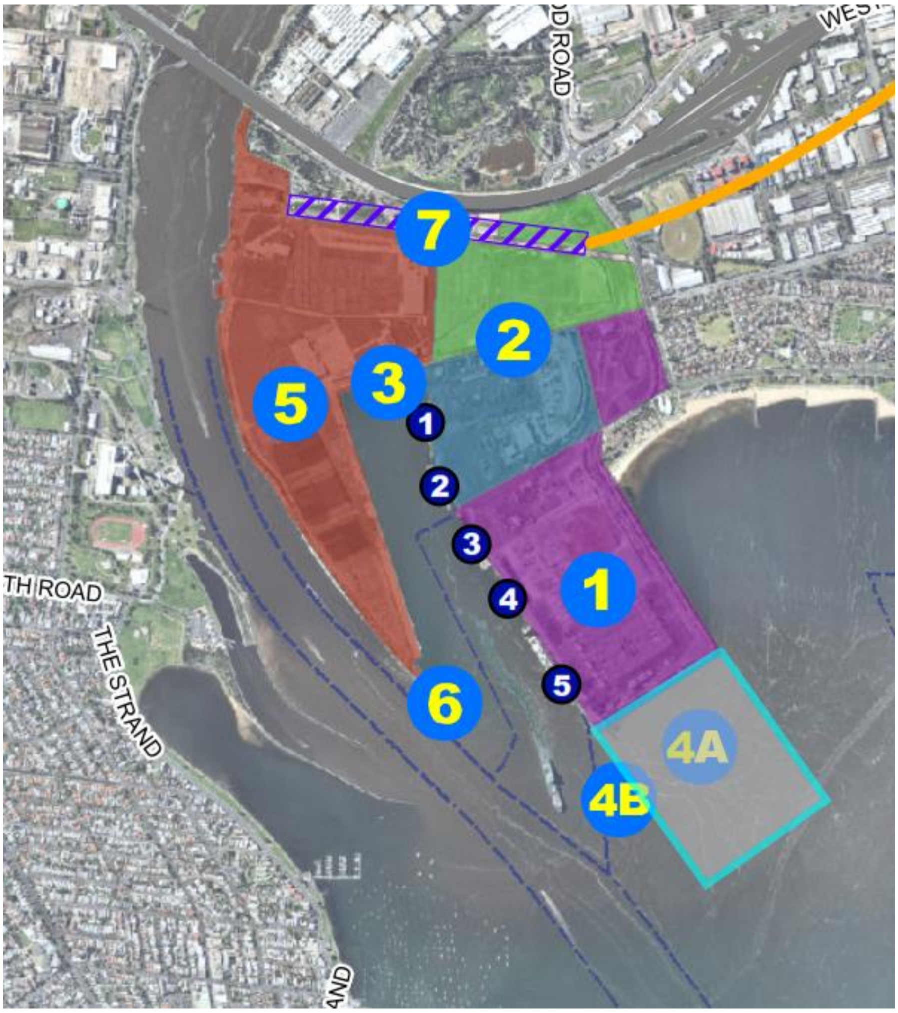

Figure 18 Yard capacity enhancement scenarios considered for Webb Dock

Figure 19 shows the individual options alongside the 'as is' capacity estimate. Figure 20 highlights how the options together enhance capacity.

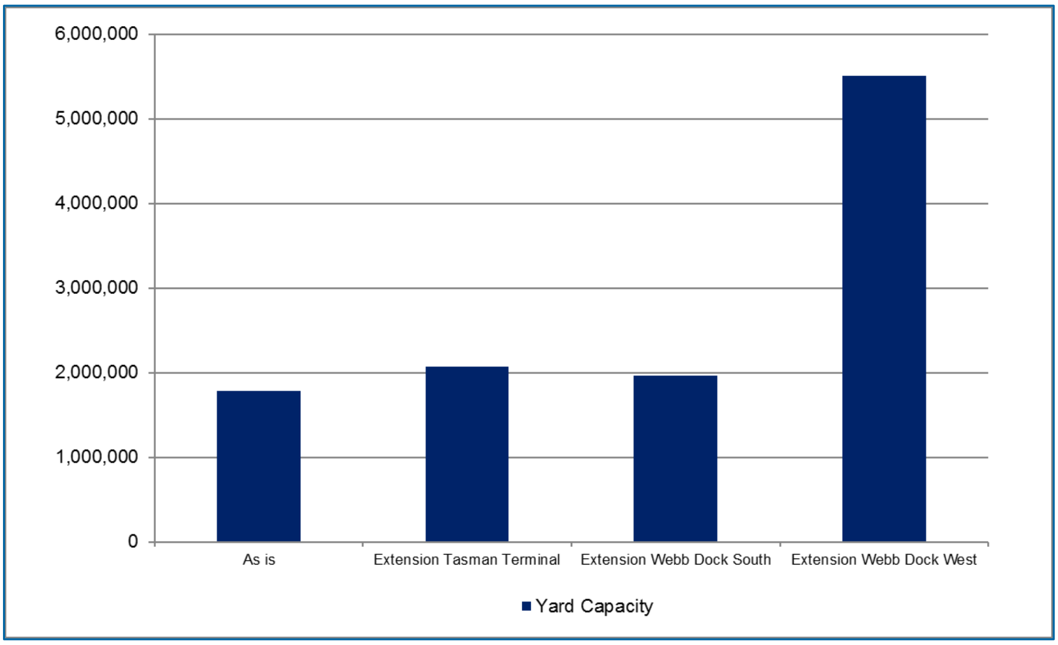

Figure 19 Yard capacity estimates for Webb Dock expansion options

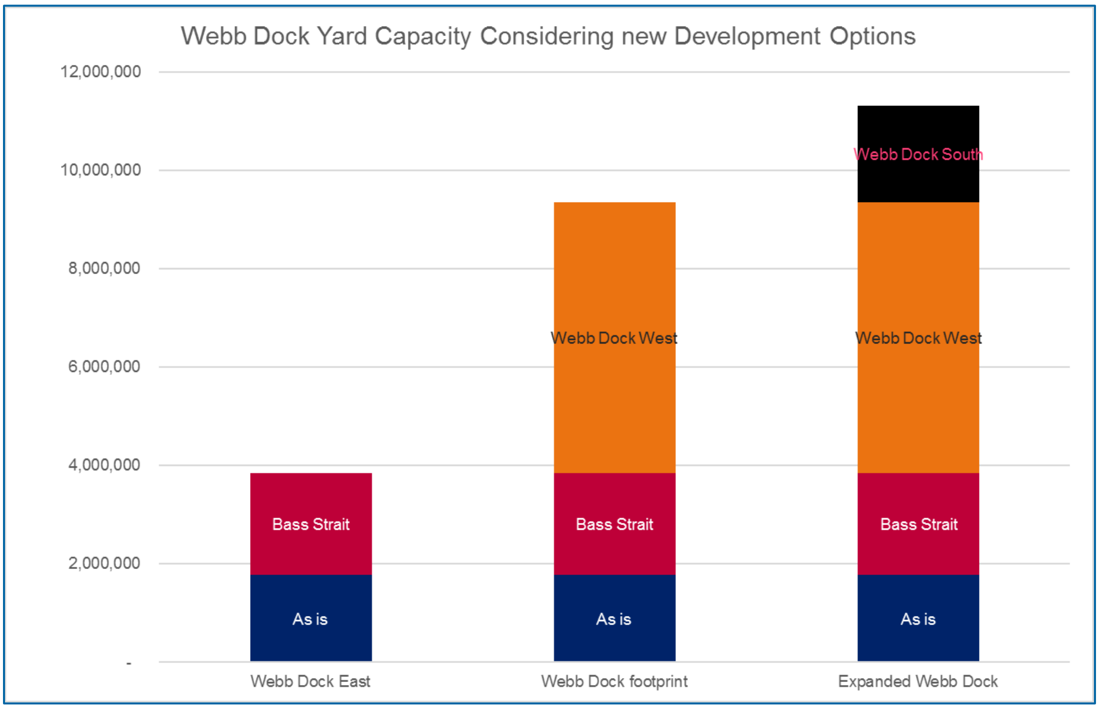

Figure 20 Alternative combinations of additional yard capacity at Webb Dock

6.3.3 Key observations

- Use of the entire WDE footprint (Bass Strait + VICT) would provide a yard capacity of around 3.8 M TEU p.a.
- The entire Webb Dock precinct would create a yard capacity of around 9.3 M TEU p.a .
- An expanded Webb Dock would create a yard capacity of around 11.3 M TEU p.a.
- Yard capacity is not limiting for Webb Dock.

6.4 Webb Dock gate capacity

6.4.1 Existing capacity

The gate capacity of Webb Dock has been estimated to reflect a benchmarked application of truck gate lanes for ASC systems.

The gate capacity is estimated to be 5.7 M TEU p.a, as indicated in Table 25.

Table 25 Gate capacity estimate for VICT

Factor	VICT
Gate Lanes	4
Process period (mins)	2
Peaking provision (%)	44%
Estimated gate capacity	5.7 M TEU

6.4.2 Gate capacity enhancement opportunities

The gate capacity at Webb Dock can be increased through improvement in the productivity of truck calls, better management of peaking, extra gate lanes and improvement in gate processing times. Benefits may also result, from a natural increase in the TEU factor over time.

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Table 26 presents the findings of the following five (5) scenarios that have been considered:

a. Improving gate process times to 1 minute.

b. Increase in the TEU factor from 1.5 to 1.6

c. Levelling out of the peak, to no more than 10%. Expected to be achieved through better management of the scheduling collections / drop offs.

d. Improving the truck exchange productivity to 2.5 per call

e. Combining the peak management solution and truck exchange productivity increase

f. The impacts of exchanging containers during off-peak periods, over 14 hours in 24 hours.

Table 26 Webb Dock gate capacity enhancement estimates

System	Total p.a. (TEU)	Increase %
As is	5.7	-
Improved gate processing times	11.3	100%
As is TEU factor (1.5 => 1.6)	6.0	7%
Levelling out peak (1.1)	7.4	31%
Increase containers/truck (2.5)	8.0	43%
Combine peak & containers/truck	10.6	87%
Off peak use only (14 hours)	3.3	-42%

6.4.3 Key observations

- There may be sufficient capacity in the existing gate system to allow container exchanges to occur in only in off peak periods (14 hours). The capacity in this scenario is estimated to be 3.3 M TEU.
- All other options provide capacity well in excess of the berth and yard capacity estimates.
- Gate capacity does not limit port capacity.

6.5 Limiting capacity profiles for Webb Dock

Figure 21 summarises the capacity profile for each initiatives considered at Webb Dock. This indicates that berth and yard capacities are generally, well matched. The exception is Webb Dock West yard, where land to the north and west creates capacity that is far in excess of the corresponding berth capacity.

VICT, in its current arrangement is considered to be limited by the berth capacity at around 1.4 M TEU annually, but if this were extended by around 90 m (to the north) the berth and yard capacities would be matched at around 1.8 m TEU.

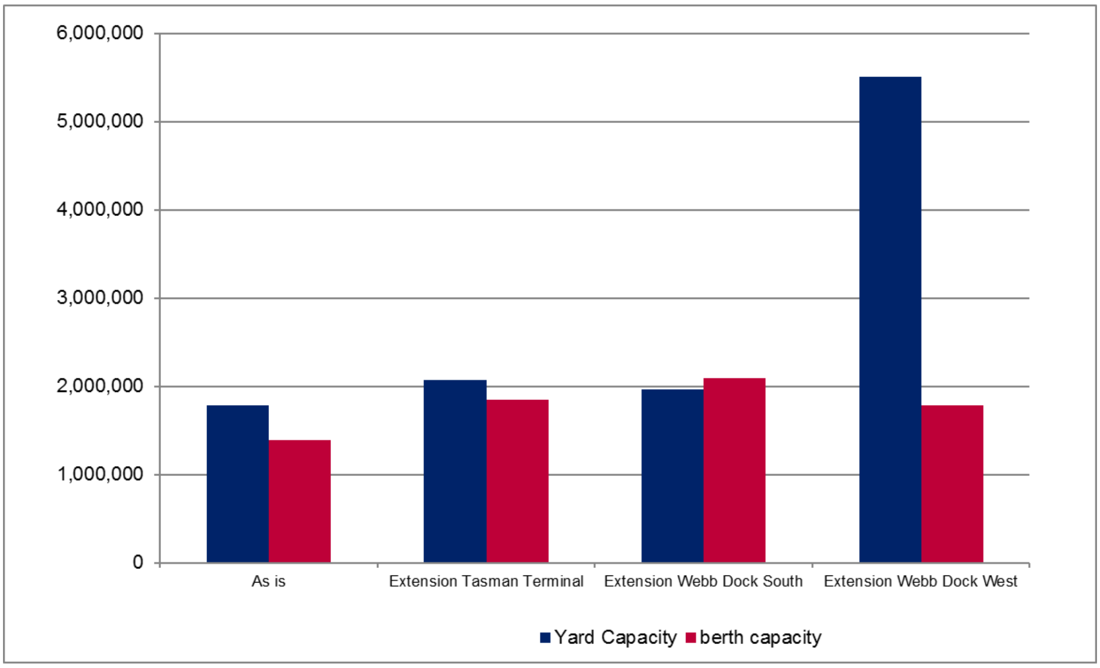

Figure 21 Limiting capacity profile at Webb Dock (M TEU)

6.5.1 Favourable capacity enhancement options

A plausible development path for Webb Dock is discussed further in Section 10.5.

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7. Road Network Capacity

7.1 Study inputs

The assessment of road capacity at the Port of Melbourne has been undertaken by Jacobs for Infrastructure Victoria. This section provides a summary of their findings, which has been limited to SIDRA modelling of the road junctions immediately outside the port gates at Swanson and Webb Dock terminals.

7.2 Swanson Dock

7.2.1 Overview

The Port of Melbourne Swanson Dock container terminals are connected to the external road network via three main access routes:

1. Appleton Dock Rd, which leaves Footscray Rd via a grade separated interchange at the north eastern corner of the precinct.
2. Mackenzie Rd, at the north western corner, which connects to Sims St, and Footscray Rd via grade separated intersections. Sims St runs north To Dynon Rd.
3. Dock Link Road which also links to Footscray and Dynon road to the north.

Footscray Rd provides direct connection to the freeway network via Citylink, although many port trucks reportedly use alternative arterial roads that avoid tolls

These arterial roads include Whitehall St, Francis St and Williamstown Rd are to the west, and Footscray Rd, Dudley St, Wurundjeri Way to the south east. The main roads are indicated in Figure 22.

At present Coode Rd provides an internal connection between SDE and SDW to the north of Swanson Dock basin but is seen as a constraint affecting ease of access to the rail sidings to the north of Coode Rd from the main terminals. However, there are plans by DPW to close Coode Rd west of Dock Link Rd, and Patrick is understood to have considered closing Coode Rd between Appleton Dock Rd and Phillips Rd. Both of these proposals would provide better linkages between the container terminal yards and the proposed MIRT site (refer Section 8.7).

It is generally concluded that the stevedore entry and exit gates do not pose constraints on truck access and handling at the stevedore terminal currently (refer Section 5.4). Queue accommodation is understood to only be needed when the capacity of the terminal yard equipment is less than that needed to satisfy the volume of trucks booked with the Vehicle Booking System (VBS) timeslots.

Port truck traffic has however been a longstanding cause of tension for residents in the inner west of Melbourne, particularly on Francis St, Somerville Rd and Williamstown Rd. VicRoads has recently imposed curfews on trucks on Francis St and Somerville Rd in an effort to reduce social and amenity impacts. The curfew has caused inefficiencies in night-time logistics operations and resulted in additional cost to importers and exporters as trucks have to longer travel distances and toll costs across the City Link.

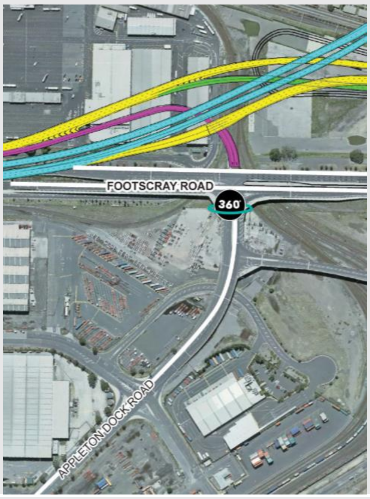
There have been numerous State Government plans to provide alternative truck routes that cause less amenity impacts in the inner west, with the recent Transurban proposal for 'Western Distributor' being most recent. While solutions continue to be explored, port traffic on inner west roads is likely to remain a significant issue for the new port owner.

In this assessment, the Western Distributor is assumed to be constructed.

7.2.2 Key inputs to the capacity assessment

Table 27 summarises the inputs and assumptions that have been used in the road intersection capacity assessment (Source: Jacobs).

Table 27 Swanson Dock modelling inputs

Input / Assumption	Description
Intersection layout	As per Western Distributor Reference Design available on the project website (http://wdmap.u-c.com.au/imap07/) and confirmed in discussions with the Western Distributor Authority (WDA), layout diagram provided in Appendix A. It is assumed that Dock Link Road and Coode Road (western end) will be closed. *Mackenzie Road ramps*  *Appleton Dock Road ramp* 
Phasing	Appleton Dock Road: Using a starting point of the current phasing at Appleton Dock, this was updated using professional judgement to minimise overall vehicle delays at the intersection with a fixed cycle time of 120 seconds (advice from WDA). Mackenzie Road: Optimised to minimise overall vehicle delays at the intersection with a fixed cycle time of 120 seconds (advice from WDA).
Traffic Volumes	Volumes on Footscray Road taken from the 2031 VITM Reference Case Port-related traffic estimated by Jacobs Traffic from Dynon rail yards is assumed to have disappeared by 2031 and has not been included in the intersection analysis.
Classification	Truck traffic movements were estimated by Jacobs using a first principles approach, main data sources were Port of Melbourne truck surveys, GHD (2010) and professional observations. The following vehicle classification[30] breakdown for all traffic in and out of Swanson Dock has been adopted for 2016 and all future years: 15% semitrailers

[30] High Performance Freight Vehicles (HPFV) have not been allocated a separate category as the timing and scale of the expected uptake is uncertain

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	40% b-doubles (60% of which are 30m, the remainder are 25m) 25% cars and derivatives 10% courier vans and light rigids 10% heavier rigid trucks On Footscray Road it is assumed that Heavy Vehicles comprise 18% of all vehicles (including port related heavy vehicles). This is based on published VicRoads AADT data.
Growth (peak hours)	Port traffic: 2.7% per annum from 2031 onwards based on Deloitte TEU forecasts Non-port traffic: 0.5% per annum from 2031 onwards
Direction of travel	Based on Jacobs projections that combine known OD information and future projections, the following directionality has been assumed: • Western Distributor (west): 44% • Footscray Road (west): 21% • Monash Freeway (east / south): 14% • Citylink (north): 14% • Dudley St / Wurundejri Way (inner city, Webb Dock): 7% Swanson Dock traffic is split 50:50 between the DP World Terminal (Mackenzie Road) and Patricks Terminal (Appleton Dock Road). Additional traffic (1700 trucks per day) is also generated to Appleton Dock and Victoria Dock, this results in a split of truck volumes between the access routes of 42% Mackenzie Road and 58% Appleton Dock Road.
Avg Contrs per Truck	Average Load (TEUs): 1.2 (including empty running). Freight trends suggest that this value has been stable for many years
Rail mode share	10% (assuming that the current share can be maintained)
Time period	Ratio of peak hour to daily traffic Period — 2031 — Flows AM Peak (8-9am) — 5.0% — 60% of port traffic is inbound PM Peak (4-5pm) — 4.6% — 40% of port traffic is inbound
Years modelled	2031: post WD Opening using VITM volumes on Footscray Road 2031+: design life assessment using assumed growth rates
Containers	2031: 3.0m TEU, growing at 2.7%p.a. thereafter

7.2.4 Existing situation – 'As is' (Swanson Dock)

The starting year for modelling Swanson Dock is taken as 2031, this is post construction of Western Distributor (as per Figure 22) and allows for a sufficient ramp-up period.

At 2031 Swanson Dock is assumed to be handling 3.0m TEU, equivalent to 11,300 total truck movements (6,500 at Appleton Dock and 4,800 at Mackenzie Road). At 2031 the Appleton Dock Road / Footscray Road intersection operates at acceptable levels during the AM and PM peak (see Table 28), however priority is given to through traffic on Footscray Road rather than traffic in and out of the port. There are no issues at Mackenzie Road.

Table 28 2031 Appleton Dock road movement summary (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	E	64	145	D	45	132
North	E	62	77	E	69	47
East	B	18	188	C	27	379
West	B	15	252	A	9	116
Overall	B	20		C	22	

Beyond 2031, peak hour design life analysis (performed by Jacobs) shows that the Appleton Dock Road intersection would reach capacity after 23 years (from 2031) in the AM peak and 15 years (from 2031) in the PM peak.

The queues that result at this time (see Table 29) will cause major issues within the port, with queues more than half way back to Appleton Dock, blocking internal roads such as Enterprize Road and Anderson Road.

Capacity under current operating conditions is therefore estimated at 4.4m TEU that may be reached by 2040.

Table 29 Appleton Dock road movement summary at capacity (AM: ~2054, PM: ~2046) (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	F	94	401	F	98	474
North	E	57	140	F	99	99
East	E	57	428	E	56	705
West	E	76	670	B	16	194
Overall	E	69		D	46	

The Mackenzie Road ramps on and off Western Distributor do not appear to have the same issues as Appleton Dock Road. The modelling indicates capacity will not reached during any of the peak periods until after 2070. The intersection summaries continue to show that the when the intersections are modelled together an acceptable threshold (LOS D) has been reached at 2066 (50 years from today) on the ramps into Mackenzie Road.

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Whilst the modelling has demonstrated that access to the port from Western Distributor via Mackenzie Road poses no capacity constraint over the next 50 years the assessment has highlighted a risk that there will be be significant issues caused at Sims Street and the ensuing ramps used to and from Footscray Road, and intersection upgrades may be required.

In summary, with upgrades to the Sims Street / Footscray Road intersection and freight movements continuing without changing the time of operation Swanson Dock would be constrained on the landside at around 4.4m TEU in the mid 2040's.

7.2.5 Swanson intersection enhancement initiatives

The following initiatives are recognised:

(1) Connecting to Western Distributor – as summarised above

(2) To upgrade Sims Street / Footscray Rd intersection

(3) To shift truck operations to off-peak (night time) periods.

Options (1) and (2) are indicatively shown in Figure 22. The shift to off-peak periods is further in this section.

Figure 22 Road capacity enhancement initiatives for Swanson Dock

7.2.6 Swanson intersection cost estimates

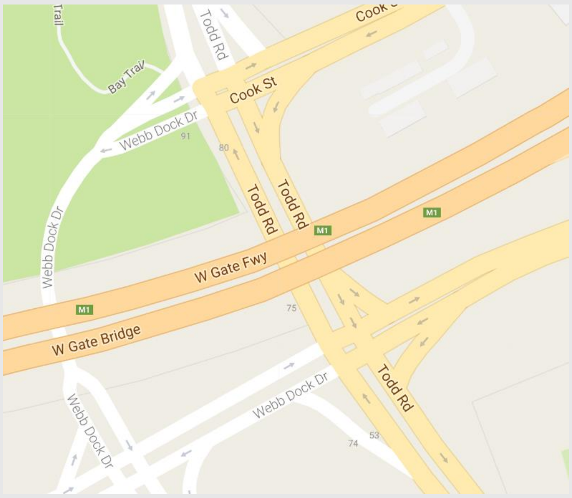
The cost estimate for the upgrade of the Sims St interchange is estimated to be $70 million.

7.4 Webb Dock

7.4.1 Study inputs & assumptions

Table 30 summarises the key inputs and assumptions that have been used in the Webb Dock intersection modelling.

Table 30 Webb Dock intersection inputs (Source: Jacobs)

Input / Assumption	Description
Intersection layout	As per upgrades made in September 2016. Assume that the Webb Dock Access Project (part of Western Distributor project) will add a new lane in each direction on Cook Street between Todd Road and the West Gate Freeway, but intersection will by unchanged. 
Phasing	Operations sheets provided by VicRoads. IDM, Strategic Monitor Graph and history files provided by VicRoads covering the AM peak (6-9am) and PM (3-7pm) on 16/11/16
Traffic Volumes	SCATS (unclassified) counts by turning movement for every 15 minute period from 14/11/16 to 20/11/16. Our design day is based on Wednesday 16th November 2016. Source: VicRoads Open Data Portal.
Classification	First principle estimate of truck traffic movements by Jacobs, main data sources were Port of Melbourne truck surveys, GHD (2010) and professional observations. The following vehicle classification[31] breakdown for all traffic in and out of Webb Dock has been adopted for 2016 and all future years: • 45% semitrailers • 20% b-doubles (nearly all 25 m) • 25% cars and derivatives • 5% courier vans and light rigids • 5% heavier rigid trucks

31 High Performance Freight Vehicles (HPFV) have not been allocated a separate category as the timing and scale of the expected uptake is uncertain

<table>
<tr><td></td><td>On the surrounding roads (namely Todd Road, Cook Street and West Gate Freeway Ramps), it is assumed that Heavy Vehicles comprise 15% of all vehicles in the AM peak but only 3% in the PM peak (excluding port related heavy vehicles). This is based on observations at the intersection during peak periods and published VicRoads AADT data.</td></tr>
<tr><td>Growth (peak hours)</td><td>Port traffic: 16% per annum from current to 2020, 2.0% per annum thereafter. This is based on the rapid uptake of VICT and then a slowdown. All vehicle types grown at the same rate, movements grow at different rates due to match the change in ‘direction of travel’ shown below.

Non-port traffic: 0.5% per annum from current to 2020 (based on VITM forecasts in the area), 2.0% per annum thereafter, consistent with expected growth across Melbourne (including Fisherman’s Bend developments).</td></tr>
<tr><td>Direction of travel</td><td>Based on Jacobs projections that combine known OD information and future projections, the following directionality has been assumed:
<table>
<tr><th>Access/egress point (direction)</th><th>2016</th><th>2020</th><th>2030</th></tr>
<tr><td>Monash Freeway (east and north):</td><td>44%</td><td>36%</td><td>35%</td></tr>
<tr><td>West Gate Freeway (west):</td><td>32%</td><td>45%</td><td>47%</td></tr>
<tr><td>Todd Road / Lorimer St / Wurundjeri Way:</td><td>23%</td><td>19%</td><td>17%</td></tr>
<tr><td>Williamstown Road:</td><td>1%</td><td>1%</td><td>1%</td></tr>
</table>
The key change impacting the shift in these numbers is the growth, post 2020 of international container trade through Webb Dock. This trade will lead to a reduction in the percentage of total trade moving between Webb and Swanson Dock and a relative increase in the percentage movements over the West Gate bridge to staging yards in the west.</td></tr>
<tr><td>Avg Containers per Truck</td><td>Average Load (TEUs): grows from 1.2 in 2016 to 1.35 in 2020 then to 1.5 in 2030 (including empty running)</td></tr>
<tr><td>Rail mode share</td><td>0%</td></tr>
<tr><td>Time period (Ratio of peak hour to daily traffic)</td><td>
<table>
<tr><th>Period</th><th>2016</th><th>2020</th><th>2030</th><th>Flows</th></tr>
<tr><td>AM Peak (8-9am)</td><td>11.6%</td><td>7.8%</td><td>7.7%</td><td>60% of port traffic is inbound</td></tr>
<tr><td>PM Peak (4-5pm)</td><td>10.8%</td><td>7.6%</td><td>7.4%</td><td>40% of port traffic is inbound</td></tr>
</table></td></tr>
<tr><td>Years modelled</td><td>2016: using data provided by VicRoads and calibrated to existing traffic queues

2020: updated traffic volumes to a point where VICT handles International 1.0m TEU

2020+: design life assessment using a growth rate of 2.0%p.a.</td></tr>
</table>

Containers (million TEU)	Period	2016	2020	2030
	International	0.0	1.0	1.5
	Domestic	0.3	0.6	0.7
Port truck volumes by load type (two-way)	Load type	2016	2020	2030
	International containers	0	3,167	3,871
	Bass Strait containers	1,035	1,882	1,908
	Other	1,601	1,935	2,334
	Total	2,636	6,984	8,113
Port truck volumes by time period (two-way)	Period	2016	2020	2030
	AM Peak	306	546	627
	PM Peak	286	530	602
	Daily	2,636	6,984	8,113
	• 40% of international containers are moved overnight (7pm-6am) • 90% of motor vehicle, domestic containers and other trade are moved during the day			

7.4.2 Existing situation – 'As is' (Webb Dock)

Modelling of the recently upgraded entry and exit points to Webb Dock (modelled in SIDRA as a network of two intersections) highlights long queues as a result of considerable non-port related traffic in the commuter peak directions. Despite the intersection operating at an acceptable LOS of C, queues between the intersections (along Todd Road) are a concern and appear to stretch to around 150m (matching recent observations).

Table 31 and

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Table 32 highlight the movement summary findings for the north and south intersections respectively in 2016.

Table 31 2016 movement summary north intersection - Todd Road / Cook St (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	C	30	79	C	20	20
North	D	38	22	D	42	96
East	C	24	119	B	19	101
West	D	37	13	D	43	37
Overall	C	28		C	28	

Table 32 2016 movement summary south intersection - Todd Road / Cook St (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	C	31	50	D	46	78
North	B	17	108	C	21	152
East	E	60	92	D	51	148
West	E	60	33	D	51	63
Overall	C	33		C	33	

At 2020 it is assumed that VICT has reached a volume of 1.0m TEU (international containers), in conjunction with 0.7m domestic containers, motor vehicles and other Tasmanian related trade. An additional lane in each direction has been added to Cook Street as part of the Webb Dock Access improvements.

The modelling at VICT for 2020 indicates a large increase in volumes in and out of Webb Dock, which creates a decrease in intersection performance to LOS D, predominantly as a result of queues on Cook Street, even with the additional lanes.

Table 33 and Table 34 highlight the movement summary findings for the north and south intersections respectively in 2020.

Table 33 2020 movement summary north intersection - Todd Road / Cook St (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	D	38	85	D	36	52
North	D	45	84	C	23	171
East	D	37	231	D	54	137
West	D	52	100	E	62	101
Overall	D	39		D	37	

Table 34 2020 movement summary south intersection - Todd Road / Cook St (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	D	36	52	D	49	83
North	C	23	137	C	25	166
East	D	54	171	D	55	173
West	E	62	101	D	45	79
Overall	D	37		D	36	

`

To test the ultimate capacity of the two intersections all movements were grown by 2.0% per annum from 2020, which indicated a design life (based on capacity) of between 12-19 years depending on the intersection and peak period. The design life capacity refers to a network that has reached capacity; it is preferable to not let the intersections reach this point as traffic delays tend to increase exponentially beyond this point. In particular Cook Street traffic was shown to queue all the way back to the West Gate Freeway off-ramp.

The movement summaries provided in Table 35 and Table 36 represent a realistic 2030 scenario with the following assumptions:

- 1.5 containers per truck (VICT are promising more efficient matching of trucks in and out of the port, compared to Swanson Dock which has an average of 1.2)
- 40% of international containers moved overnight (24% of total truck movements)
- 2.2m TEU (1.5m international, 0.7m domestic) and motor vehicle trade

The queues and delays at the intersections are considered unacceptable and would also be having significant effects on surrounding roads and intersections, including the West Gate Freeway.

This suggest the existing 'as is' road network is constrained to around 1.7 M to 2 M TEU.

Table 35 2030 movement summary north intersection - Todd Road / Cook St (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	D	49	117	D	55	45
North	D	43	91	F	95	229
East	F	81	362	F	129	432
West	D	47	96	D	40	93
Overall	E	65		F	101	

Table 36 2030 movement summary south intersection - Todd Road / Cook St (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	D	37	52	F	178	221
North	C	25	145	C	32	196
East	D	54	189	F	142	403
West	E	57	116	D	50	102
Overall	D	39		F	80	

7.4.3 Enhancement initiatives

The modelling looked at the peak AM and PM periods and highlighted significant constraints on achieving a large growth in container movements at Webb Dock even with a high proportion of international containers being transported overnight (40%). Figure 23 shows the hourly profile of traffic through both intersections, as expected the traffic volumes overnight are very low, therefore a potential response to congestion by freight operators to is increase overnight operations.

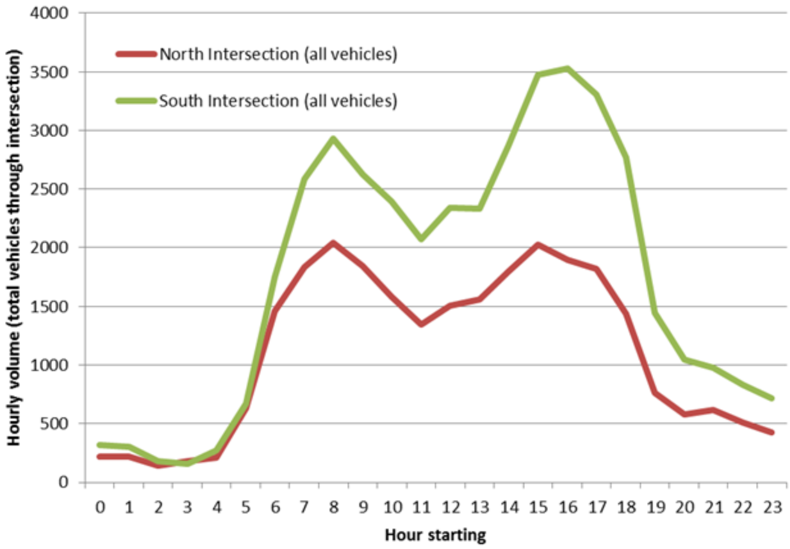

Figure 23 Current time profile of Webb Dock intersection volumes

Modelling the same intersections with traffic volumes reduced to overnight levels (around 10% of the AM peak) suggest that there is potential for up to 1,400 trucks per hour to be accommodated in and out of the port (see Table 9) before the intersection reaches LOS D.

Note that 1,400 trucks per hour will result in the following issues on the surrounding network:

- Within the port gates at the intersection of Webb Dock Drive and Kooringa Way. Given the amount of spare land around the intersection we assume any congestion issues here could be solved in the future.
- Hairpin turn from Cook Street onto West Gate Freeway westbound, based on traffic engineering principles it could theoretically cater for 420 trucks per hour (one lane). The hairpin should therefore be safely widened to two lanes. The merge with traffic from Prohansky Street on-ramps and then onto the West Gate Freeway will also need revision

Table 37 overnight movement summary – 1400 trucks, 2038 (Source: Jacobs)

	AM Peak (8-9am)			PM Peak (4-5pm)		
Approach	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**	**LOS**	**Ave Delay (sec / veh)**	**Queue (m)**
South	D	55	13	D	39	7
North	E	69	225	C	34	19
East	D	41	357	D	53	437
West	D	49	260	C	25	170
Overall	D	49		D	38	

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Using the AM, PM and overnight truck capacities from the aforementioned scenarios, the theoretical maximum throughput of trucks in and out of Webb Dock under a 24-hour operation (every hour of the day) at LOS D is estimated at a maximum potential of 22,300 trucks per day, which equates to 7.7m TEU. However, in reality this is not considered feasible for the following reasons:

- The road network would be at a highly unstable condition 24 hours a day, the chance of traffic breakdowns will be very high each day, resulting in significant delays to port and non-port related traffic.
- This scenario would require 65% of truck movements to occur overnight (7pm-6am). This compares to current overnight movements of 28% at Swanson Dock. The shift, and associated cost, in current operational arrangements needed to accommodate a change from 28% to 65% is considered unrealistic. Whilst some increase from 28% could be expected, an upper planning limit of closer to 50% of total movement overnight is more reasonable, noting that achieving even 50% will have a cost impact for the freight sector and may also require regulation to achieve.
- Traffic volumes are likely to conflict with the aims of the Fisherman's Bend development. There is a high degree of uncertainty regarding the impact on road traffic of full of Fishermans Bend to accommodate 80,000 new residents and 60,000 jobs. There is a real risk that traffic on Todd road could increase well above current forecasts, impacting 24/7 capacity at the port gate.
- Webb Dock currently lacks heavy vehicles access to the freeway network (beyond 68 tonnes). This limitation, until resolved, will have some impact on the degree to which the freight sector can operate the most efficient trucks available to Webb Dock – reducing likelihood of larger than expected increases in overnight movements supported by higher truck utilisation. It is unlikely that required truck numbers could be further mitigated by forecast a higher than expected increase in truck. Utilisation. Our assessment has assumed that average containers per truck to Webb Dock will be 1.5 at Webb Dock. Given this is 25% higher than the historical average at Swanson Dock we believe it unrealistic to propose growth above 1.5 TEU per truck is likely it

A more realistic proportion of trucks operating overnight is envisaged to be between 30% and 50% along. If this occurred, in conjunction with a better uptake during the inter peak period (9am-3pm), this would allow Webb Dock intersections to reach 3.2 to 4.9 million TEU annually.

Table 38 summarises the feasibility and impacts of shifting truck movements to overnight.

Table 38 Impacts of shifting Webb Dock freight overnight

Proportion overnight	Trucks per day	Achievable throughput TEU (m) per annum	Notes
67%	22,300	7.7	Network at breaking point 24-hours per day
50%	15,100	4.9	Ambitious target
30%	10,800	3.2	Achievable proportion
24%	8,100	2.2	Expected operations

In summary, to grow Webb Dock up to 3.2m TEU per year, overnight movements will need to increase to at least 30% and a package of upgrades will be required to the interchanges and intersections connecting Webb Dock to the M1 freeway. This will include an additional lane for

the on ramp heading west over the West Gate Bridge and signalling to provide dedicated space for truck merging overnight.

It is reasonable to assume that Webb Dock will be able to handle between 3.2m to 4.9m TEU with a continued shifting of operations to overnight (up to 50%) and truck productivity gains occur.

At 4.9m TEU annually, landside capacity becomes a serious issue and significant new network capacity and transport connections, by either road or rail, will be needed.

It reasonable to expect that planning and delivery of new network capacity should be underway as volumes pass 3.2 million. Recognised infrastructure options to increase transport network capacity million include:

- Construction of a new rail line connecting Webb Dock to the rail network at Appleton Dock. This involves approximately 3.6km of elevated rail structure with two rail lines. The route loosely follows the Bolte Bridge, crosses over the Yarra River, the M1 and then along the southern edge of the M1.
- Construction of a new road connecting Webb Dock to the Western Distributor and CityLink corridors. This includes approximately 5km of two lane elevated road. The route follows the same alignment as the rail corridor and then includes ramps onto Western Distributor to the west and Citylink to the north.

Figure 24 provides an overview of the how a freight link may be configured between Webb Dock and the Western Distributor. The rail component is discussed further in Section 8.8.2 and 8.8.3, it is noted that alternative alignment options do exist.

7.4.4 Webb Dock transport infrastructure cost estimates

Table 39 summarises the cost estimates for the upgrade options.

Table 39 cost estimates for upgrading transport infrastructure at Webb Dock

Network upgrade	Cost estimate
Additional lane(s) for the on ramp heading west over the West Gate Bridge and signalling to enable truck merging overnight	$50 M (each)
New road and rail transport link (Freight Link) connecting Webb Dock to the rail network through the Dynon rail yards and road to the Western Distributor	$3.5b
Road only version of the above	$2.5b

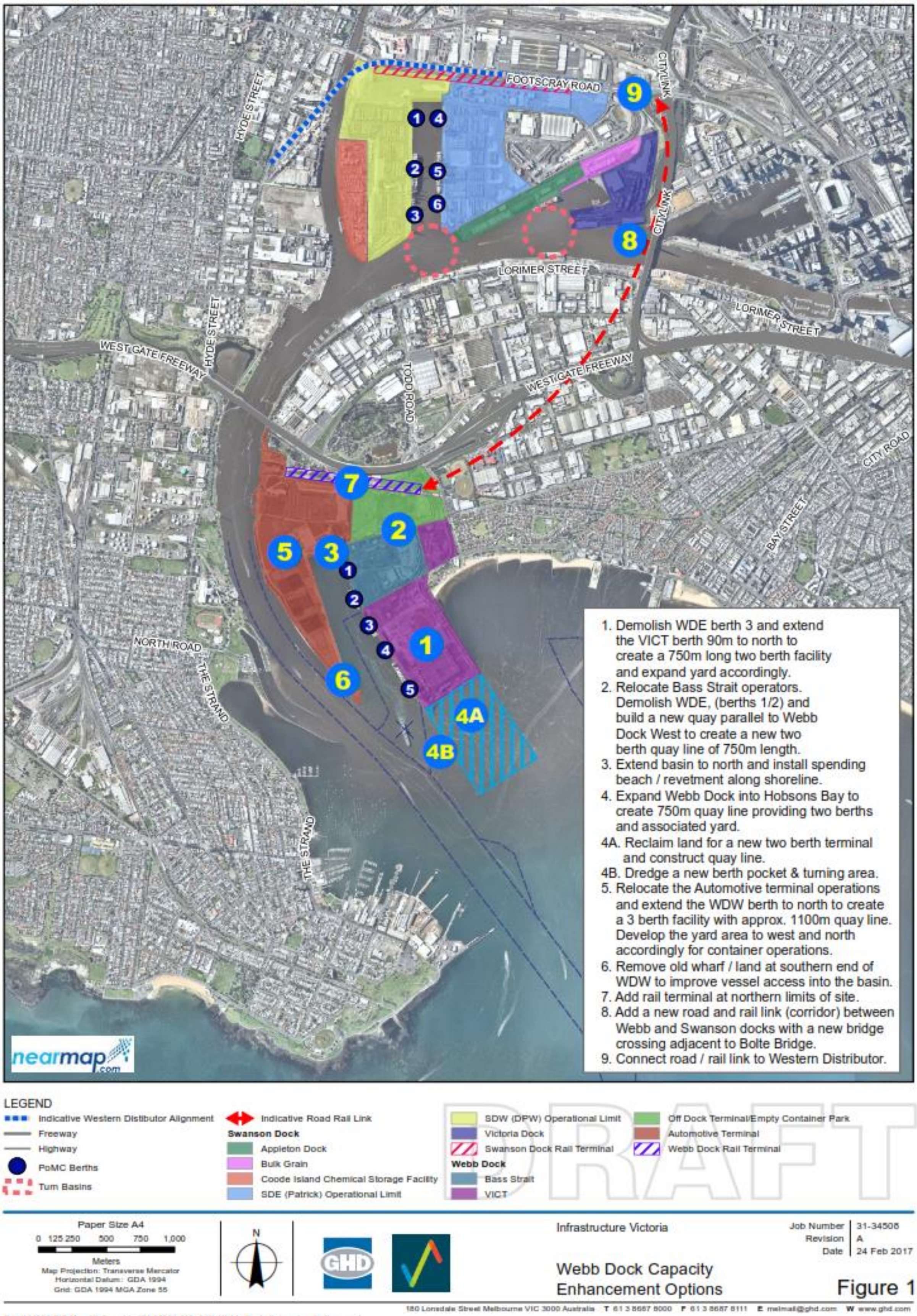

Figure 24 Potential Freight Link connection to Webb Dock & other capacity enhancement options

8. Rail Network Capacity

8.1 Overview

This section looks at rail network capacity at the Port of Melbourne, and considers how such capacity may benefit port operations.

8.2 Demand for rail transport supporting Victorian container ports

Current demand for rail transport to the Port of Melbourne for containerised goods is generally focussed on export products transported through regional intermodal terminals across Victoria and interstate locations into southern NSW. Core export products vary across the port catchment areas, but typically include:

- Meat and dairy from Warrnambool
- Wine, fruit, vegetables, grain, feed and mineral sands at Merbein and Donald
- Rice, grains and mixed products at Deniliquin and Tocumwal
- Paper products at Maryvale

Regional intermodal trains generate a rail demand of up to 18 one-way trips across the network on peak days and compete for network access with passenger trains, other freight trains carrying grain, aggregate, steel and rail maintenance trains and works.

These regional exports train services operating through intermodal terminals including:

- Dooen, (SG)
- Merbein, BG – soon SG
- Donald (BG – Soon SG
- Deniliquin, BG
- Mooroopna, BG
- Tocumwal BG (NSW),
- Warrnambool, BG
- LOGIC Wodonga, SG
- Maryvale, BG
- Morwell BG (proposed)
- Ettamogah (NSW) SG,
- Griffith(NSW) SG
- Bomen (NSW), SG and
- Harefield (NSW),SG (currently utilised for traffic to Port Botany)

Note: (BG) = Broad Gauge; (SG) = Standard Gauge; (DG) = Dual Gauge

These terminals operate on either Broad Gauge rail lines (BG) or Standard Gauge rail Lines (SG) which highlights the need for a dual gauge network to support these exports in the port precincts.

The locations of the key regional terminals handling export products is presented in Figure 25.

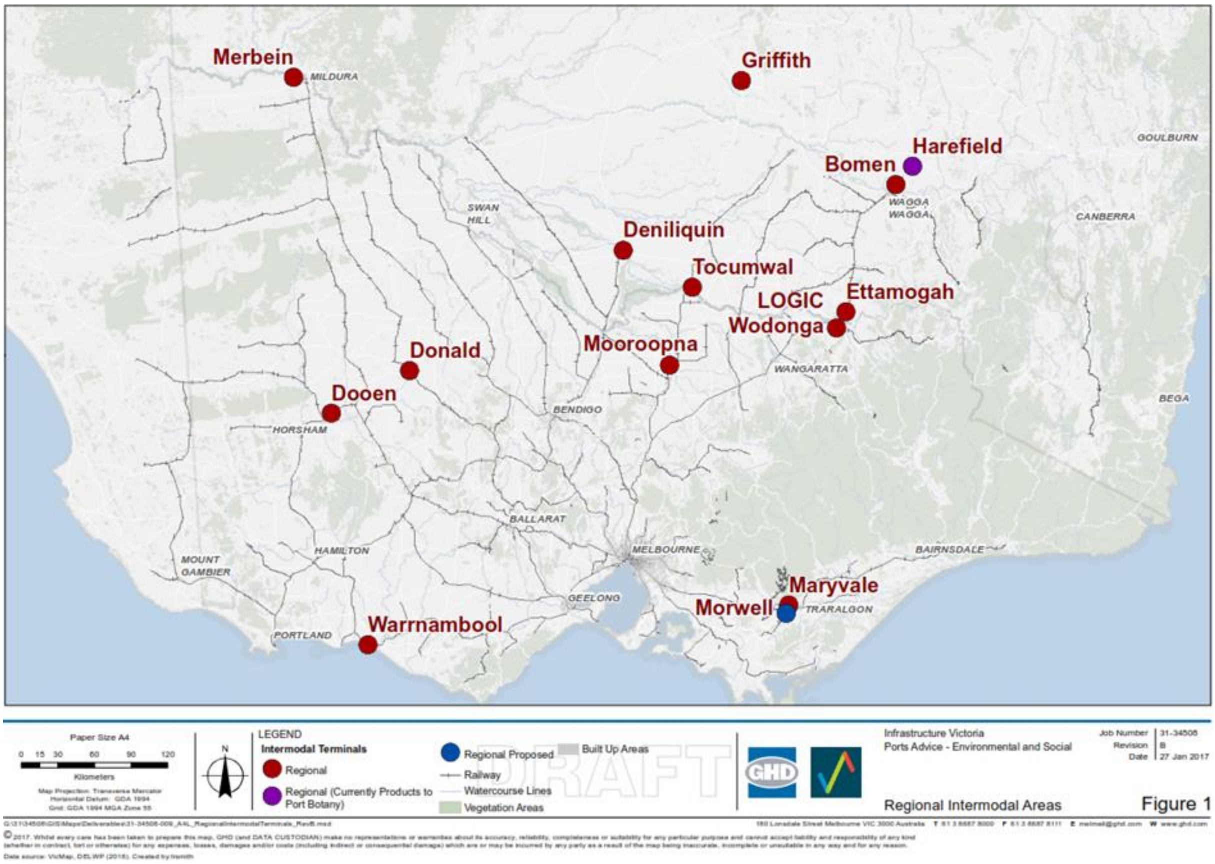

Figure 25 Location of key regional rail export terminals

8.3 Metropolitan terminals

There are also metropolitan terminals at key locations including:

- Somerton
- Laverton, and
- Altona

With plans for additional terminals and connections at locations including:

- Lyndhurst
- Altona (2nd terminal); and
- The Western Interstate Freight Terminal (WIFT) (which may include both interstate and Import/Export terminal areas

Figure 26 shows the location of the metropolitan intermodal locations.

Four terminal locations currently operate in the metropolitan areas, including the operation of warehousing on each site. The Altona and Lyndhurst terminals are not currently connected to the rail network:

- The **Laverton Terminal** operated by SCT (in conjunction with their interstate rail and road logistics centre on the site) is currently operating regular shuttle trains into the West Swanson rail sidings and DP World port terminal with exports from their Dooen terminal and other locally based export products.

  The SCT site operates as a significant interstate and local road and rail logistics business from the site including client warehousing for clients such as Heinz food products.

- The **Somerton terminal** forms part of a larger industrial precinct and has four dual gauge rail sidings in place for loading (two adjacent to hardstand) and a longer storage siding. The tracks can hold five MIS trains.

  The Somerton Rail Port inside the 300 acre Somerton Business Park in an industrial area with direct road access to the Hume Highway and Somerton Road, and rail connections to the Port of Melbourne, South Australia, Victoria and New South Wales.

  DP World Australia and Austrak have announced plans for development at Austrak's business park at Somerton, north of Melbourne. The stevedore is to operate the new inland freight hub, to be known as Somerton Rail Port, positioned 23 km north of the Port of Melbourne and Melbourne CBD.

  The new facility is expected to be fully customs bonded and is to connect Somerton directly by rail shuttle with the Port of Melbourne. The new Somerton facility has been quoted by DP World to have capacity for 200,000 TEU per annum, with an expected capacity growth to 400,000 TEU over time.

  Kraft / Linfox currently occupies a temperature controlled warehouse on the Inland Port site along with a large Coles Distribution Centre.

- The **Altona terminal** is 40 Ha in size and has two standard gauge rail connections (turnouts) and signalling in place, however rail connection of the last km is required into the site. It is planned to hold two MIS style trains. Road access is via the Princes Freeway, Kororoit Creek Road and Burns Road with planned HPFV access.

  Maersk Shipping Line have a 5 Ha lease for empty containers on the site.

  A new warehouse is proposed for the site, along with the development of a large FCL Storage facility for Imports and Exports.

- The **Dandenong South terminal** is 185 Ha in size and has plans for a broad gauge rail connection, which requires connection from the terminal back to the Cranbourne line at Lyndhurst with signalling works and a possible staging siding alongside the main line. Planned works will enable four MIS trains to be held in the terminal.

  Road access is via the Westernport Highway with new high capacity road access proposed for the site enabling HPFV vehicles.

  A 45,000 sqm Bunnings Distribution Centre occupies the site and Maersk Shipping Line along with several other International Shippers propose to lease sites adjacent to the Rail Terminal for both empty and FCL container management.

  A new 16ha "State of the Art" Distribution Centre is currently be constructed on the Dandenong South Terminal site for major retailer Woolworths, to service their Victorian supermarket stores.

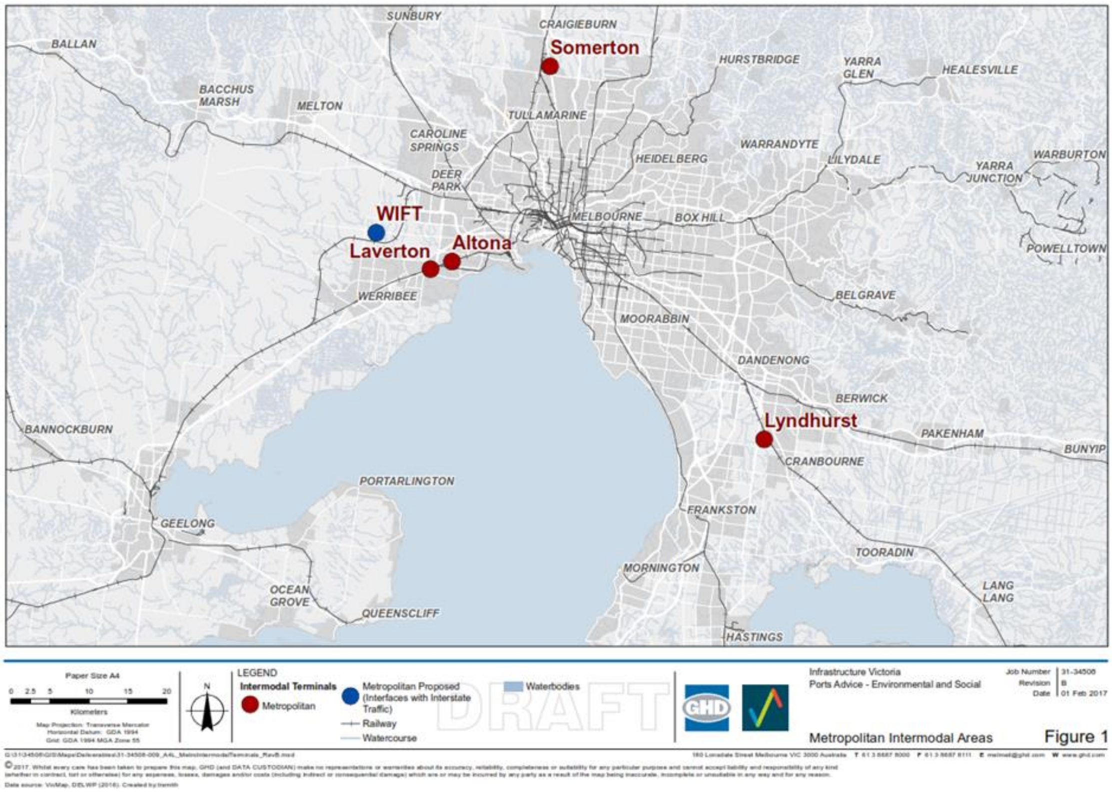

Figure 26 Metropolitan intermodal locations

8.3.1 Metropolitan rail terminal operations

Three metropolitan terminal locations at Somerton, Altona and Lyndhurst and adjoining network connections have been the subject of significant government planning under inland port projects since the early 2000's as part of a Metropolitan Intermodal System and later the Port Rail Shuttle Project. The Laverton site can now be added with a potential for other terminals (such as WIFT terminal in the future, which may contribute to local port related shuttle train movements.

The project identified the need for MIS trains to run on the same network with Electrified Metropolitan passenger trains in the short to medium term and a need for these trains to be of a configuration which matched the performance characteristics of other trains on the network.

A train configuration of double headed locomotives on trains of 600 m in length with 42 wagons equipped with ECP braking and capable of carrying 2 TEU (effectively regardless of mass subject to the current normal container mass limits) was established. A train capacity of 84 TEU was established although utilisation of 80% (68 TEU per trip) was an agreed likely operational outcome.

High level capacity options for train paths on the Metropolitan network were identified and a general business case was developed. The system would utilise both the broad and standard gauge networks Altona on standard gauge, Lyndhurst on broad gauge and Somerton with dual gauge infrastructure and flexibility for either network.

Additional development sites are also a potential within the Melbourne metropolitan area..

8.4 The Metropolitan Intermodal System (MIS)

8.4.1 Background

The Metropolitan Intermodal System (MIS) was developed through the Victorian Government as part of Freight and Logistics planning for the state and the development of the Port of Melbourne to enable a greater rail modal share of container transport to and from the port.

The MIS Project (later renamed Rail Port Shuttles (RPS) investigated and developed a business case for the development of efficient integration of metropolitan rail and road movements linking the port of Melbourne with metropolitan terminals at Somerton, Lyndhurst and Altona by high capacity road transport and rail. This provided for reduced road traffic impacts and a consolidation of the line haul task allowing staging/storage at terminals and local pick up and delivery to Melbourne's key industrial areas.

The project addressed key barriers in place; including the need for a critical mass for rail to operate, network capacity, train configuration and operational issues.

Empty container parks were also planned at the metropolitan terminals providing for return access to the port by rail and a reduction in road traffic across Melbourne returning unloaded containers to the current container park locations in the inner western suburbs.

The terminals are planned to act as inland ports with a 2 hour container load transfer cycle enabling quick turnaround and responsive movement of container to and from the port. This will enable them to be utilised as "extended gate" terminals working in an integrated way with the stevedore terminals at the port and enhance the operation and capacity of the port.

Figure 27 provides an overview of inland port linkages.

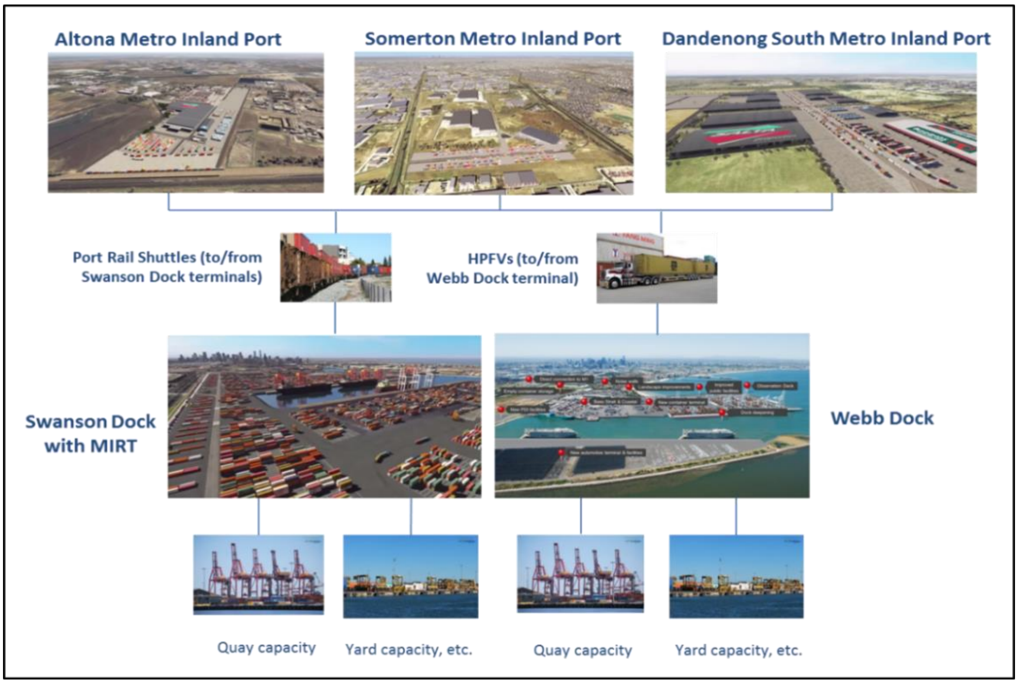

Figure 27 Elements of the port and MIS system–Elements of the port and MIS system

8.4.2 The inland terminals

The inland terminals are proposed as follows:

- The designated location where MIS trains and HPFV's will be loaded / unloaded at Metropolitan Inland destinations (assumed to be Somerton, Altona and Lyndhurst).

- To be operated as integrated ‘on dock’ rail and yard storage facilities, incorporating sufficient numbers of rail sidings and container ground slots to satisfy peak rail demands.
- To operate in a 24/7 basis, allowing containers to be transferred between rail sidings and ground storage slots on a continuous cycle using container handling equipment selected by the Inland Port operator.
- To be loaded / unloaded quickly (approximately 2 hrs expected) to facilitate its return path to the port-rail interface.

8.4.3 Port rail interface

Port of Melbourne Port rail terminal interface options were developed as part of the MIS and business case development. This considered the following locations around the port of Melbourne:

- In the east Swanson rail sidings with an interface to the existing Patrick terminal or east Swanson Stevedore terminal;
- Within the Melbourne Market site which is now vacant
- Along the west Swanson sidings (parallel to Footscray Road) and access to extended terminals for both east and west Swanson docks

A preferred location was identified along the northern boundary of the Swanson Dock terminal with the rail terminal to the south interfacing with the stevedoring terminals.

The planning since the development of this option has progressed to an appropriate timing and requirements for the closure of Coode road, which currently separates the stevedoring terminals and additional land from the west Swanson rail sidings. Once Coode road is closed in the area north of the terminals, there is an opportunity to extend terminals and provide a seamless movement of containers direct to rail facilities reducing rail costs and bring this option to a similar in line with road arrangements.

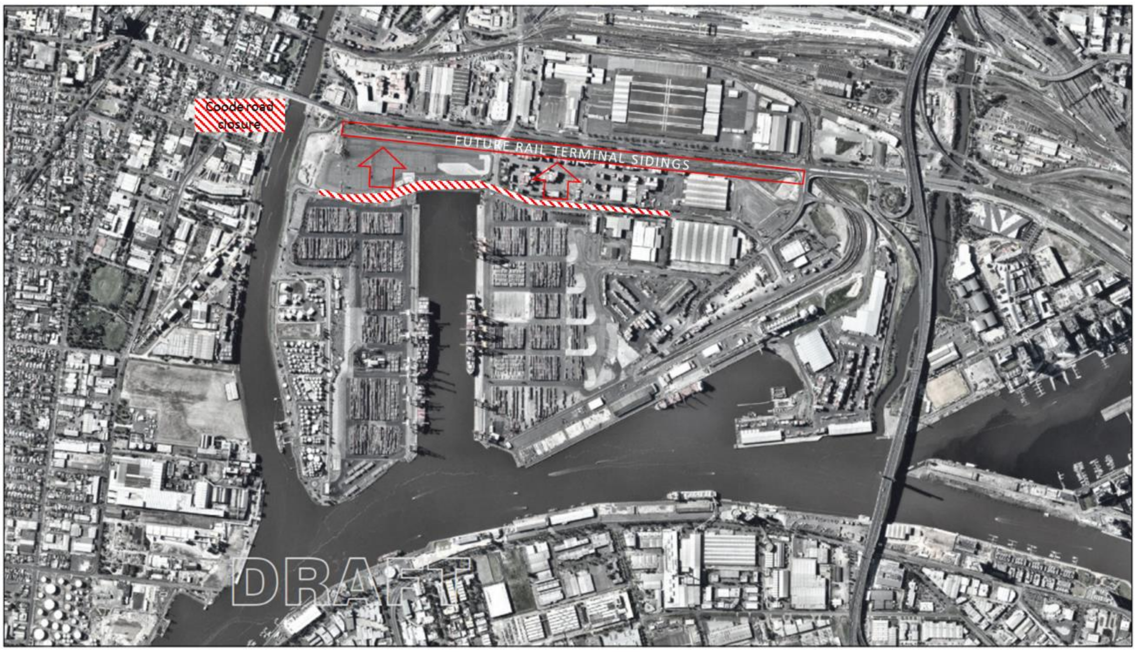

Figure 28 Map illustrating the potential arrangement of an intermodal rail terminal at Swanson Dock

The port rail interface (potentially called the Melbourne Intermodal Rail Terminal (MIRT)) will require significant enhancement to cater for an increased rail mode share and the development

of container terminals linked to the anticipated removal of Coode Road west of Phillips Road will provide an opportunity to expand container storage and integrate with rail services.

The development of additional rail sidings (up to 4-5 sidings) on either side of Dock Link Road to the south of Footscray Road with direct access to stevedore terminals and the allocation of equipment and transfer areas, will be necessary to provide for multiple train handling container transfer cycles, loading imports to the terminals and unloading empties and exports.

A further enhancement may include staging sidings at the north of the market site, enabling loaded trains to exit the loading areas and wait direct access through the key Sim Street junction area.

This infrastructure, developed progressively with relevant lifting and transfer equipment from reach stackers to rail mounted gantries would provide for a capacity of 8-900,000 TEU enable the MIS system to reach its key objectives and provide key benefits outlined below.

8.4.4 Perceived benefits of the MIS system

Benefits of the MIS system are:

- A reduction of truck traffic on metropolitan roads and reduced traffic impacts
- The ability to increase throughput at the port by moving containers directly to and from metropolitan terminals, leading to a reduction in container dwell times at the port and increased overall capacity.
- The development of improved transport network options at the port providing increased overall landside network capacity.
- Relocation of some of the empty container storage task to inland terminals with return rail or truck options to the port reducing the scope of cross-city road movements to existing empty container parks in the inner west and providing options for bulk rail movements to the port.
- Potentially the MIS system provides for an extended gate system for the Port of Melbourne and future ports enabling ‘Just in Time’ movements which can extend the capabilities and capacity of the port precinct.

8.5 Metropolitan origins and destinations for containers

The most recent assessment of Port of Melbourne container trade origins and destinations in 2009 indicated a broad spread of metropolitan container trade movements. The study recognised four outer metropolitan areas in the west, north, east and south east of Melbourne allocating container movements generally within these four areas and an inner zone closer to the port.

While movements within the inner zone were only likely to operate on trucks direct from the port, modal share in the other four areas may be subject to mode competition on rail. The regions identified within the study are shown in Figure 29 below.

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Figure 1: Metropolitan Melbourne

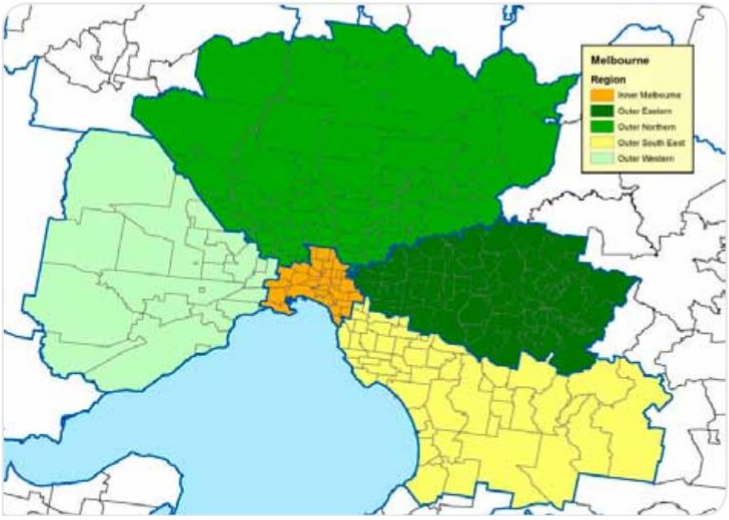


Figure 29 Port of Melbourne recognised metropolitan regions

Table 40 summarises the resulting metropolitan statistics to highlight the percentage share of imports and exports that have historically gone to each metropolitan region.

Table 40 Estimated share of trade to metro locations

2009 PoMC areas	Metro trade share %
Inner	14 %
Outer Northern	18 %
Outer East	27 %
Outer South East	7 %
Outer Western	33 %

Utilising the identified rail terminals to these regions the Outer East and Outer South East areas would both be serviced by the Lyndhurst terminal. Table 41 indicates a reallocation of container movements to indicate the container spread aligned to terminal locations.

Table 41 Metropolitan region destinations based on available rail terminals

2009 PoMC areas	Metro trade share %
Inner	14 %
Outer Northern	18 %
Outer South East	34 %
Outer Western	33 %

8.5.1 Resulting rail task

Table 43 illustrate the train trips that would result if 10% and 20% of metropolitan containers were on rail using MIS trains for scenarios of 3.0 million or 6.0 million TEU through a port. The estimate assumes the 'area' split identified in Table 41 applies across the system.

Table 42 Indicative Metro rail trips per day at 3.0 million TEU

Total Port 3.0 M TEU Demand /Metro 87%								
Metro Region	Metro share 87 %		Rail @ 10%			Rail @ 20%		
	TEU ('000)	%	TEU ('000)	Trips pa @10%	Trips/ day	TEU ('000)	Trips pa @ 20%	Trips /day
Inner Melb	391.5	15	39	0	0	78.3	0	0
Outer North	469.8	18	47	691	2	93.96	1382	4
Outer SE	887.4	34	89	1305	4	177.48	2610	7
Outer West	861.3	33	86	1267	4	172.26	2533	7
Total	2610	100	261	3263	9	522	6525	19

Table 43 Indicative Metro rail trips per day at 6.0 million TEU

Total Port 6.0 M TEU Demand /Metro 87%								
Metro Region	Metro share 87%		Rail @ 10%			Rail @ 20%		
	TEU ('000)	%	TEU ('000)	Trips pa @10%	Trips/ day	TEU ('000)	Trips pa	Trips /day
Inner Melb	783	15	78.3	0	0	157	0	0
Outer North	939.6	18	93.96	1382	4	188	2764	8
Outer SE	1774.8	34	177.48	2610	7	355	5220	15
Outer West	1722.6	33	172.26	2533	7	345	5066	14
Total	5220	100	522	6525	19	1044	13050	37

Note - A train trip represents a one way journey and a train arriving and departing the port after unload and loading represents two trips.

8.6 Port of Melbourne rail access capacity

Rail access to the Port of Melbourne currently includes regional intermodal services, grain trains, some steel train operations, the transfer of some traffic from interstate services (from South Australia) and associated locomotive provisioning and maintenance movements. Increased demand from these services is seen to be reasonably limited, although the important links to agriculture will see seasonal impacts, which will result in variances of demand requiring additional capacity in some periods.

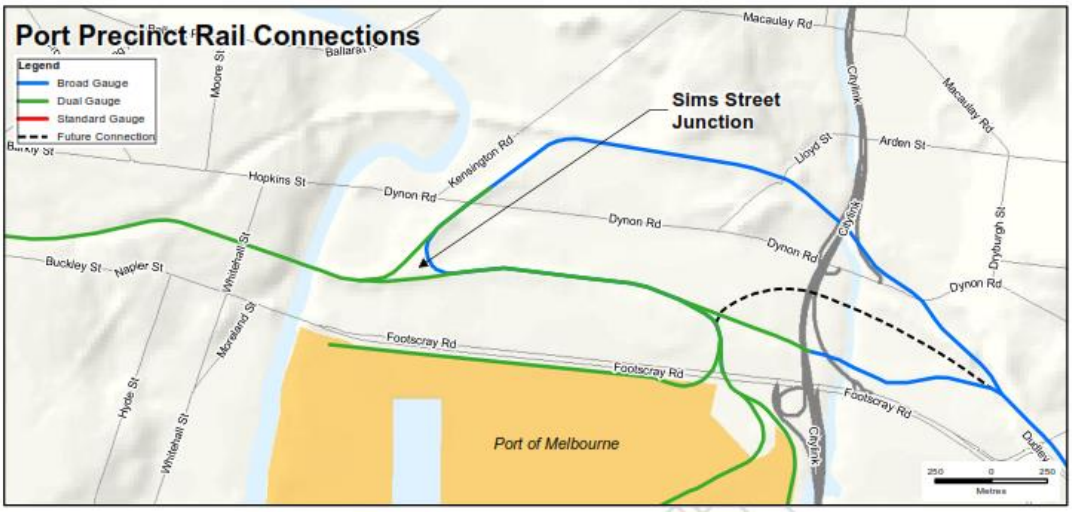
The implementation of Metropolitan Rail Port Shuttle Operations has been the subject of significant planning which includes consideration of additional network capacity enhancements which can be aligned to the demand trends as the system grows and interfaces with other rail demand drives a need for capacity enhancements and infrastructure development.

Rail infrastructure within the Port of Melbourne is exclusively dual gauge allowing flexibility to link back to the broad gauge local network and the growing scope of the standard gauge infrastructure interstate and within Victoria. The Port of Melbourne rail network access connects directly to the Australian Rail Track Corporation (ARTC) national network providing a two track dual gauge link which forms the key point of access for all movements. These tracks link westward through the Bunbury Street Tunnel to Tottenham, where the network splits away from

the local broad gauge network and operates as a single line standard gauge network north towards Sydney and south and west towards Perth. The Somerton Terminal is located on this northern link and the Altona terminal (and Laverton) is located on the western link. The Dynon rail terminal precincts adjacent to the port also connect to the ARTC network one kilometre from the port connections at Sim Street junction where interstate intermodal services, interstate and regional passenger trains, rail provisioning and maintenances movements also access the ARTC network.

Figure 30 and Figure 31 indicate port rail links within the port precinct and on the broader networks to the west. Eastern links (to Lyndhurst) are via a direct connection with the metropolitan rail network at South Kensington or North Melbourne. Connections to the local Broad gauge networks also branch north and east from the ARTC network dual gauge at the port access, Sim Street Junction and at Tottenham.

Figure 30 Rail access within the Port of Melbourne precinct



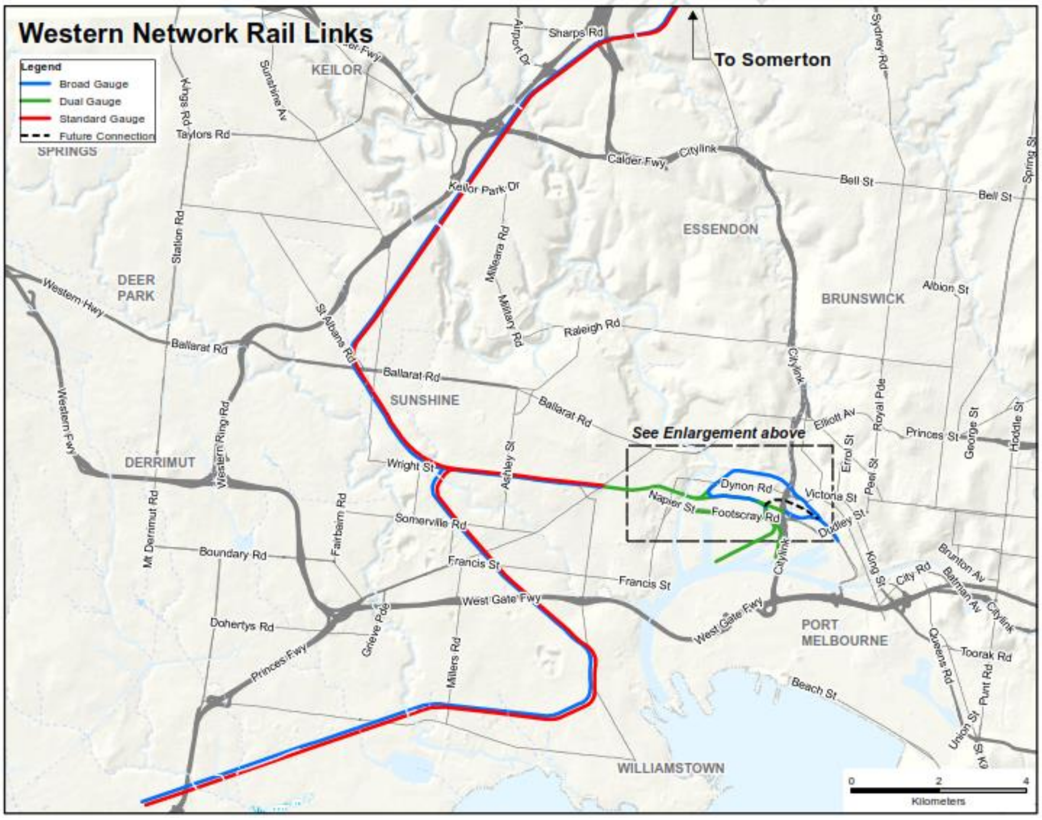


Figure 31 Western Melbourne rail network connections

8.6.1 Key issues impacting capacity

Key areas of impact issues for rail network capacity impacting Rail Port Shuttle traffic to the port are:

- at Sim St Junction (the Interface with Dynon rail terminals);
- connections with the broad gauge metropolitan network heading east towards Lyndhurst terminal; and
- the need for additional capacity (over time) on the single line sections of the ARTC network to Altona and Somerton.

As the Somerton and Laverton Terminals are the only terminals connected to the network at the current time there is no immediate driver for rail network managers to address capacity issues.

Current capacity exists for an indicative 200,000 TEU on the ARTC network (8-9 trips per day) with additional access and indicative capacity on the Dandenong rail corridor for a further 200,000 TEU (8 -9 Trips daily) based on off peak and overnight operations between existing services.

8.6.2 Standard gauge network

Assessment of demand expectations on the standard gauge network indicate increased demand in interstate freight and passenger train movements on the ARTC network are likely to impact capacity in the short to medium term, however general planning is in place to progressively address these issues. The network is generally sufficient with some available capacity currently existing on the main interstate corridors north and west of Tottenham Junction. However, the rail corridor between Tottenham and the Dynon precinct is more heavily utilised and is approaching its capacity threshold. There is some capacity to facilitate additional port shuttles at present subject to timetabling in appropriate off peak periods.

A number of options for network development are under investigation by ARTC to address medium to longer term capacity in the vicinity of the Dynon precinct This includes the development of additional holding sidings at Tottenham Yard to facilitate the make up and break down of 1800 m long interstate trains to shorter lengths for handling within the Dynon terminals.. The holding sidings would remove the current practice of interstate train configuration on the main line and within the Sim Street Junction for extended periods, releasing capacity for additional movements between Tottenham, Dynon terminals and the port in peak operating periods.

This change would likely create additional train paths for Rail Port Shuttles and other services up to 20 % mode share (approximately 14 trips) within approximately a 2025 timeframe (approx. 300,000 TEU on SG)

ARTC is also currently developing the inland rail link from Brisbane to Melbourne on the national network, planned for implementation in approximately 2025. Demand for longer distance services on this new north south corridor and increased east west volumes from Perth are anticipated on the ARTC network over time. Further network developments are planned to address this increased demand with the proposed development Western Intermodal Freight Terminal (WIFT) in Truganina in the late 2020s or early 2030s,, further releasing capacity in the Sim St and Dynon area network. Commercial alignment of demand expectations and infrastructure development will be critical to WIFT timing and well as staged withdrawl of interstate services (and support functions) from the Dynon precinct

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Assuming WIFT implementation, the number of services impacting the area east of Tottenham junction will be significantly reduced opening capacity for Port shuttles and the reuse of holding sidings at Tottenham for port shuttles or other uses..

In the longer term additional, capacity is likely to be required on the single line sections of the ARTC interstate network, north between Tottenham and Somerton and south west between Tottenham and Altona for rail port shuttles, however these requirements would be driven by a broader demand of which Rail Port Shuttles are one element. Interstate services and increased passenger demand is also likely to impact these areas Line sections from Albion to Jacana (connecting to Somerton) and Tottenham to Newport on the standard gauge can also be upgraded or duplicated to increase capacity to meet demand in these areas.

Based on total demand planning for new services, and relevant upgrades, a capability for Port shuttle trains on the ARTC network with a 20% rail mode share would move from approximately 14 train trips daily in 2025 (5 to Somerton, 9 To Altona) to 22 trips in 2042 (8 to Somerton, 14 to Altona). Progressive network enhancement will be required, aligned to broader interstate and regional growth to meet demand requirements. Effectively moving from a port shuttle capacity of 320,000 TEU to 520,000 TEU on the ARTC network. **Effectively moving from a port shuttle capacity of 320,000 TEU to 520,000 TEU on the ARTC network**.

8.6.3 Broad gauge network

Access from the port to the broad gauge network to the east links through Sim St Junction, and via a direct link to the North Melbourne area and a bypass track beside Southern Cross station. Metropolitan train control manages the network outside the port and rail freight precincts and access for freight movements is between Metropolitan and regional passenger services. Access is provided via the city rail viaducts, through Flinders street station and links to Lyndhurst via the Dandenong Rail Corridor. Peak periods from 6:45 to 9:00 am and 3:45 to 7:30 pm are essentially out of scope due to peak passenger demand, however headways between trains services fall from 3-4 minutes during peak to 20-30 minutes in the off peak allowing capacity for existing regional passenger trains, existing freight services and maintenance trains on the network.

Existing freight trains operate on schedules that fit within passenger train timetables during periods with twenty minute train headways. Based on appropriate performance capabilities of Rail Port Shuttles, utilising non-peak periods there are up to 12 hours daily where there is a potential for at least two train paths available and a further 4 hours overnight where addition access paths can be obtained subject to maintenance and intermediate services. Assuming only part of this potential availability a capacity of approximately 300,000 TEU (8-9 Rail port shuttles could access the network on weekdays with additional services of 12-14 trips on weekends).

Theoretically, there are additional train paths, however integration with existing metropolitan and regional passenger timetables and current freight and maintenance train operations need to be aligned with the operational fit of port shuttle container transfer cycles and entry/exit from the networks avoiding peak periods.

There are also a number of changes being developed on the Dandenong rail corridor including Level Crossing Removals (2016-19), Melbourne Metro development (current to 2025) and an upgrade to higher capacity signalling where not all of the demand, capacity and interface issues are yet clear.

The is potential within the proposed projects for increased access capacity between Flinders Street and South Yarra as a result of Melbourne Metro implementation in 2025 and the realignment of Dandenong services via the new rail underground alignments, however specific capacity beyond South Yarra is not clear. Improved links closer to Port are also planned and can increase flexibility and access capacity within the port precincts.

Allowing for retention of existing capacity scope and some increased flexibility after 2025 a Rail Port Shuttle capacity of at least 350,000 TEU (approximately 10 trips per weekday day linked with other integrated services and additional services at weekends) could be provided. This would cater for a 20 % mode share for rail shuttles to Lyndhurst through the 2030 timeframe however; limitations beyond this capacity may be impacted by other corridor service developments resulting in a capacity ceiling until significant corridor upgrade changes are implemented. As a result a rail mode share of a 6.0 M TEU port at approximately 2042 may reduce to a limited capacity less than 20%.

Further detailed study may provide further available capacity on the Dandenong corridor, however this will require detailed alignment with metro service planning areas and projects, including the alignment with future planned schedules affecting the corridor. Where existing capacity is reached with a two track railway, there is a need for substantial major works to include a new additional rail line, impacting all tracks on the Dandenong Corridor, a high capital investment and a significant disruption factor for all train services on the corridor. The implementation of this option for rail shuttle traffic alone may be constrained.

The Broad gauge network also has capability to link to the Somerton terminal (which is dual gauge) providing links over ARTC network dual gauge tracks from the Port of Melbourne to Tottenham and Albion to Jacana however this access would also interface with metropolitan passenger services on the Sunbury line and the Broadmeadows/Craigieburn lines. Alignment of service planning with multi network links may be difficult, however some additional capacity may be achieved overnight. It is likely that a standard gauge approach to Somerton connection is preferred.

8.6.4 Overall port shuttle capability

The potential capacity developments on both the Standard gauge and Broad gauge networks are subject to major infrastructure projects over the short to medium term with potential changes providing both gains and constraints on capacity as other projects are implemented. While planning for capacity enhancement is in place, the timing and implementation of changes will be demand driven by a range of projects including rail port shuttles.

Based on available information and anticipated developments Port of Melbourne Port Shuttle Rail Capacity is likely to move from an estimated 450-500,000 TEU pa at the current time to a scope of capacity of approximately 850 – 900,000 TEU with relevant network enhancements to 2042.

Enhancements required include:

- Additional SG sidings at Tottenham (release capacity in Sim St)
- Progressive duplication /dual gauging of second tracks Albion to Jacana and Tottenham to Newport.
- WIFT connection and development
- Melbourne metro development
- Eastern Freight track connection to the port
- Higher capacity signalling on the Dandenong rail corridor (freight inclusion

8.7 Rail capacity enhancement at Swanson Dock

8.7.1 Capacity enhancement mechanism

The use of rail benefits capacity in any of the following ways:

1. A reduction in truck movements to/from the port that may prolong the time until road capacity is reached and reduce the number of containers that are caught up in road congestion.
2. To reduce import container dwell periods, as import containers can be transferred directly to an on-dock rail facility from the quayside. This avoids them having to be stacked in the main yard. In this scenario, additional yard equipment may be required to ensure yard equipment can match STSC productivity.
3. To reduce import container dwell periods as a consequence of import containers being transferred to an on-dock rail facility via the main yard but within a time period that is less than current yard dwell periods for imports. i.e. import dwell periods within the main yard being less than 0.5 days, potentially in temporary holding stacks.
4. A reduction in export container dwell period as a consequence of export containers being transferred to the yard via the MIRT to a ‘just in Time’ schedule that reduces average export container dwell periods in the main yard. i.e. export dwell periods being less than 3.0 days.

This section focusses on the benefits a rail facility provides to yard capacity through reduction in dwell period.

Figure 32 illustrates how the MIRT transfer options benefit container dwell periods and container transits through the terminal.

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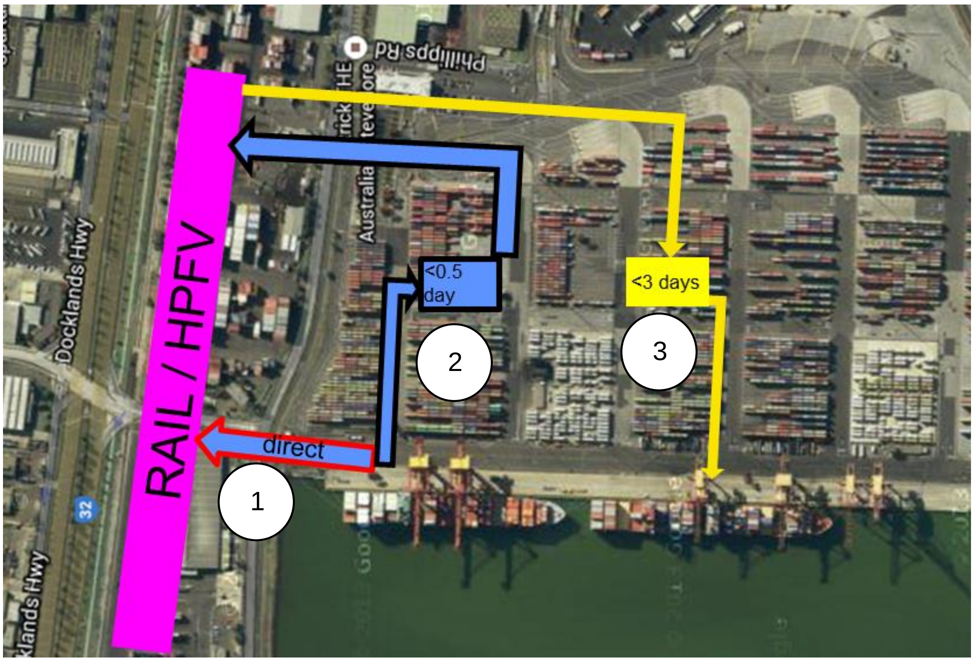

Figure 32 – Yard – MIRT container transfer options

8.7.2 Swanson scenario testing

The capacity enhancement analysis has considered the following rail terminal throughput scenarios.

Four scenarios are adopted to align with an envisaged development in rail network capacity up to a future maximum of 1.6 M TEU. The capacity steps align with the initial network capacity findings outlined in Section 8.6. The rail throughput scenarios include:

a. 400,000 TEU

b. 800,000 TEU

c. 1,200,000 TEU

d. 1,600,000 TEU

8.7.3 Container dwell time reduction estimate

Table 44 shows the estimated dwell time reductions that would result from use of an on-dock rail terminal for the four rail throughput volume scenarios.

The results suggest dwell time reductions of around 0.5 days could be achieved with the use of the envisaged capacity MIS shuttles (800,000 TEU), and up to 1 day, if the network capacity was increased to 1.6 m TEU.

Table 44 Effective dwell time reductions for each of the on-dock rail volume throughput scenarios at Swanson Dock

Rail terminal TEU volume	SDW – Avg dwell (days)	SDW - Dwell reduction (days)	SDE – Avg dwell (days)	SDE - Dwell reduction (days)
As is	2.9	-	2.9	-
400,000	2.59	0.31	2.63	0.27
800,000	2.34	0.56	2.40	0.5
1,200,000	2.13	0.77	2.21	0.69
1,600,000	1.96	0.94	2.05	0.85

8.7.4 Swanson capacity enhancement estimate from on-dock rail

Table 45 shows the capacity enhancement that is estimated for ‘0.5 day’ and ‘1.0 dwell ‘time reduction scenarios against the previous yard capacity enhancement scenarios.

As a reminder, the following five yard capacity enhancement scenarios considered are:

a. The implications of the basin widening considered in the berth capacity scenarios.

b. The expansion of the current yard system (straddle carriers) to the full leased area.

c. The use of a Rubber Tyred Gantry (RTG) based system on the existing yard areas of both SDE and SDW. RTG systems can offer storage density increases over straddle systems of in excess of 20%.

d. The use of existing yard areas for an RTG based system on SDW and an ASC based system on SDE. An ASC system has marginal storage density improvements over RTG systems with the added benefit of automation.

e. Scenario (d) across the full lease area(s).

Table 45 Effective yard capacity enhancement arising from dwell time reductions of 0.5 day and 1.0 day through SDW and SDE (M TEU)

System	No change	0.5 day dwell reduction	1.0 day dwell reduction	% increase on ‘as is’ with 0.5 day	% increase on ‘as is’ with 1.0 day
SC (as is)	3.0	3.6	4.6	21%	53%
Widened basin	2.7	3.2	4.0	9%	37%

RTG	4.0	4.8	6.0	70%	102%
RTG/ASC	4.3	4.8	5.7	62%	90%
Expanded SC system	4.9	5.9	7.5	98%	150%
Expanded RTG/ASC	11.1	13.5	17.0	350%	469%

The results suggest:

- If a 0.5 day dwell can be achieved, yard capacity increases of between 9% and 350% could theoretically be achieved.
- If a 1.0 day dwell can be achieved, yard capacity increases of between 37% and 470% could theoretically be achieved.
- The 'as is' Straddle Carrier system could potentially be lifted to 4.6 M TEU capacity with a 1.0 day improvement on dwell and 3.6 M TEU capacity (annually) with a 0.5 day improvement.
- The estimated yard capacity arising from rail operations in conjunction with existing operations (Straddle Carriers) is comparable to the capacity estimates for alternative RTG / ASC scenarios without rail considered in Section 5.3.1.
- The use of on-dock rail is complimentary to existing terminal operations at Swanson Dock, and an on-dock rail facility could be developed, with less impact on existing yard capacity or operations that a complete overhaul of terminal system.

8.8 Rail capacity enhancement options at Webb Dock

8.8.1 Background

Similar capacity enhancement benefits could be achieved at Webb Dock if rail were connected and network capacity was available.

Two different scenarios have been considered in the provision of rail capacity to Webb Dock:

- A Victorian Government investigation assessing a rail or road capacity enhancement through construction of a dedicated Freight Link
- A Port of Melbourne option of a part elevated development along the existing Webb Dock Rail Reserve

Both options would require a new bridge across the Yarra river west of the Bolte Bridge

8.8.2 Freight rail/road link

The development of a Freight rail (and road) link between the Swanson and Webb precincts has been investigated for the Victorian Government providing the option of a road or rail connection to increase capacity for access and movements from the Webb Dock back to the Swanson precinct and Footscray Road area.

The study identified the link would require an additional bridge across the Yarra river and at least a partially elevated structure between Port Melbourne and across the West Gate Freeway to the Webb precinct (as indicated in Figure 24).

Rail access capacity in the network will also be a factor in its implementation, as the link will bring trains back through the Swanson precinct from where available capacity to date would be taken up with a share of the Swanson terminal throughput. In this regard, and without a major

network capacity improvement, rail infrastructure at the Port of Melbourne is only likely to benefit Swanson or Webb Dock individually.

8.8.3 Development on the existing Webb Dock rail reserve

As an alternative to the alignment presented in Figure 24, there is an option that considers the use of the existing Webb Dock Rail Reserve. This borders the port of Melbourne South Wharf area (alongside Lorimer St), Todd Road and a separate corridor south of Wharf Road to Webb Dock. This alignment would comprise an elevated section of track from the Yarra River to Wharf road and would operate with dedicated rail services back to the general rail network.

As a dedicated corridor this connection could provide additional rail mode share capacity of approximately 850,000 to 1.1.M TEU with relevant terminal access and capacity in the Webb dock area, however it is noted that this network connection under Footscray Road would share the same access as all rail movements to the Swanson precinct. The available network capacity from this point remains limited to that indicated in section 8.6. This connection will potentially limits rail access for trains from the Swanson and Webb precincts with competition for access. Priorities would need to be established prior to investment or additional capacity development would be required within the general freight network.

8.8.4 On-dock rail terminal development at Webb Dock

The positioning of a rail terminal at the Webb dock site has to date, been planned for the north of the precinct. This is based on other developments which may occur on the site prior to the timing of a rail link and terminal development and that the arrangement of VICT is unable accommodate a rail terminal.

The location of a rail terminal to the north would be some distance from VICT, and it is likely that such a location would best suit future terminal development at either WDW or in the northern areas of WDE (Bass Strait). This would reduce the container transfer distances undertaken by terminal equipment.

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Figure 33 Potential rail transfer location from Webb Dock

8.9 Equipment needs for the MIRT

Equipment options for the transfer of containers to and from a container yard to an-dock rail terminal include:

- Straddle carriers.
- Independent transfer vehicles (ITV's).
- Automated vehicles (AGV's / Autostrads etc.).

The use of Straddle Carriers aligns well with existing systems of operation at Swanson, while Autostraddles would be expected to align well with operations at Webb Dock.

Equipment options for the transfer of containers to and from the rail wagons include:

- Reach stackers (RS), and
- Cantilever Rail Mounted Gantry Cranes (CRMG's).

Reach stackers are considered appropriate for lower volume solutions and where transport distances are minimal (<200,000 TEU).

CRMG's are better suited for higher volume solutions, and where multiple trains are located side by side, as indicated in Figure 34. The benefits of CRMG's are that they can be configured to service both rail and truck systems of operation in a mix of arrangements.

A selection of possible arrangements that could be considered for an on-dock rail facility are presented in Figure 34. These provide flexibility for low and high volumes and integrated road and rail loading and unloading.

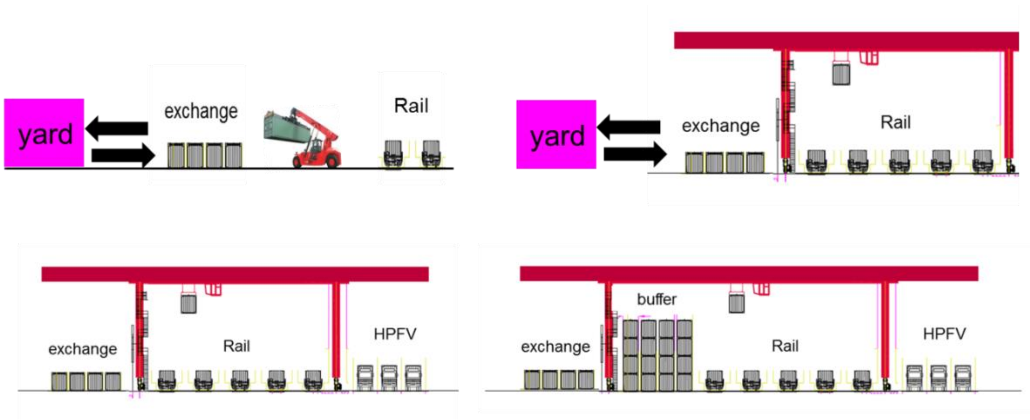

Figure 34 – On-dock container rail loading / unloading options

8.10 Conclusions on capacity enhancement from on-dock rail

- A rail capacity of up to 950,000 TEU per annum exists currently.
- The use of rail within available capacity can provide increased capacity in the terminal areas as a consequence if the reduction in container dwell time through the yard.
- A key element of the metropolitan terminal model is the positioning of empty containers across a broader spread of locations than the existing situation. Provision of just in time return to the port for ship loading from these terminals can also support reduced dwell time outcomes.
- The overall rail network capacity remains constant whether it is applied at Swanson or Webb Dock.
- An on-dock rail facility could be added at Swanson Dock at low capital cost and with minimal impact on existing yard capacity – i.e. no need to conduct expensive / disruptive overhaul of yard areas to provide infrastructure for alternative yard systems.
- The development of rail capacity at Webb dock will be linked to the decision to invest in a dedicated freight link. This item was identified in Figure 24 (Sec. 7.4.3) and is discussed further in Section 10.5. A key consideration is the very high capital cost (up to $3.4bn).
- An on-dock rail facility at Swanson can provide an increase to yard capacity at Swanson Dock that is comparable to the maximum berth capacity estimate for the existing terminals (assuming limited development of the berth i.e. 3 extra STSC are installed).
- The yard equipment that is currently in use at both SDW and SDE can be used to perform the transfer of containers to an on-dock rail facility at Swanson Dock.
- Flexibility exists for the choice in equipment and final layout. The rail facility could be configured to service both rail and HPFV's. This has the potential benefit of unlocking the HPFV constraints that exist at SDW currently.
- An ondock rail facility could theoretically be used in combination with alternative yard systems of operation. If combined with a RTG / ASC combination systems discussed previously, the maximum yard capacity at Swanson Dock could theoretically be lifted to around 6 M TEU.

8.10.1 Cost estimates

An on-dock rail facility is estimated at around $70M, excluding rail connection or network track upgrades.

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9. Shipping & Channel Capacity

9.1 Potential future container ship sizes and number of port calls

9.1.1 Introduction

This section looks towards the long-term future in terms of the possible scenarios of container ship size development given forecast trade growth, some shipping line consolidations, and the Port of Melbourne with constrained and unconstrained ship access. Given economies of scale of larger ships, and sufficient trade volumes, container ship sizes will tend to increase until an infrastructure constraint is reached as is currently the case with the Port of Melbourne. The typical way to increase shipping supply with a ship size constraint at a port is to add more shipping services, which results in more ship calls at a port. Shipping line and market share consolidation tends to accelerate container ship size increases as more container volumes are available to fill larger ships over and above underlying trade growth.

The range and timing of the various possible future containership sizes serving Victoria (the Port of Melbourne) and the resulting number of ship calls has been modelled using several Fleet Spectrum Scenarios to cover the range of ship size development possibilities (see Table 46 below).

It should be noted that the capacity assessment in Section 10 references the 'constrained' scenario 2 and the 'unconstrained' scenario 4.

Table 46 Range of fleet spectrum scenarios used for ship size modelling

Fleet Spectrum Scenario	Containership Size Growth	Containership Port Access Constraints	Use of Swanson Dock Capacity	Use of Webb Dock Capacity
1 – Less Rapid Ship Size Growth / Unconstrained Ship Access	Organic Trade Growth Only (No Service Consolidations)	Unconstrained up to maximum 18,500 TEU ship size	Not applicable	Not applicable
2 – Less Rapid Ship Size Growth/ Constrained Ship Access/ Equal Dock Capacity Use	Organic Trade Growth Only (No Service Consolidations)	Constrained: (1) Swanson Dock max. 7,500 TEU ship size, (2) Webb Dock & Heads max. 14,000 TEU ship size	Full use of available capacity (i.e. Asia Services remain) with no Large Ship migration to Webb Dock	Equal use of available capacity to Swanson Dock
3 – Rapid Ship Size Growth / Unconstrained Ship Access	Organic Trade Growth Only + Capped Service Consolidations on Asia trades*	Unconstrained up to maximum 18,500 TEU ship size	Not applicable	Not applicable
4 – Rapid Ship Size Growth / Constrained Ship Access / All Large Ships to Webb	Organic Trade Growth Only + Capped Service Consolidations on Asia trades*	Constrained: (1) Swanson Dock max. 7,500 TEU ship size, (2) Webb Dock & Heads max. 14,000 TEU ship size	Only services with ships <7,500 TEU call at Swanson (i.e. smaller, non-Asia trades) resulting in redundant capacity	All services with ships >7,500 TEU call at Webb (i.e. Asia trade) and capacity increased to match demand

(*) Assumed to be two services consolidated every five years on Australia / N&E Asia and Australia / SE Asia trades with capped resulting market share per service of around 33% for assumed regulatory competition approval, plus an assumed market service-level requirement on N&E Asia trade of minimum 6 services to cover long port range.

The ‘bookends’ of the future Fleet calling at the Port of Melbourne (i.e. which have the potential largest impacts on capacity use at Swanson and Webb Dock) are defined in Fleet Spectrum Scenario 2 and Fleet Spectrum Scenario 4 (see Table 46).

To generate the various Fleet Spectrum forecast for the Port of Melbourne, further assumptions were incorporated in modelling the potential future size of container ships, and number of calls:

- Use of the Central container trade forecast (imports and exports, and by region) for Victorian ports over the period 2016 to 2065 as produced by Deloitte for the IV study which produced a forecast of 10.8 million TEU throughput by 2066
- International, transhipment and mainland coastal container imports and exports continuing to be handled by international container ship services at the Port of Melbourne’s Swanson Dock and as of January 2017 also at Webb Dock
- Bass Strait container trade is split into two parts – one ‘freight-only’ part handled by two container roll-on / roll-off services at the Port of Melbourne, and a second (lesser) part handled by the Tasmanian passenger ferry service at Station Pier. The part of the Bass Strait trade carried by the Tasmanian passenger ferry service is considered out of scope for the container capacity assessment of the Port of Melbourne which focuses on Swanson Dock and Webb Dock (including possible expansions). Consequently, the Tasmanian passenger ferry port calls are considered as non-container ship visits for the channel capacity analysis
- Container shipping lines will continue to operate the same type of weekly direct, multi-port calling services on the same overseas shipping routes for the Australian trades (which includes Victoria) based on the head-haul trade direction of a shipping route determining overall shipping supply capacity
- The current (Nov. 2016) container ship sizes deployed on the respective international shipping routes to/from Australia, and also the Bass Strait freight-only trade route, together with the number of services per shipping route and frequencies of services, are the starting points of the forecasts of future container ship sizes and number of ship visits
- The optimum economic response for shipping lines to an increase in international trade, market share or consolidation of services on a shipping route is to increase ship size with the required ships able to be sourced from the future global shipping fleet (or through dedicated new-buildings) until a port access constraint caps ship size with the resulting response to increased container volumes being to either upgrade a less-than-weekly calling frequency to weekly, or adding an extra weekly service with total service capacity matched to the required demand.

9.1.2 Fleet Spectrum Scenario 1 - Potential future container ship sizes with unconstrained port access and less rapid ship size growth

Based on the assumptions used in the analysis, the **average** size of international container ships that may possibly visit Victoria in the Fleet Spectrum Scenario 1 (unconstrained port access / less rapid ship growth) is estimated to increase from a current 4,035 TEU to 7,197 TEU by 2036 and 13,970 TEU by 2066 (see Table 47).

The **maximum** size of international containerships is estimated to increase from a current 5,779 TEU to 9,423 TEU by 2036 and 18,500 TEU by 2066 driven by the Asian shipping routes (see Table 47 and Figure 35). The smaller international vessels are assumed to be deployed on the North America and Oceania (NZ/South Pacific) shipping routes.

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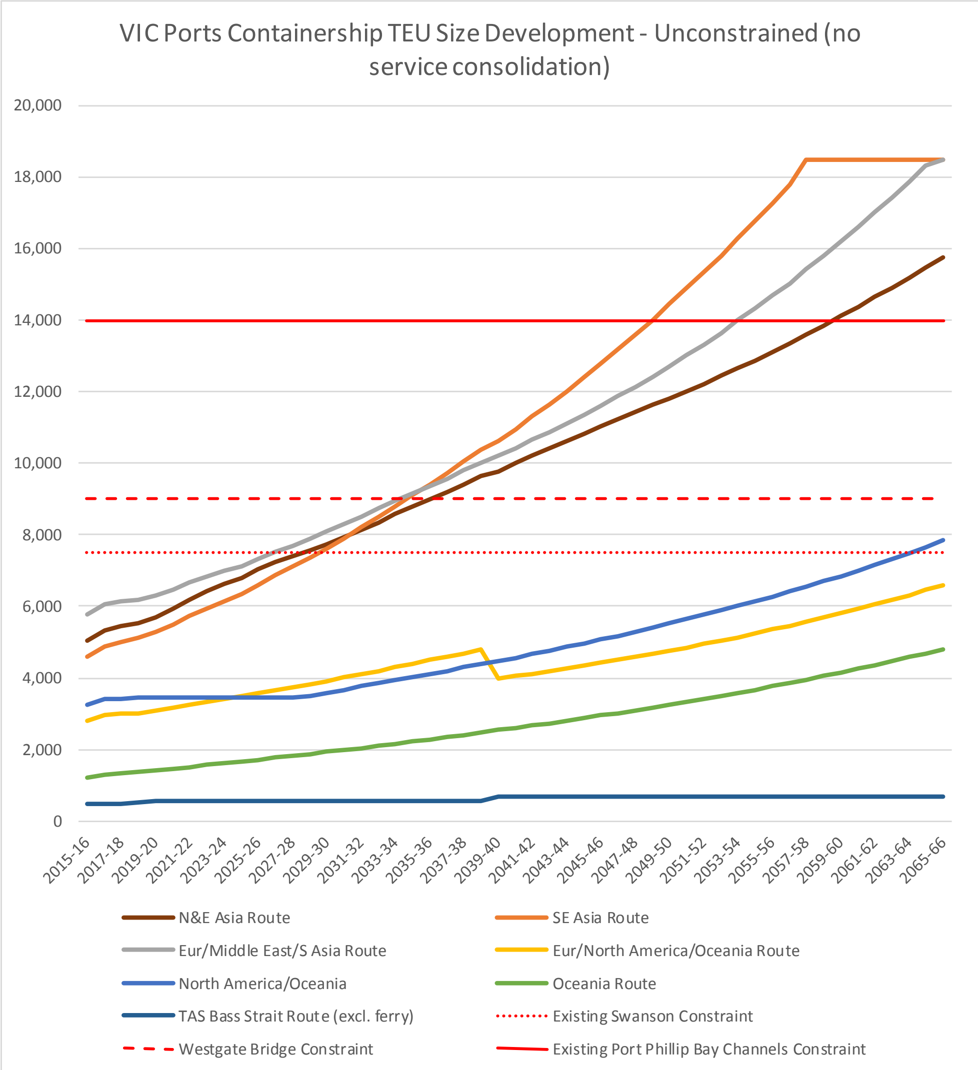

Figure 35 Fleet spectrum scenario 1 - Containership size development by shipping route, Source: GHD analysis, 2016

Table 47 Fleet spectrum scenario 1 - Summary of potential future international average and maximum container ship sizes calling Victoria, 2016-2066, Source: GHD analysis, 2016

FY End	Unconstrained Average Ship TEU Size	Unconstrained Maximum Ship TEU Size
2015-16	4,035	5,779
2020-21	4,666	6,454
2025-26	5,436	7,323
2030-31	6,253	8,306
2035-36	7,197	9,423
2040-41	8,035	10,965
2045-46	9,069	12,791
2050-51	10,204	14,895
2055-56	11,482	17,287
2060-61	12,803	18,500
2065-66	13,970	18,500

The Fleet Spectrum Scenario 1 with unconstrained ship access generates estimated total ship calls (incl. Bass Strait freight-only container ro-ro ships) of 1,755 as of 2016, 1,782 by 2036, and 1,964 by 2066 – see Figure 36 for breakdown of forecast ship calls by ship size classes.

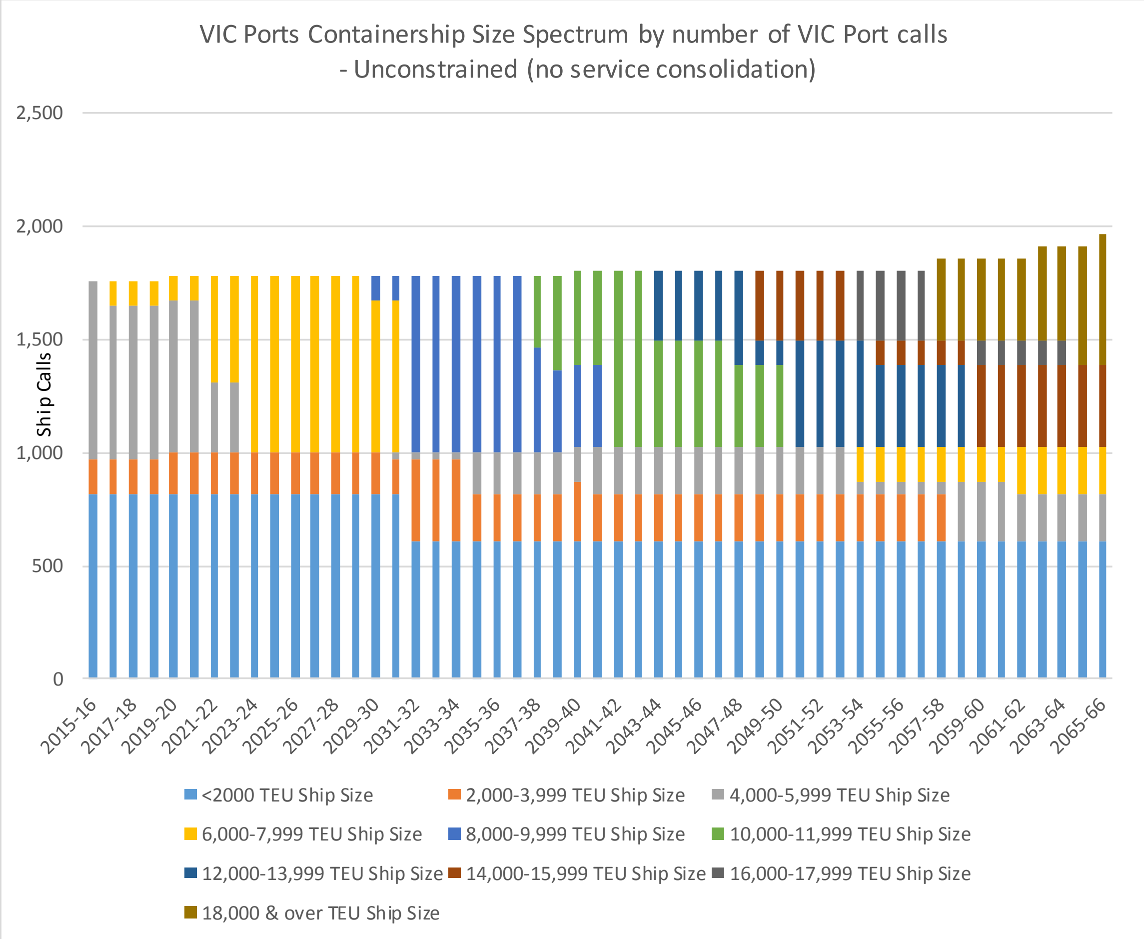

Figure 36 Fleet scenario 1 – Containership calls by ship size classes, 2016-2066, Source: GHD analysis, 2016.

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9.1.4 Fleet spectrum scenario 2 - Potential future container ship sizes with constrained port access and less rapid ship size growth

Based on the assumptions used in the analysis, the **average** size of international container ships that may possibly visit Victoria in the Fleet Spectrum Scenario 2 (constrained port access / less rapid ship growth / equal Dock capacity use) is estimated to increase from a current 4,035 TEU to 6,993 TEU by 2036 and 10,062 TEU by 2066 (see Table 48).

The **maximum** size of international containerships is estimated to increase from a current 5,779 TEU to 12,900 TEU by 2036 and 13,900 TEU by 2066 driven by the Asian shipping routes (see Table 48 and Figure 37). The smaller international vessels are assumed to be deployed on the North America and Oceania (NZ/South Pacific) shipping routes.

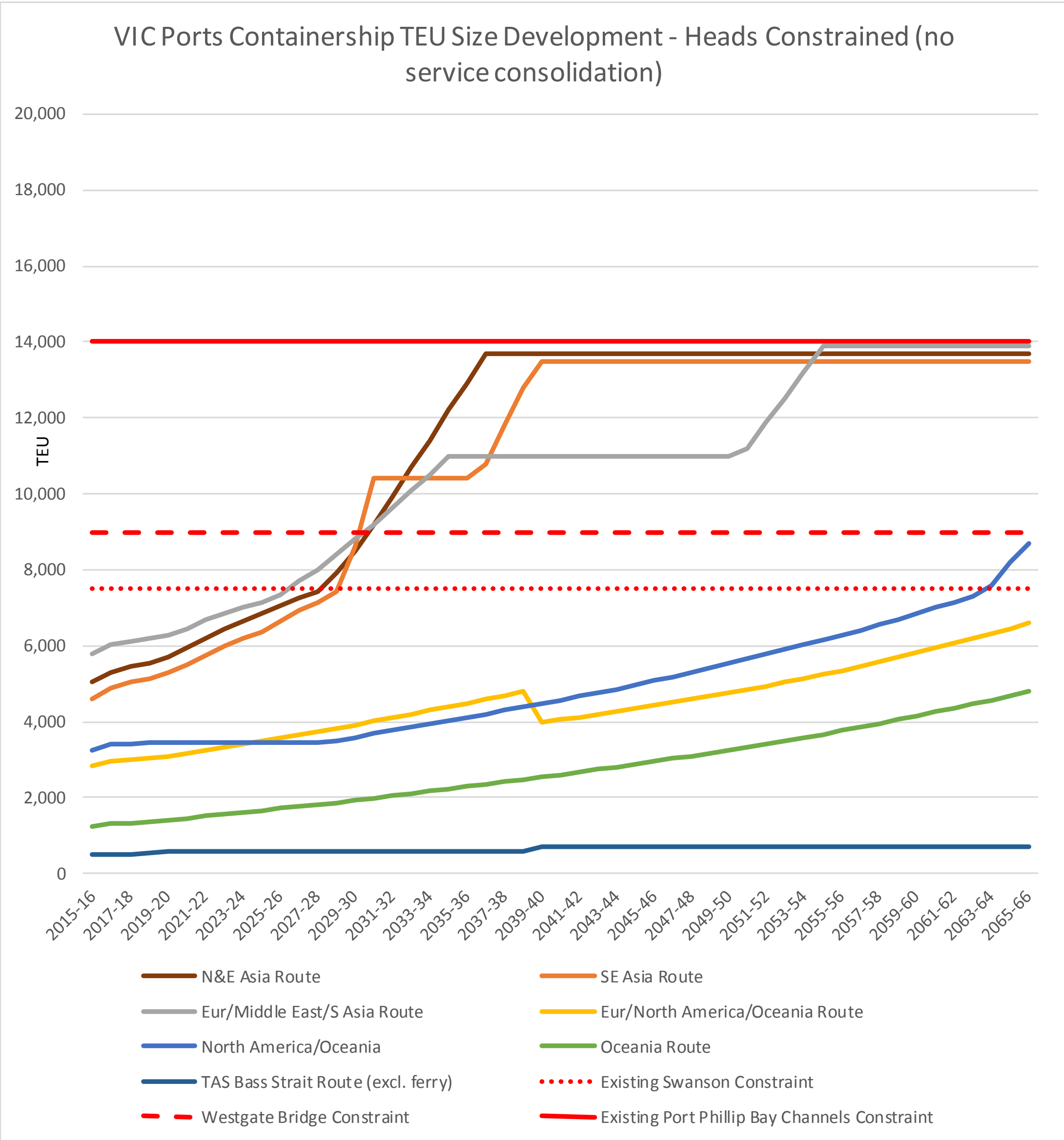

Figure 37 Fleet spectrum scenario 2 - Containership size development by shipping route, Source: GHD analysis, 2016

Table 48 Fleet spectrum scenario 2 - Summary of potential future international average and maximum container ship sizes calling Victoria, 2016-2066, Source: GHD analysis, 2016

FY End	Constrained Average Ship TEU Size	Constrained Maximum Ship TEU Size
2015-16	4,035	5,779
2020-21	4,669	6,460
2025-26	5,441	7,341
2030-31	6,287	10,400
2035-36	6,993	12,900
2040-41	7,806	13,700
2045-46	7,927	13,700
2050-51	8,452	13,700
2055-56	8,951	13,900
2060-61	9,363	13,900
2065-66	10,062	13,900

The Fleet Spectrum Scenario 2 with constrained ship access generates estimated total ship calls (incl. Bass Strait freight-only container ro-ro ships) of 1,755 as of 2016, 1,886 by 2036, and 2,642 by 2066 – see Figure 38 for breakdown of forecast ship calls by ship size classes.

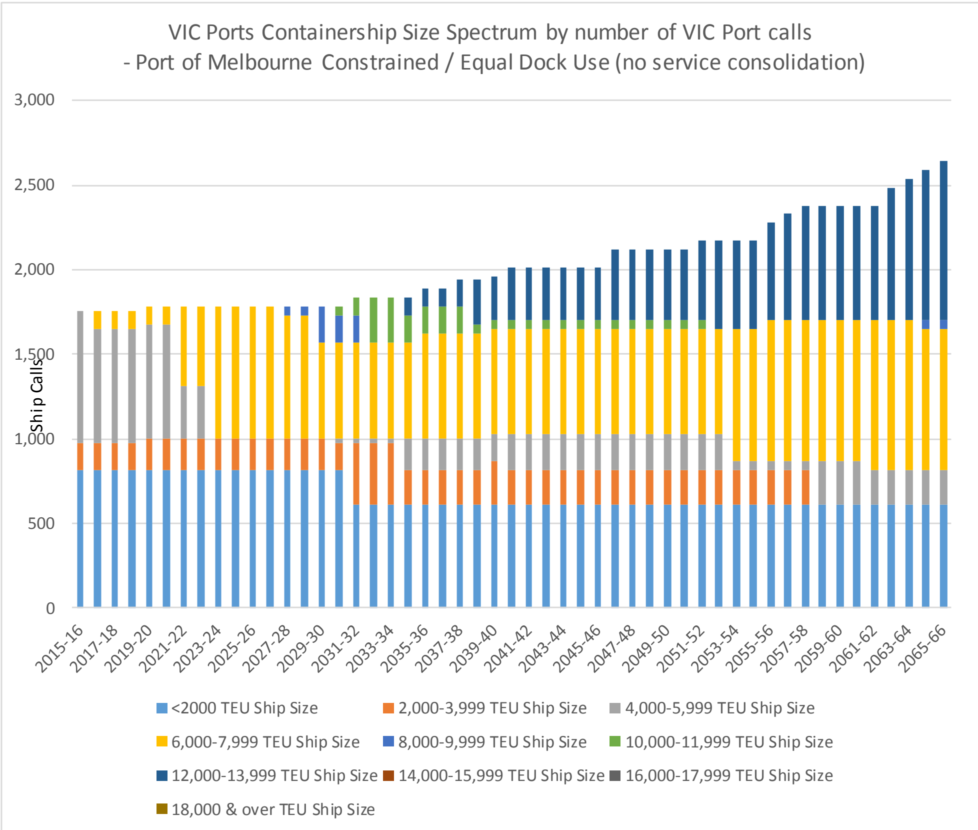

Figure 38 Fleet scenario 2 – Containership calls by ship size classes, 2016-2066, Source: GHD analysis, 2016

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9.1.5 Fleet spectrum scenario 3 - Potential future container ship sizes with unconstrained port access and rapid ship size growth

Based on the assumptions used in the analysis, the **average** size of international container ships that may possibly visit Victoria in the Fleet Spectrum Scenario 3 (unconstrained port access / rapid ship size growth) is estimated to increase from a current 4,035 TEU to 9,200 TEU by 2036 and 14,529 TEU by 2066 (see Table 49).

The **maximum** size of international containerships is estimated to increase from a current 5,779 TEU to 18,500 TEU by 2036 and continuing at 18,500 TEU to 2066 driven by the Asian shipping routes (see Table 49 and Figure 39). The smaller international vessels are assumed to be deployed on the North America and Oceania (NZ/South Pacific) shipping routes.

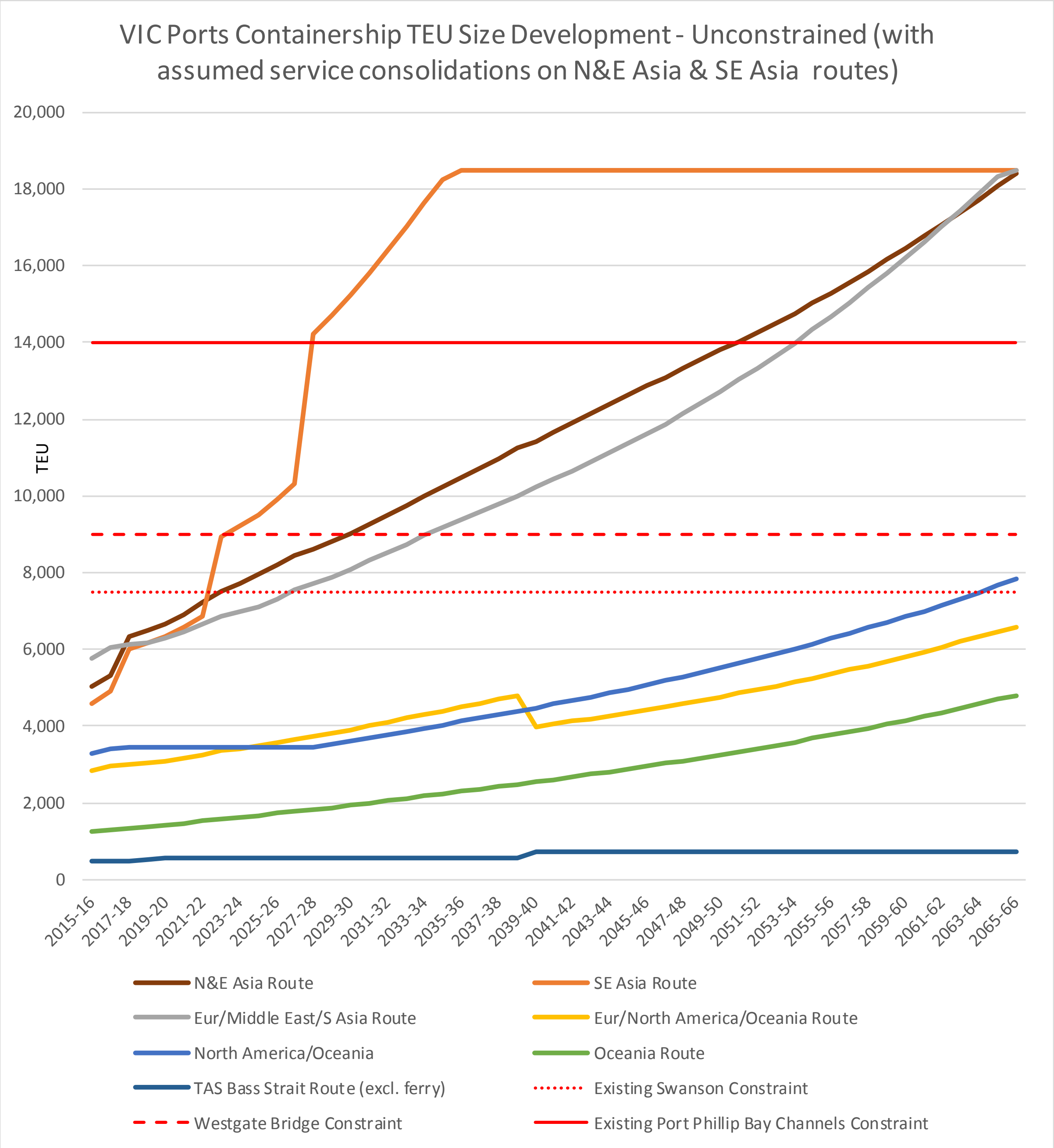

Figure 39 Fleet spectrum scenario 3 - Containership size development by shipping route, Source: GHD analysis, 2016

Table 49 Fleet spectrum scenario 3 - Summary of potential future international average and maximum container ship sizes calling Victoria, 2016-2066, Source: GHD analysis, 2016

FY End	Unconstrained Average Ship TEU Size	Unconstrained Maximum Ship TEU Size
2015-16	4,035	5,779
2020-21	5,122	6,912
2025-26	6,272	9,895
2030-31	7,605	15,826
2035-36	9,200	18,500
2040-41	9,650	18,500
2045-46	10,683	18,500
2050-51	11,325	18,500
2055-56	12,335	18,500
2060-61	13,360	18,500
2065-66	14,529	18,500

The Fleet Spectrum Scenario 3 with unconstrained ship access generates estimated total ship calls (incl. Bass Strait freight-only container ro-ro ships) of 1,755 as of 2016, 1,625 by 2036, and 1,912 by 2066 – see Figure 40 for breakdown of forecast ship calls by ship size classes.

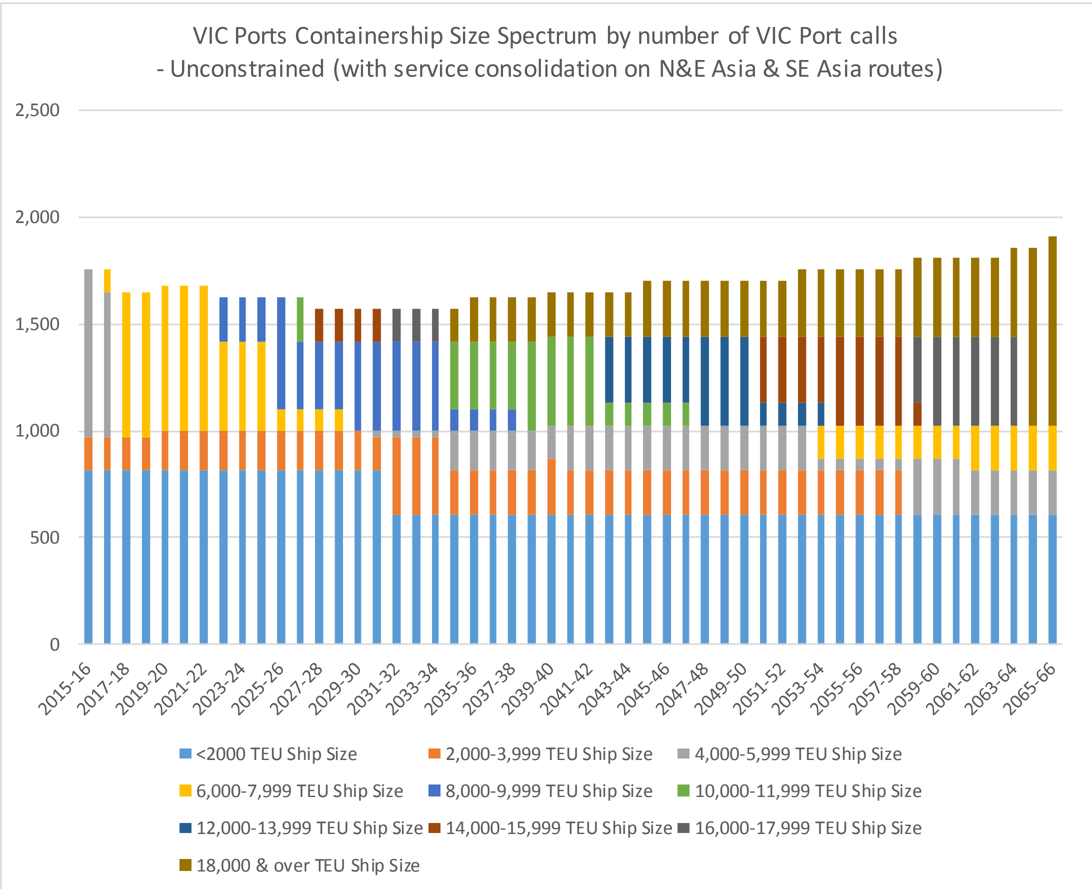

Figure 40 Fleet scenario 3 – Containership calls by ship size classes, 2016-2066, Source: GHD analysis, 2016

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9.1.6 Fleet spectrum scenario 4 - Potential future container ship sizes with constrained port access and rapid ship size growth

Based on the assumptions used in the analysis, the **average** size of international container ships that may possibly visit Victoria in the Fleet Spectrum Scenario 4 (constrained port access / rapid ship growth) is estimated to increase from a current 4,035 TEU to 8,556 TEU by 2036 and 11,838 TEU by 2066 (see Table 50).

The **maximum** size of international containerships is estimated to increase from a current 5,779 TEU to 14,000 TEU by 2036 and continuing at 14,000 TEU to 2066 driven by the Asian shipping routes (see Table 50 and Figure 41). The smaller international vessels are assumed to be deployed on the North America and Oceania (NZ/South Pacific) shipping routes.

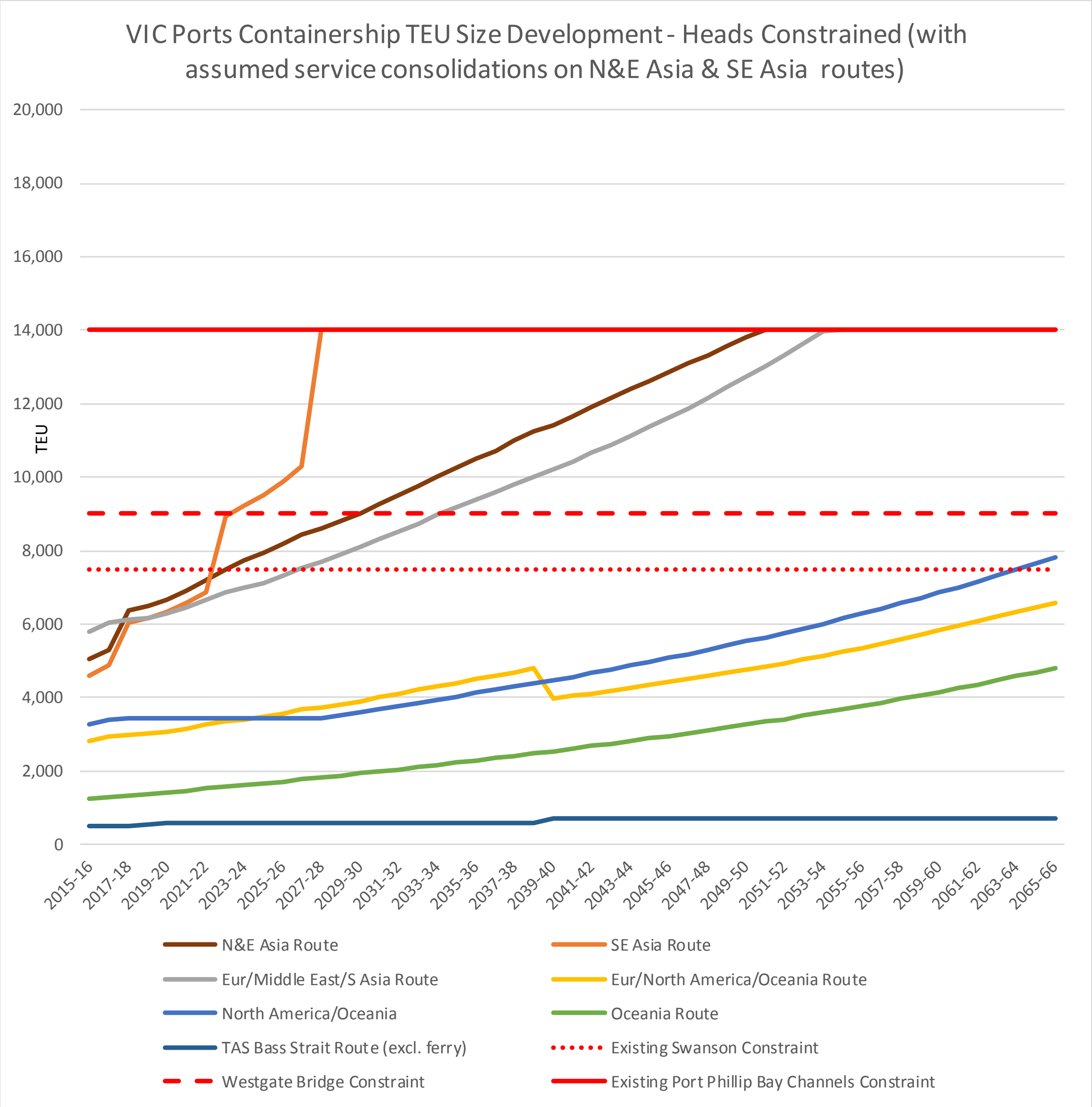

Figure 41 Fleet spectrum scenario 4 - Containership size development by shipping route, Source: GHD analysis, 2016

Table 50 Fleet spectrum scenario 4 - Summary of potential future international average and maximum container ship sizes calling Victoria, 2016-2066, Source: GHD analysis, 2016.

FY End	Constrained Average Ship TEU Size	Constrained Maximum Ship TEU Size
2015-16	4,035	5,779
2020-21	5,122	6,912
2025-26	6,272	9,895
2030-31	7,652	14,000
2035-36	8,556	14,000
2040-41	9,000	14,000
2045-46	9,811	14,000
2050-51	10,579	14,031
2055-56	11,201	14,000
2060-61	11,569	14,000
2065-66	11,838	14,000

The Fleet Spectrum Scenario 4 with constrained ship access generates estimated total ship calls (incl. Bass Strait freight-only container ro-ro ships) of 1,755 as of 2016, 1,677 by 2036, and 2,120 by 2066 – see Figure 42 for breakdown of forecast ship calls by ship size classes.

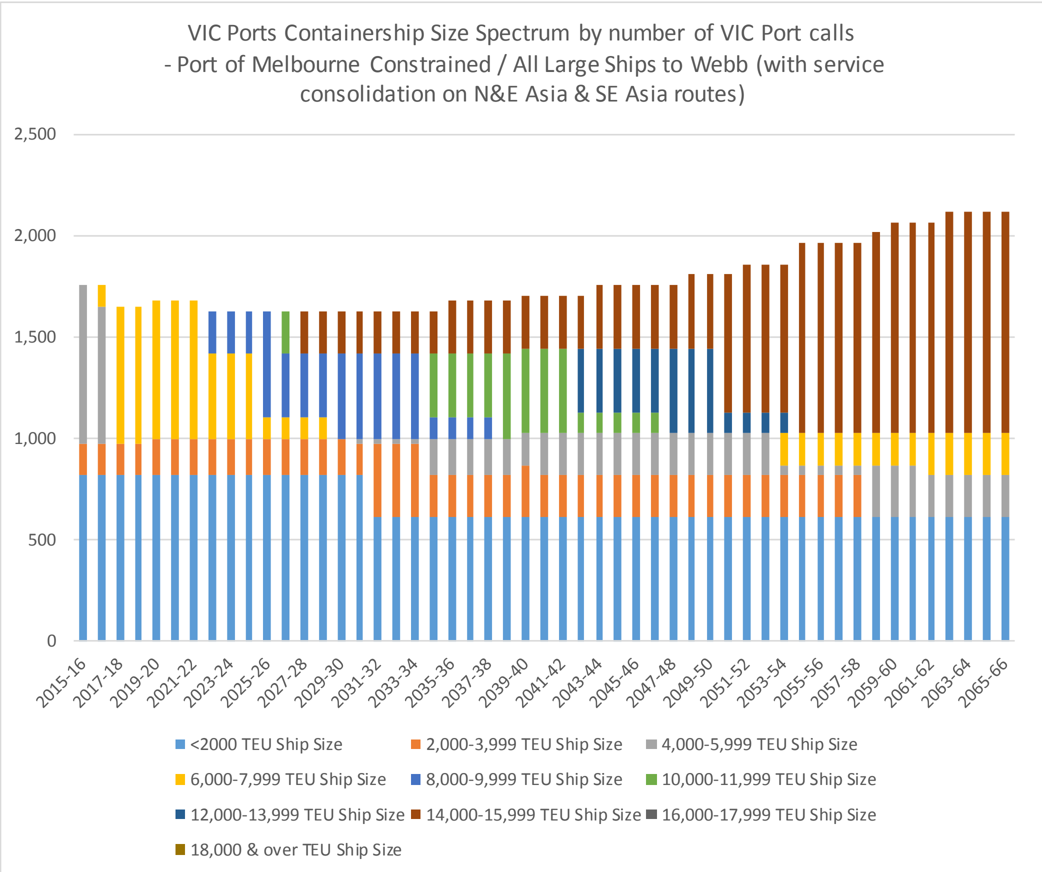

Figure 42 Fleet scenario 4 – Containership calls by ship size classes, 2016-2066, Source: GHD analysis, 2016

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9.1.7 Implications of constraining future container shipping sizes calling Victoria

Based on the assumptions used, the ship size and call numbers analysis of comparing unconstrained and constrained Victoria (Melbourne / Port Phillip Bay) port access shows a number of key features with implications:

- The current maximum ship size limits of Swanson Dock (without any upgrading) are estimated to start constraining vessels sizes by around mid-2020s with less rapid ship size growth, and early-2020s with more rapid ship size growth (i.e. including the possibility of some shipping line/service consolidations)
- The estimated maximum ship air draught limit under the Westgate Bridge of 50.1m is estimated to start constraining international container ships of around 9,000 TEU and above wanting to call Swanson Dock by mid-2030s with less rapid ship size growth, and mid-2020s with more rapid ship size growth, given other current Swanson Dock ship size limits were removed.
- Once the maximum ship size limit at Swanson Dock is reached, ship sizes are Webb Dock are estimated to be greater than in the unconstrained scenario as compensation for the constraints imposed by Swanson Dock, i.e. the gap in required ship route capacity is assumed to be absorbed by deploying larger ships at Webb Dock
- The estimated maximum ship size limits of the Port Phillip Bay Channels (including the Heads) are estimated to start constraining vessel sizes by around late 2040s for less rapid ship size growth, and by around late 2020s for more rapid ship size growth
- The differential in average international ship sizes between Victorian unconstrained port access and constrained port access under less rapid ship size growth is estimated to reach an average size penalty of 10% by 2044, increasing to 25% by 2054 and 39% by 2066. This translates into increased costs for shipping lines based on economies of scale of increasing ship size and least TEU-slot cost ocean ship economics.

9.1.8 Resulting container share between Swanson & Webb Dock

The modelling of containership size developments under the different scenarios as described above produces two ranges of container shares and capacity use for Port of Melbourne's Swanson Dock and Webb Dock. In one scenario, it is assumed that Swanson Dock and Webb Capacity are equally used meaning that shipping lines accept the access constraint of Swanson Webb and increase the number of services (ship calls) as trade grows – see Figure 43. Here Swanson Dock reaches round 4.5 million TEU per year by around 2056.

The logic behind this scenario is that both the new PoM owner and the Swanson Dock stevedores will seek to maximise the returns on their respective investments, ensuring Swanson Dock remains highly utilised in the future. This can be achieved through a combination of:

- strategic pricing
- staging the creation of additional container capacity at Webb Dock to match organic demand growth to avoid the creation of large tranches of excess capacity
- not allowing Swanson Dock stevedores to bid for new terminal space at Webb Dock

In another scenario, with accelerated ship size growth and expanding capacity at Webb Dock to follow the demand for large ship access up to 14,000 TEU (the assumed Port Phillip Heads constraint), the share of Swanson Dock reduces quickly after 2023 as large ship services migrate to Webb Dock. In this scenario, Swanson Dock is left with the minor, smaller ship trades representing less than 2 million TEU per year – see Figure 44.

The implications on capacity enhancement requirements is discussed further in Section 10.

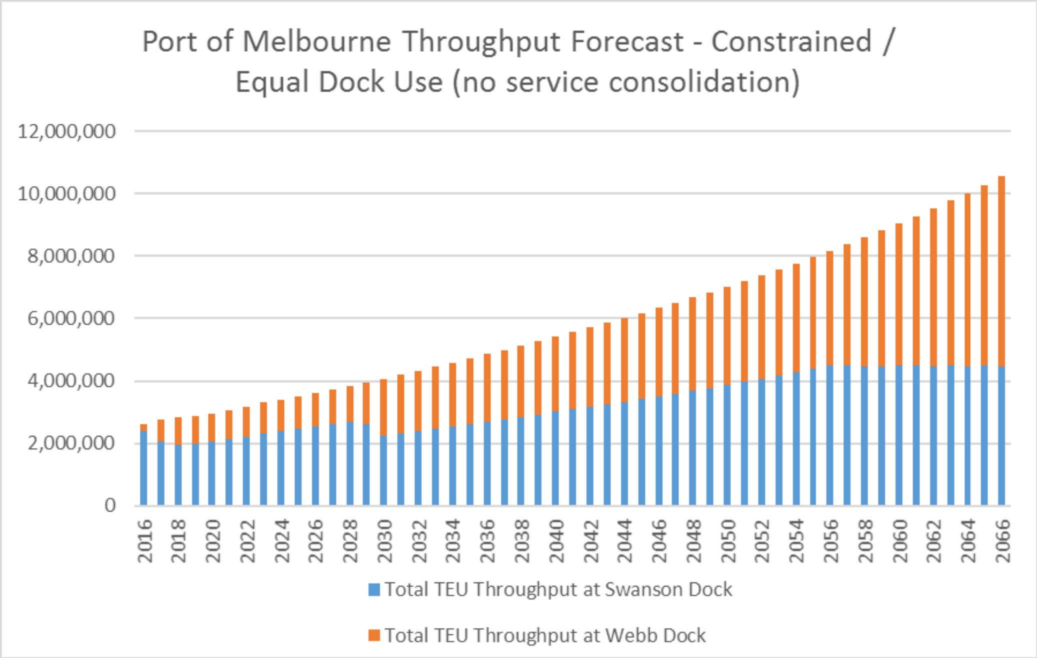

Figure 43 TEU throughput share between Swanson & Webb under Fleet Spectrum Scenario 2 (constrained port access / less rapid ship size growth / equal use Dock capacity), Source: GHD analysis, 2016

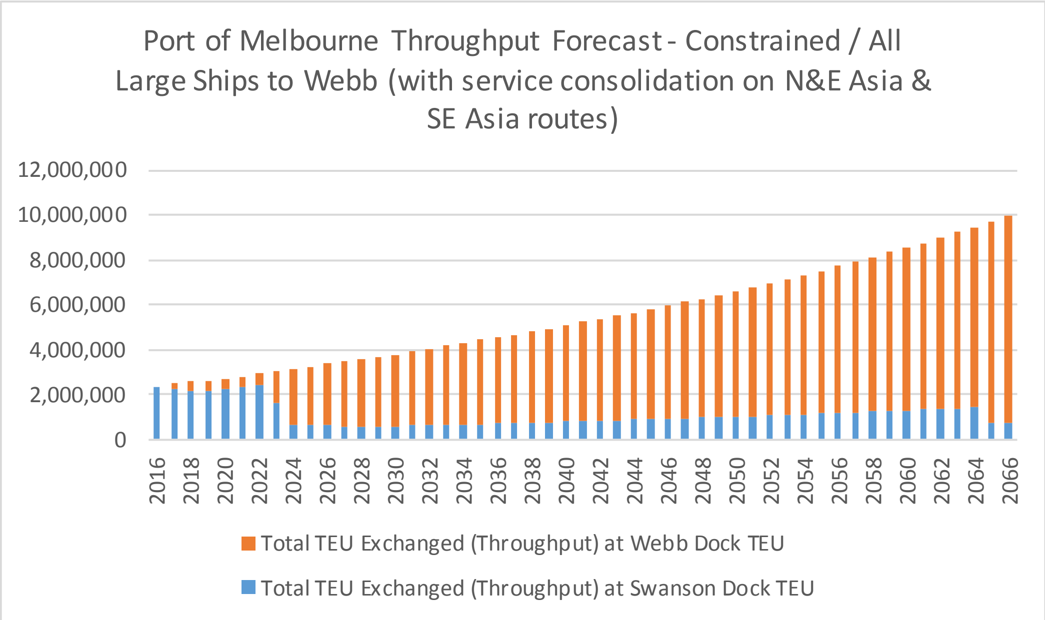

Figure 44 TEU throughput share between Swanson & Webb under Fleet Spectrum Scenario 4 (constrained port access / rapid ship size growth / large ships to Webb Dock), Source: GHD analysis, 2016

9.3 Overview of channel infrastructure

A detailed arrangement of channel infrastructure serving the Port of Melbourne is provided in Aecom' Navigation Study Report for Infrastructure Victoria.

Figure 45 provides an over view of the configuration and sections from the Port of Melbourne Channel to Swanson Dock.

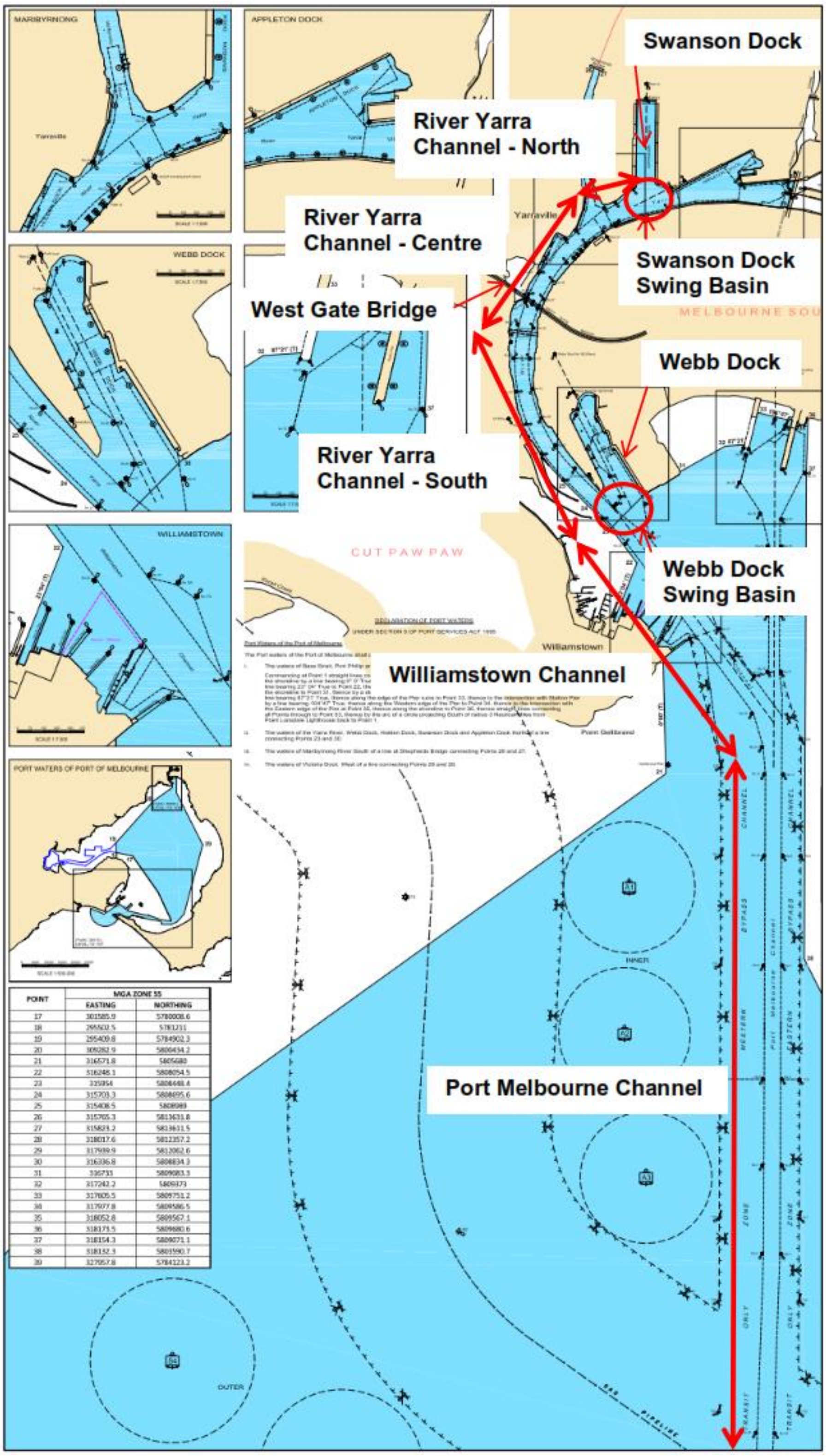

Figure 45 Port Melbourne channel to Swanson Dock

9.5 Channel infrastructure constraints (container vessels)

There are a number of constraints in Port Phillip that restrict larger container vessels accessing the Port.

9.5.1 Depth

Most of the Port of Melbourne container terminals with vessel draught limits less than 14 metres can potentially be deepened to enable larger vessels. The constraints on deepening below the existing maximum declared depth in the Port of Melbourne are:

- The River Yarra Channel is constrained by the utilities including sewer and gas pipelines that lie south of the West Gate Bridge. While it is possible to lower these services, it would a very complex and costly exercise.
- The River Yarra Channel is heavily contaminated and further dredging beyond the Channel Deepening Project design depth would be costly and difficult to obtain environmental approvals.
- The Westernport/Altona/Geelong (WAG) ethane pipeline that runs through the Port Melbourne Channel (south of Station Pier) constrains further deepening of all berths unless it is replaced with a deeper pipeline.

9.5.2 Width

Swanson Dock's capacity is limited by the "Post Panamax Constraint". Due to the 214m width of Swanson Dock, it is not possible to have a Post-Panamax vessel (Beam greater than 32.3m) passing a second Post-Panamax vessels at the southern East and West berths. A feasible mix of vessels is presented in Figure 7.

9.5.3 Length

The main vessel length constraint at the Port of Melbourne is the Swanson Dock Swing Basin which limits all ships that use the berths north of the West Gate Bridge to 320 metres length. As currently designed the Webb Dock Swing Basin will cater for vessels up to 300 metres, however greater lengths may be achievable through further dredging to expand the swing basin.

Aside from the swing basin constraints, all vessels entering Port Phillip Bay are limited by the difficult manoeuvre into and out of Port Phillip, however there is no "hard limit" published for this constraint.

9.5.4 Air Draught

The Air Draught is the Keel-To-Mast-Height (KTMH) less the sailing draught of the vessel. The actual Air Draught for vessels depend on cargo and trade characteristics and sailing patterns of the vessels in terms of how laden the vessels are at each port call and transit.

The West Gate Bridge across the lower River Yarra Channel limits the height of vessels to 50.1 metres (47.5 metres during bridge maintenance) from the Highest Astronomical Tide (1.04m CD) to the top mast. There is a 2m exclusion zone from the West Gate Bridge. With a maximum draught of 14.0m the maximum allowable keel to mast height is 65.14m or 62.54m during bridge maintenance.

9.5.5 Channel constraints summary

Table 51 summarises the vessel limits applicable to the Port Phillip channels

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Table 51 Vessel size limits in the Port Phillip channels

Section	Container Vessel Class					Comment on Limitation
	Old Post Panamax 7,000 TEU	Old Post Panamax Plus 8,500 TEU	Old Post Panamax Plus 9,500 TEU	New Post Panamax 14,000 TEU	Ultra Large Container-ship 18,500 TEU	
Great Ship Channel	✓	✓	✓	✓	X	Width of channel
South Channel	✓	✓	✓	✓	✓	
Port Melbourne Channel	✓	✓	~	~	X	Width of channel
Williamstown Channel	✓	✓	~	~	X	Width of channel
Webb Dock Swing Basin	✓	~[32]	~[32]	X	X	Size of swing basin
Webb Dock	✓	✓	✓	~[33]	~[33]	Width of northern section
Yarra River Channel	✓	X	X	X	X	Width of channel
West Gate Bridge	✓	✓	~[34]	X	X	Air draught
Swanson Dock Swing Basin	✓	X	X	X	X	Size of swing basin
Swanson Dock	✓	X	X	X	X	Width of basin

9.6 Channel capacity

Channel capacity has been assessed by AECOM. Their report provides greater detail on their assessment and finings applicable to Port Phillip. The following sections provide a summary of the findings.

9.6.1 Great Ship Channel and the South Channel

The capacity of the south channel has been assessed using a simplified approach considering the average separation between vessels and an allowance for channel unavailability. The assessment considers the following:

- Separation between vessels is 15 mins
- Channel Availability due to metocean conditions is 90%
- Vessels greater than 10,000 TEU capacity and tankers (crude oil and refined fuels) limited to 8 hours per day on average. These are termed the constrained transits

32 These vessels may be able to use the swing basin subject to further investigation;

33 Larger vessels would be able to access the southern section of Webb Dock East where VicT are located. There would be beam restrictions in the northern section if both sides are used, however this will depend on how Webb Dock is reconfigured/expanded in the future

34 Depends on the particular vessel air draught and the sailing draught at the time of the transit

Based on the 'constrained' vessel call forecast outlined in Section 9.1 the channel utilisation for constrained transits is 32% at 2066 or 41% at 2066 for all transits. Based on a maximum utilisation of 70% to allow for some flexibility in the scheduling the number of vessel transits could potentially be double the number of transits in 2066. Table 52 summarises these results.

Table 52 Theoretical channel capacity for 15 minute average separation

	2016	2026	2036	2046	2056	2066	Capacity
Total Constrained Transits	563	651	965	1,550	2,293	3,319	7,358
8hr/day Utilisation for Constrained Vessels	5%	6%	9%	15%	22%	32%	70%
Total Unconstrained Transits	6,791	7,191	7,599	7,973	8,655	9,550	22,075
Utilisation for all Vessels	23%	25%	27%	30%	35%	41%	70%

Another scenario to assess the sensitivity considers a vessel separation of 22.5 mins. This accounts for a scenario that is the average separation for two vessels heading in the same direction (15 mins) and two vessels heading in the opposite direction (30 mins through the Great Ship Channel to the two-way section of the South Channel).

Under this scenario the channel utilisation for constrained transits is 47% at 2066 or 61% at 2066 for all transits. Based on a maximum utilisation of 70% the number of vessel transits could potentially increase by 50% from the number of transits in 2066. Table 53 summarises these results.

Table 53 Theoretical channel capacity for 22.5 minute average separation

	2016	2026	2036	2046	2056	2066	Capacity
Total Constrained Transits	563	651	965	1,550	2,293	3,319	4,906
8hr/day Utilisation for Constrained Vessels	8%	9%	14%	22%	33%	47%	70%
Total Unconstrained Transits	6,791	7,191	7,599	7,973	8,655	9,550	14,717
Utilisation for all Vessels	35%	37%	41%	45%	52%	61%	70%

Based on this analysis there appears to be sufficient capacity in the Great Ship Channel and the South Channel for between 50-100% more vessels than the forecast for 2066. This will require improved management procedures to ensure that it is possible to manage this number of vessel movements.

9.6.2 Port of Melbourne

Future expansion of Webb Dock will increase the utilisation of the Port Melbourne and Williamstown Channel. This is not due solely to the increased number of vessels visiting the port but also the location of the Webb Dock Swing Basin in the Williamstown Channel.

Due to the complex nature of movement in and out of the port only the utilisation of container vessels at Webb Dock has been assessed. Vessels being swung at the Webb Dock Swing Basin lock all movements out of the port except for Gellibrand and Station Piers.

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On the inbound transits, vessel would not be able to enter the Williamstown Channel until the vessel being swung in the Webb Dock swing basin is clear of the Williamstown Channel. Movements to Gellibrand and Station Piers could still occur while a vessel is being swung at Webb Dock.

Based on the transit time from the entrance to the Webb Dock Swing Basin (30 minutes) and the time to swing a container vessel at the Webb Dock Swing Basin (30 minutes) and allowing another vessel to come up the Port Melbourne Channel (20 minutes), the time separation between vessels is taken as 40 minutes on an inbound transit and 60 minutes on an outbound transit.

Based on an average separation of 45 minutes for container vessels the channel utilisation assuming 95% availability and 1,876 container vessel transits to/from Webb Dock (2066) would be 17% for container vessels using Webb Dock

This is not expected to adversely impact the marine operations of the Port of Melbourne.

10. Effective Capacity of PoM

10.1 Overview

This section discusses the effective capacity of Port of Melbourne through consideration of all infrastructure components at Swanson Dock and Webb Dock, together with the in combination effects of trade share and ship size.

10.2 Limiting components at Swanson Dock

The limiting components of Swanson Dock are:

- Berth capacity – the number of containers that can be handled across the quay annually.
- Terminal (yard) capacity - the amount of containers that can be stored and transferred through the terminal per annum
- Landside (road) capacity – the ability of the immediate road network and junctions to handle the forecast number of truck movements per hour.
- Navigational infrastructure – which limits the maximum size of vessel that can be serviced at Swanson Dock.

In the existing arrangement ('as is'), the terminal (yard) and road junction limit capacity to around 3M TEU, while berth capacity (by virtue of the navigational restrictions) is estimated to be higher, at 3.5 M TEU.

The maximum capacity of Swanson Dock is expected to be governed by the berth. This is estimated at 5.2M TEU, and is reliant on the basin being extended to the north to increase the quayline by 200 m, and productivity gains occurring over time. A higher capacity is considered feasible if the characteristics of ship container exchange were to change significantly..

To reach 5.2M TEU, other infrastructure components need to be enhanced to ensure they do not become limiting. The preceding section has explored a number of options for each infrastructure component, and recognises that some options are incompatible and/or not cost effective when compared to others.

Table 54 summarises the relationship of the infrastructure components and indicates which capacity enhancing options are considered to have the highest feasibility. Options highlighted red are least preferred, and would be considered as a last resort.

Options tagged green are amber are preferred. Options tagged green are considered most favourable, while those tagged amber, are less favourable due to an expected negative impact or risk to other trades or container operations and/or increasing capital cost.

Figure 46 indicates how the preferred 'capacity enhancing' options can be considered together to increase the maximum capacity of Swanson Dock. The following should be observed:

- The vertical bars indicate capacity gateways in 1M TEU increments
- To move between through the capacity gateways, a capacity enhancement option located to the left of the capacity needs to be implemented for each of the berth, yard and landside areas. Multiple (grey) arrows reflect alternative options offering similar capacity increases.
- Yellow arrows indicate the capacity range that may result with technological gain over time.

Table 54 Indicative feasibility of capacity enhancing options at Swanson Dock

Component	Constraining features	Mitigation strategies	Feasibility
Berth capacity	Number of STSC and productivity (handling rates)	Increase number of STSC.. Technological improvement, improve vessel stowage patterns, 20':40' ratio changes	Cranes per vessel limited by vessel length / vessel mix. Under stevedore control. Performance improvement is expected over time through training / investment / maintenance.
	Quay length and STSC no.	Lengthen basin (add quay line) and increase STSC number.	High capex to extend the basin & quay line, some disruption.
	Vessel size that can be accommodated (LOA, Beam, Draught)	Extend basin to increase LOA	High capital cost & major disruption to operations. Longer quay would allow more STSC..
		Widen basin, increase turning basin, deepen berth pocket & modify Yarra River Channel to address Beam & Draught.	Navigational infrastructure constraints remain that are highly complex and v high capex.
Terminal (yard)	Area available	Expand footprint of operations.	Additional land appears to be available, with potential need to displace other trades.
		Adopt an alternative yard system offering higher density stacking on available footprint	Conversion to an alternative yard system impacts operational capacity as yard area is converted.
	Reduce dwell period of containers	Adopt on-dock rail & MIS shuttles to allow a proportion of containers to pass straight through terminal to reduce average dwell periods.	Rail network capacity exists, however implementation involves multiple agencies (protracted). Minimal capital investment required at Swanson Dock.
Landside (road & junction)	Truck productivity / junction capacity	Improve truck productivity (TEU/truck), encourage more truck movements at off-peak periods. Adopt on-dock rail.	Requires industry response to improve productivity outcomes. Off-peak movements may affect supply chain economics. Helps reduce dwell periods and lift yard capacity
	Junction capacity (Sim St)	Upgrade junction(s) to increase capacity onto / off Western Distributor	Considered feasible. Moderate capital cost
Navigation infrastructure	Basin / channel width / depth limit vessels to 7500 TEU	Dredge channel, widen basin and increase the diameter of the swinging area.	V high capital cost, and significant risk to existing pipeline and sewer infrastructure under navigation channels. Potential hydrodynamic impacts
	Westgate bridge limits vessels to 9000 TEU	Raise bridge	High capital cost & major disruption

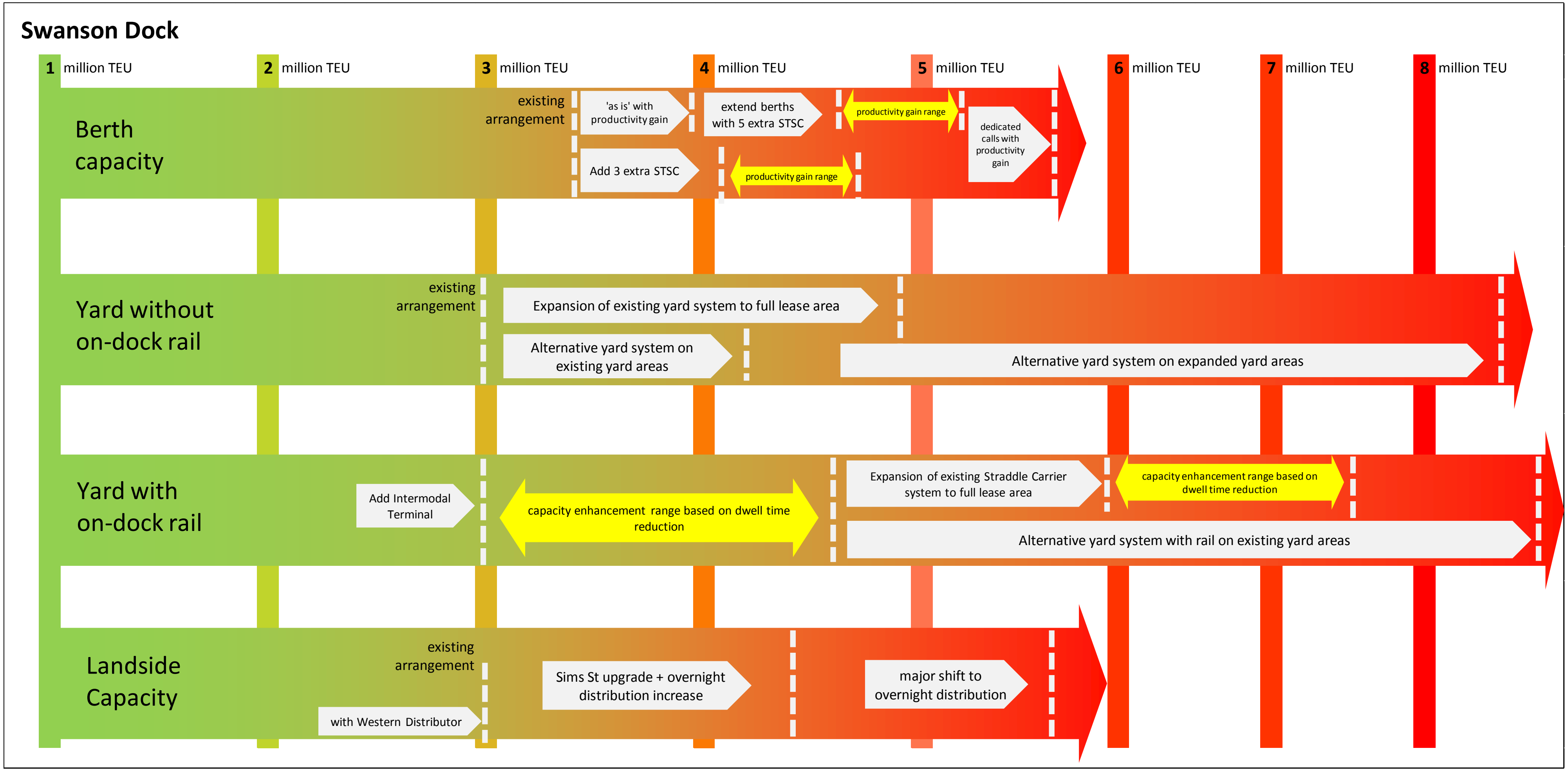

Figure 46 Capacity enhancement options for Swanson Dock and their respective capacity milestones

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10.3 Plausible capacity enhancement profile for Swanson Dock

This section considers the plausible development path for Swanson Dock, to consider:

1. Steps to reach maximum capacity
2. Steps relevant to a constrained vessel growth scenario
3. Steps relevant to an unconstrained vessel growth scenario

10.3.2 To reach maximum capacity

Figure 47 outlines a plausible development path to reach the maximum capacity of 5.2M TEU. This requires:

4. Sims Street junction to be upgraded to ensure junction capacity is not limiting.
5. Industry to continually increase the amount of off-peak distribution from the port
6. The development of an on-dock rail facility and expansion of the straddle carrier operations over time. The rail share will help alleviate road junction capacity constraints
7. The addition of extra STSC on the existing quay line initially, with future extension of the quay line and further STSC numbers later.

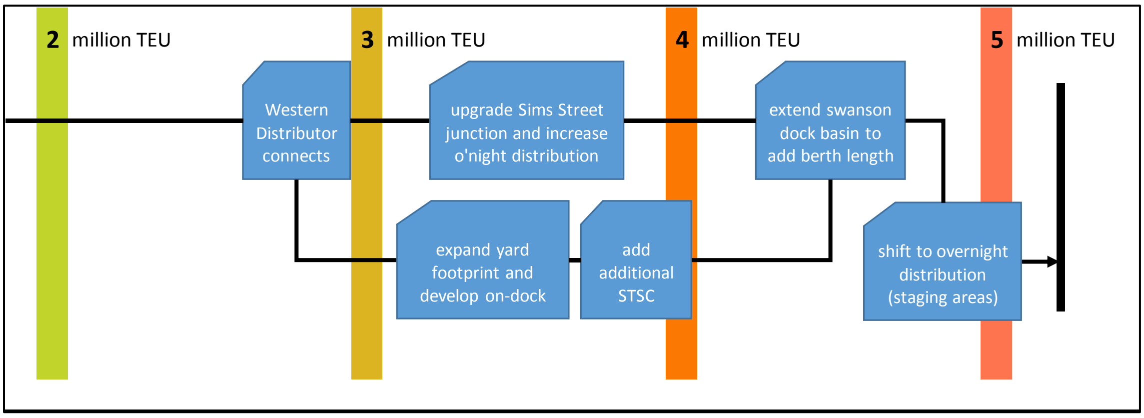

Figure 47 Plausible development path to maximum capacity (Swanson Dock)

10.3.3 Under a constrained vessel fleet scenario

In Section 9.1.5 it was highlighted that under a constrained vessel fleet scenario Swanson Dock is not expected to reach its maximum capacity. The analysis indicates throughput will not exceed 4M TEU. Under this scenario, the capacity initiatives could be limited to:

(1) The upgrade of Sims St junction after western distributor connects

(2) The expansion of the footprint of Straddle Carrier operations and/or the implementation of an on-dock rail terminal

(3) The addition of extra Ship to Shore Cranes on the existing berth.

Figure 48 summarises the plausible capacity enhancement steps and highlights that the extension of the Swanson basin to create extra berth length may not be required.

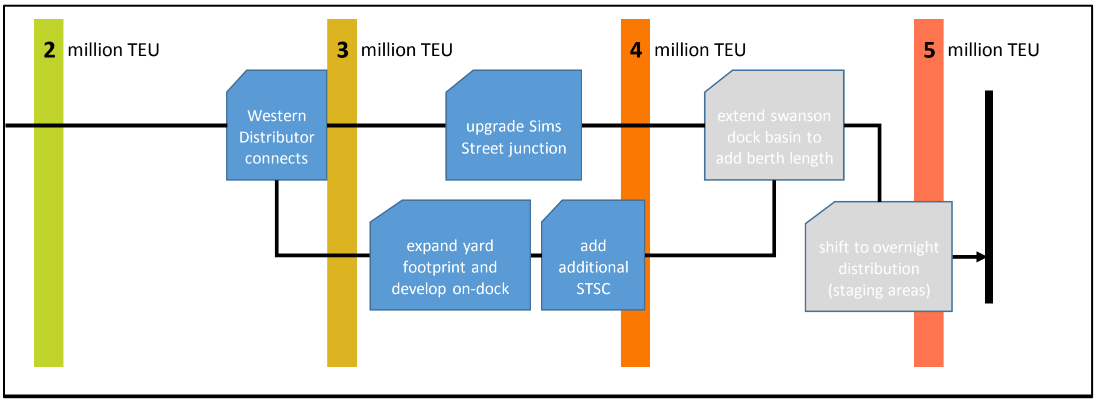

Figure 48 Plausible capacity enhancement timeline at Swanson Dock under the constrained vessel fleet growth scenario

10.3.4 Unconstrained vessel fleet scenario

Under an unconstrained vessel growth scenario, capacity does not need to be increased.

10.3.5 Plausible development timeline for Swanson Dock

A plausible development timeline has been applied to the constrained vessel scenario. This is illustrated in Figure 49, and indicates:

a) Road & yard capacity is reached around 2030. This requires Sims St junction to be upgraded and yard capacity to be lifted prior to this date. If an on-dock rail and expanded Straddle Carrier system is proposed, these would need to be continually expanded to meet demand through to 2066.

b) Berth capacity is expected to be reached at around 2055. This triggers the need for additional STSC's on both the SDE and SDW terminals.

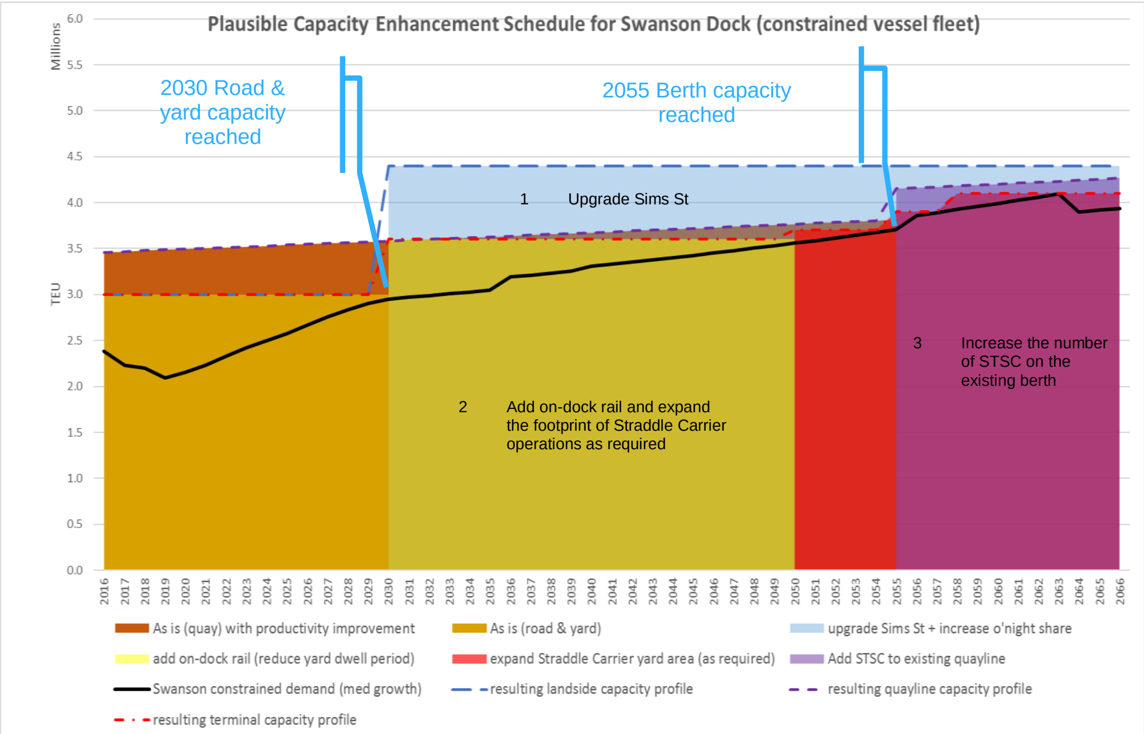

Figure 49 Plausible capacity enhancement timeline at Swanson Dock under a constrained vessel fleet growth scenario

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10.4 Webb Dock

The limiting components of Webb Dock are:

- Berth capacity – the number of containers that can be handled across the quay annually.
- Landside (road) capacity – the ability of the immediate road network and junctions to handle the forecast number of truck movements per hour; and
- Navigational infrastructure – mainly the swing basin, which limits the maximum size of vessel that can be serviced at Webb Dock.

In the existing arrangement ('as is'), the berth length limits capacity to around 1.4M TEU and yard and road junctions limit capacity to between 1.8M and 2.2M TEU. The constraint to berth capacity can be resolved easily, with a minor extension of the current quayline. This would bring the berth capacity in line with yard capacity at around 1.8M TEU.

The maximum capacity of Webb Dock is expected to be governed by the adequacy of the road linkages. Without a new 'Freight Link' (bridge crossing) to the proposed Western Distributor bypassing the Westgate Bridge the capacity of Webb Dock is expected to be limited to between 4M and 5M TEU per annum. This capacity, being somewhat reliant on a significant shift of distribution to off-peak periods.

If road capacity constraints are unlocked, Webb Dock is expected to be limited in capacity by the berth performance. Using the existing footprint, capacity is estimated at 5.4M to 6.1M TEU. If local expansion is considered (WDS), capacity is estimated to be between 7.7M TEU and 8.6M TEU per annum depending on the productivity gains occurring over time.

Other elements of the port need to be developed to match capacity, and Table 55 summarises the relationship of all infrastructure components and indicates which capacity enhancing options are considered to have the highest feasibility at Webb Dock.

Options highlighted red are least preferred, and are considered as a last resort. Options tagged green are amber are preferred. Options tagged green are considered most favourable, while those tagged amber, are less favourable due to an expected negative impact or risk to other trades and/or increasing capital cost.

Figure 50 indicates how the preferred 'capacity enhancing' options can be considered together to increase the maximum capacity of Webb Dock. In reading this figure, the following should be observed:

- The vertical bars indicate capacity gateways in 1M TEU increments
- To move between through the capacity gateways, a capacity enhancement option located to the left of the capacity needs to be implemented for each of the berth, yard and landside areas. Multiple (grey) arrows reflect alternative options offering similar capacity increases.
- Yellow arrows indicate the capacity range that may result with technological gain (productivity improvements) over time.

Table 55 Indicative feasibility of capacity enhancing options at Webb Dock

Component	Constraining features	Mitigation strategies	Feasibility
Berth capacity	Number of STSC and quay length	Extend VICT quayline by around 90m and add a single STSC taking capacity to 1.8M TEU. Technological improvement, improve vessel stowage patterns, 20':40' ratio changes	Cranes per vessel limited by vessel length / vessel mix. Under stevedore control. Performance improvement is expected over time through training / investment / maintenance.
	Add further quay length and STSC's.	Occupy Automotive terminal (WDW), extend quayline and convert land areas for containers. Provides 2.3 to 2.6 M TEU capacity	Moderate capex to extend the basin & quay line. Can be phased, initial stages are straightforward. Existing businesses displaced
		Occupy Bass Strait terminal (WDE), extend quayline and convert land areas for containers. Provides 1.9 to 2.1 M TEU capacity	High capex to demolish existing structures, extend the basin & quay line. Existing businesses displaced
		Expand WD to South (WDS) to create a new 2 berth terminal through land reclamation. Provides 1.9 to 2.1 M TEU	V. high capex to extend the basin, dredged extents & quay line.
	Vessel size (LOA, Beam, Draught)	Modify basin to increase LOA and beam limits	High capital cost & disruption to existing operations.
		Increase turning basin, deepen berth & modify approach channels to address Beam & Draught.	Navigational infrastructure constraints remain that are complex with v high capex.
Terminal (yard)	Area available	Expand footprint of operations.	Refer to terminal berth capacity options outlined above.
		Adopt an alternative system	Existing system is optimal
	Reduce dwell period of containers	Adopt on-dock rail & MIS shuttles to allow a proportion of containers to pass straight through terminal to reduce average dwell periods.	Rail network capacity concerns (if operating in parallel with Swanson), implementation requires Freight Link. V. high capital investment required.
Landside (road & junction)	Truck productivity	Improve truck productivity (TEU/truck), encourage more truck movements at off-peak periods.	Requires industry response to improve productivity outcomes. Off-peak movements may affect supply chain economics.
	Westgate interchange capacity	Upgrade the freeway interchange to increase capacity onto / off Westgate Freeway	Considered feasible. Moderate capital cost
	Road capacity	New 'Freight Link' bypassing Westgate Bridge. Road / Rail connectivity to network around Swanson Dock	V high capital cost (est. $3Bn), and risk to viability of Fishermans bend proposed developments.
Navigation infrastructure	Swing basin, channel limit vessels to 9500 TEU	Widen northern part of basin and increase the diameter of the swinging area.	High capital cost. Potential dredge (depth) risk to existing pipeline infrastructure under navigation channels. Potential hydrodynamic impacts

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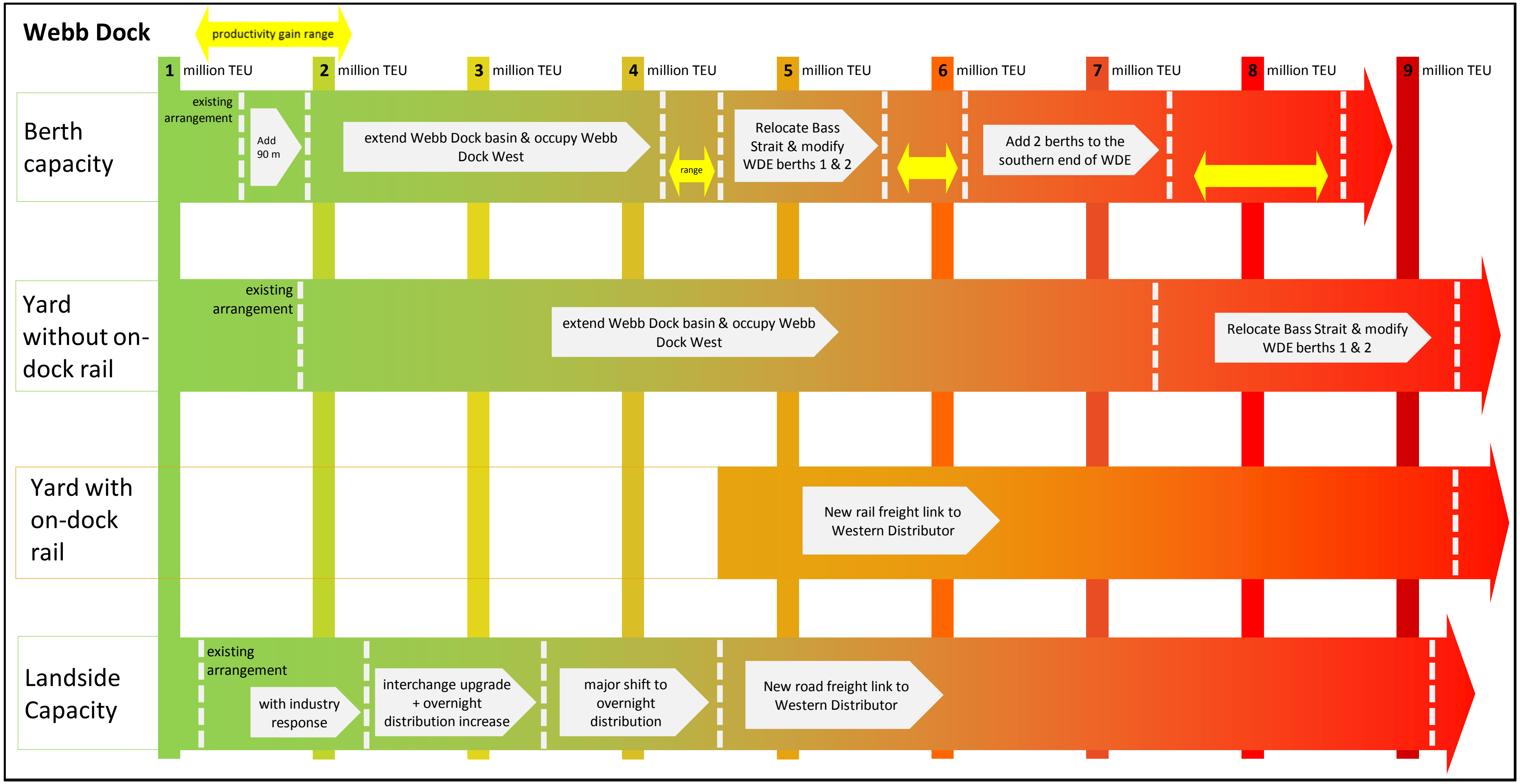

Figure 50 Capacity enhancement options for Webb Dock and their respective capacity milestones

10.5 Plausible capacity enhancement profile at Webb Dock

This section considers the plausible development path for Webb Dock, to consider:

1. Steps to reach maximum capacity
2. Steps relevant to a constrained vessel growth scenario
3. Steps relevant to an unconstrained vessel growth scenario

10.5.2 To reach maximum capacity at Webb Dock

Figure 51 outlines a plausible development path to reach the maximum capacity of 8.6M TEU. This requires:

1. Extension of the VICT quayline by around 90m to allow berth capacity to match yard capacity.
2. Industry to continually increase the amount of off-peak distribution from the port and truck productivity to improve. A performance of >1.5TEU/truck is required.
3. The upgrade of the Westgate freeway interchange from Webb Dock to exceed 3M TEU capacity.
4. The phased occupation and development of the existing automotive terminal (WDW) to create 1,100m quay and up to 60Ha of terminal space. This take capacity up to a possible 4.4M TEU.
5. To proceed beyond 4.4M TEU, a new Freight Link to Western Distributor is required together with the redevelopment and occupation of the Bass Strait terminal and construction of a new terminal (WDS) to the south of VICT.

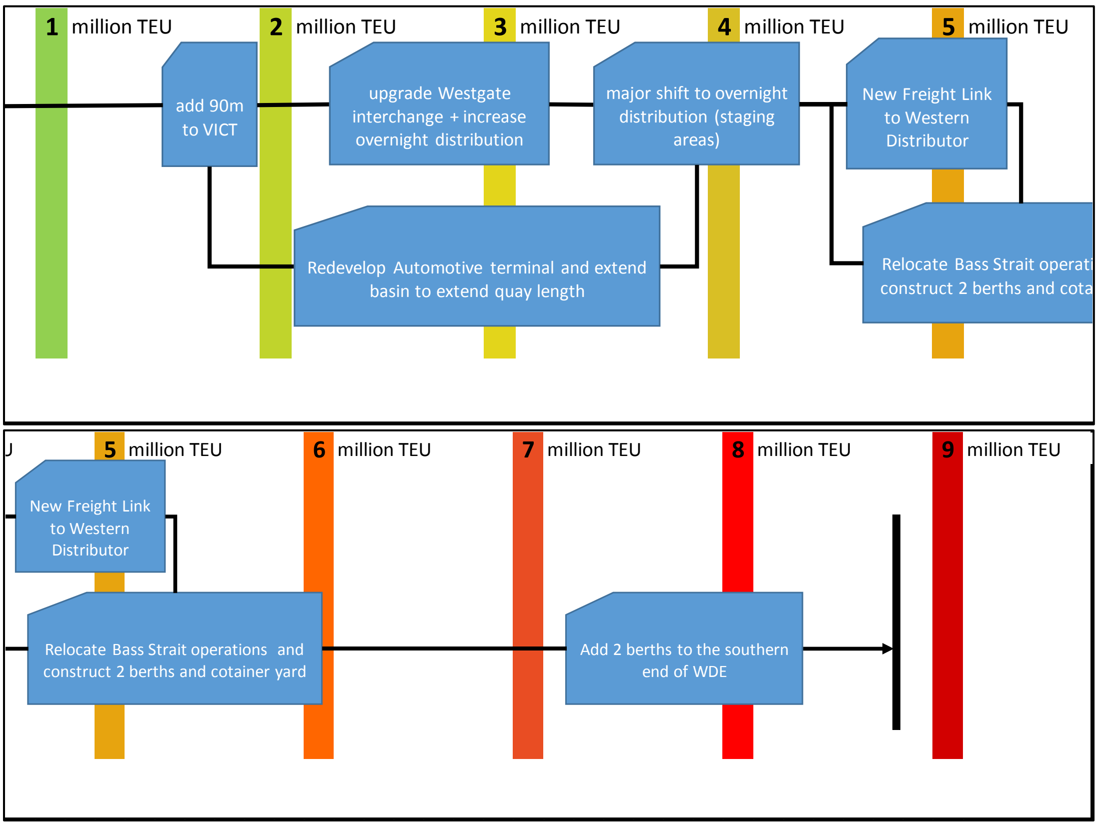

Figure 51 Plausible development path to maximum capacity (Webb Dock)

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10.5.3 Under a constrained vessel fleet scenario

In Section 9.1.5 it was highlighted that under a constrained vessel fleet scenario Webb Dock is not expected to reach its maximum capacity before 2066. The analysis indicates throughput will reach around 6M TEU. Under this scenario, the plausible capacity initiatives are proposed as:

1. Extension of the VICT quayline by around 90m to allow berth capacity to match yard capacity.
2. Industry to continually increase the amount of off-peak distribution from the port and truck productivity to improve. A performance of >1.5TEU/truck is required.
3. The upgrade of the Westgate freeway interchange from Webb Dock to exceed 3M TEU capacity.
4. The phased occupation and development of the existing automotive terminal (WDW) to create 1,100m quay and up to 60Ha of terminal space. This take capacity up to a possible 4.4M TEU.
5. The construction of a new Freight Link to Western Distributor together with the redevelopment and occupation of the Bass Strait terminal.
6. Widening of the Webb Dock swinging basin to suit longer vessels.

Figure 52 summarises the plausible capacity enhancement steps in this scenario. This would not require the expansion of the Webb Dock precinct to create extra terminal space, unless this was selected in place of the Bass Strait terminal option.

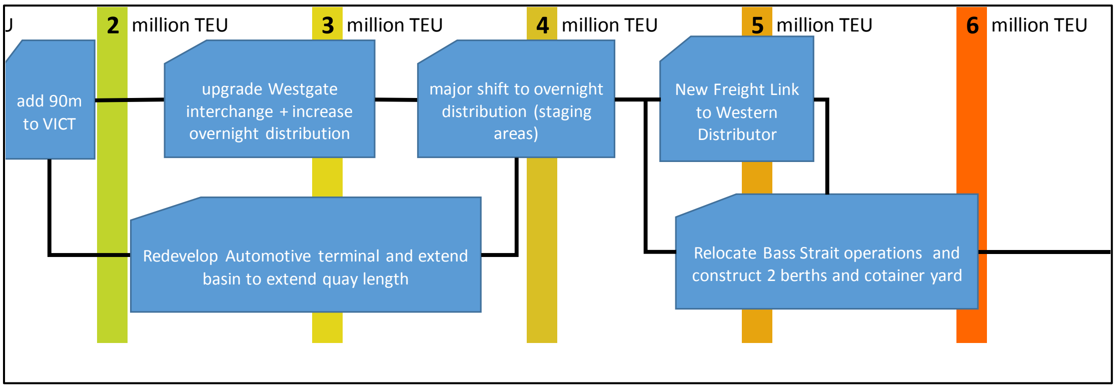

Figure 52 Plausible capacity enhancement timeline at Webb Dock under the constrained vessel fleet growth scenario (to 6M TEU)

10.5.4 Unconstrained vessel fleet scenario

Under an unconstrained vessel growth scenario, Webb Dock capacity would need to be increased to its maximum before 2066. In this scenario, the development set out in Section 10.5.2 and Figure 51 could be expected.

10.5.5 Potential development timeline at Webb Dock

The development timeline for Webb Dock under the constrained and unconstrained vessel scenarios is presented in Figure 53 and Figure 54 respectively.

The unconstrained scenario requires the earliest development in Webb Dock around 2022, with WDW occupied by 2024, Bass Strait relocated by 2039 and the Freight Link in place by 2042.

The constrained scenario requires the earliest development in Webb Dock around 2036, with WDW occupied by 2037, Bass Strait relocated by 2057 and the Freight Link in place by 2058.

A comparison of key dates is presented in Table 56.

Table 56 Comparison of key development dates at Webb Dock for constrained and unconstrained vessel fleet scenarios

Fleet scenario	90m quay	WDW	Interchange	Bass Strait	Freight Link	WDS
constrained	2036	2037	2043	2057	2058	N/A
unconstrained	2022	2024	2024	2039	2042	2054

10.6 Transport network enhancement summary

There are a number of potential landside network enhancement responses which would, in the first instance, ensure efficient land side connections up to the proposed volumes and then, in the longer term, extend capacity beyond the 50 years forecasts. These enhancements would likely be implemented in stages in the following order:

- Active freight sector policy (i.e. regulation) encouraging a shift to moving more freight overnight beyond current Swanson Dock levels (28% overnight) to up to 50%.
- Freight sector policy (i.e. regulation) to increase increased truck utilisation, raising the average TEU's per truck (towards 1.8), lowering the number of vehicles needed for the task.
- Upgrade of key connections in the near port road network, in particular at key interchanges and intersections, around Footscray Road, Sims Street, Todd Road, West Gate Freeway ramps and Citylink ramps. These upgrades would be designed to ensure that the 2046 throughput will be efficiently accommodated; they would be unlikely to provide capacity beyond this level.
- Move more freight by rail through introduction of metropolitan rail shuttle services. This initiative initially supports increased, efficient throughput at Swanson Dock, but could be extended to Webb Dock in the case a new rail connection is built.
- Construction of a new road or rail network capacity connecting to Webb Dock

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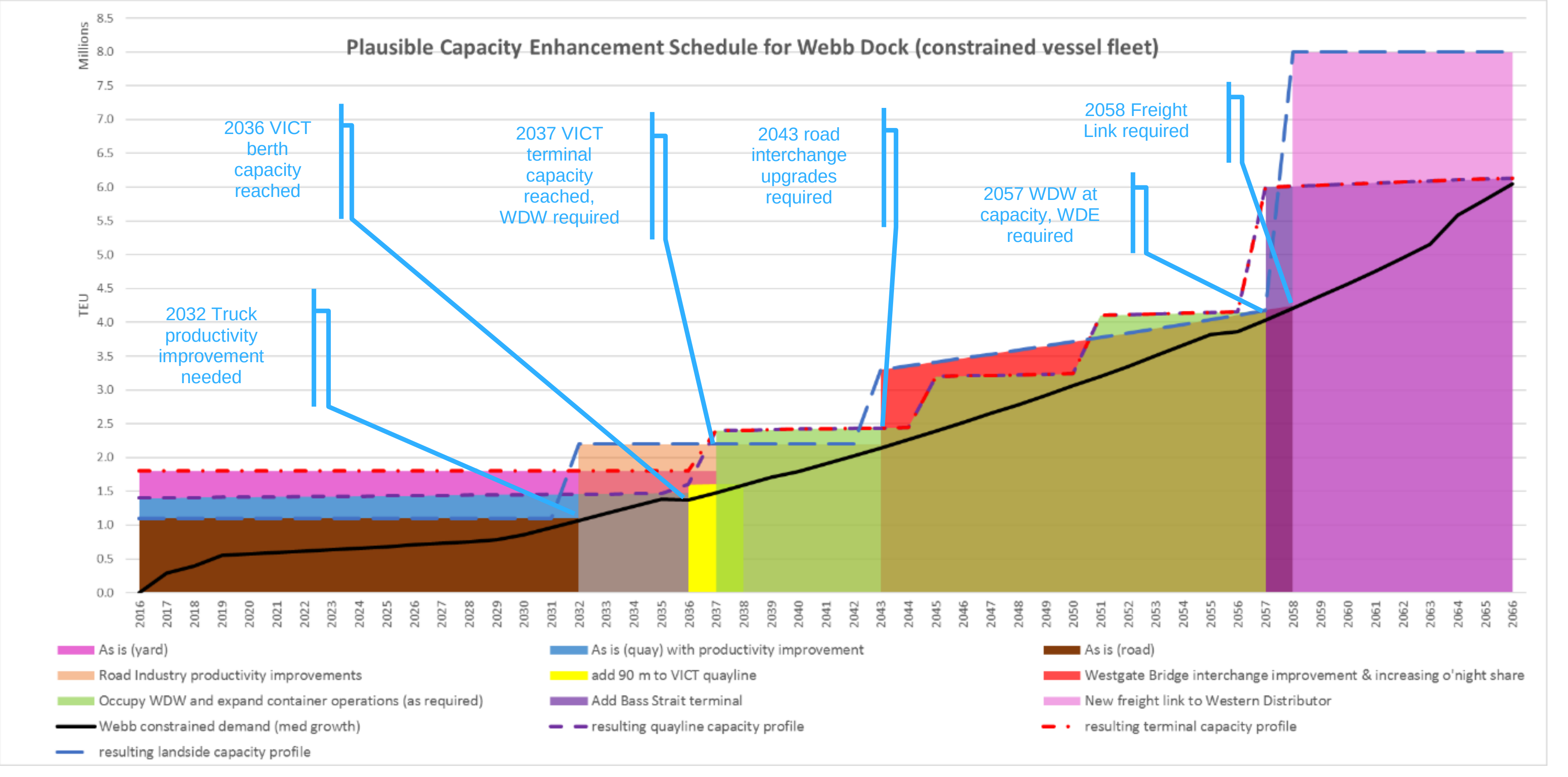

Figure 53 Plausible capacity enhancement timeline at Webb Dock under the constrained vessel fleet growth scenario

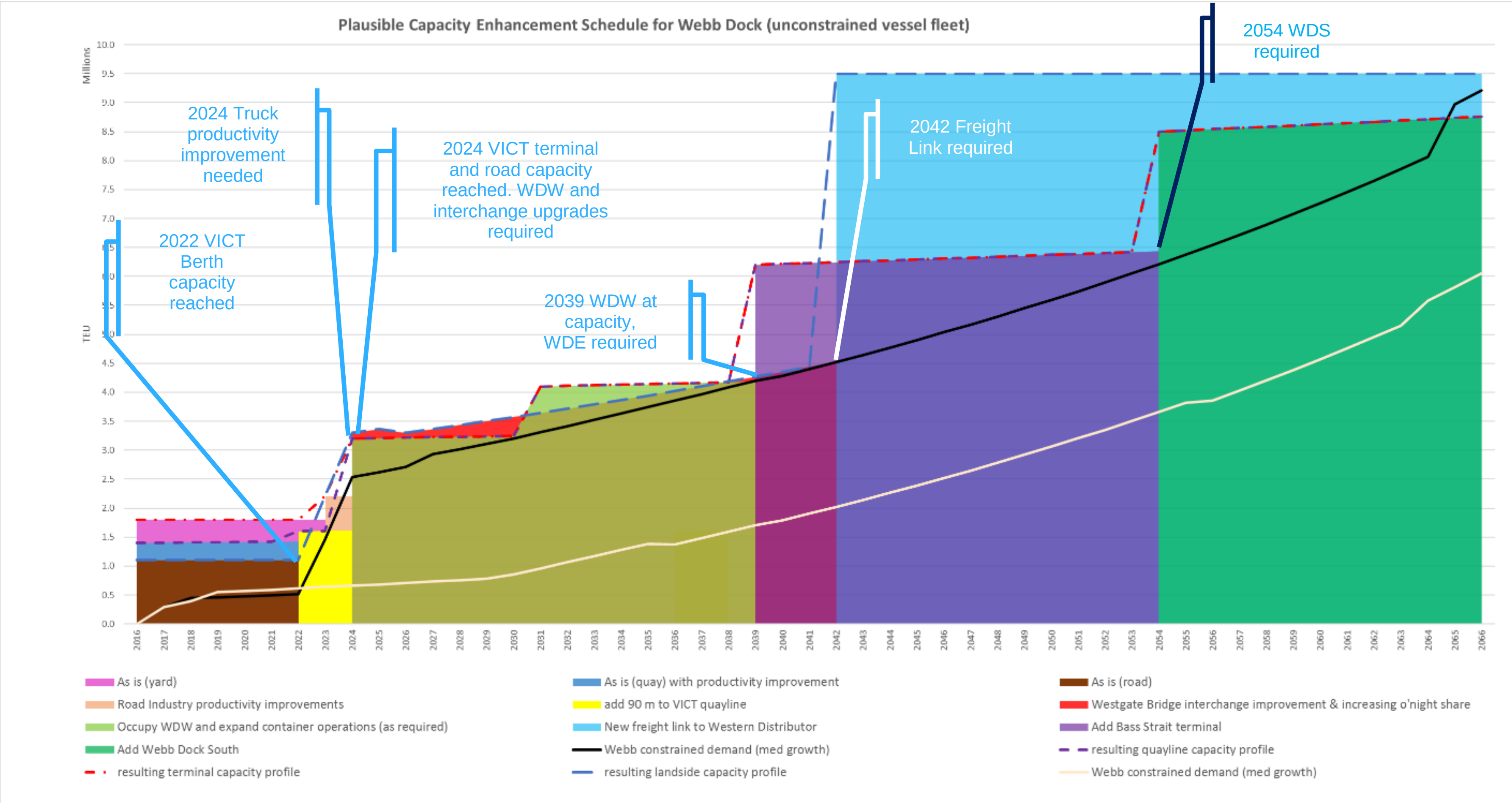

Figure 54 Plausible capacity enhancement timeline at Webb Dock under the unconstrained vessel fleet growth scenario

11. Key factors and risks impacting successful implementation

Implementation of the capacity enhancement initiatives will be impacted by external factors. A number of these will be out of the control of the Stevedore, Port owners and Government.

Table 57 provides an overview of the key risks.

Table 57 Key factors and potential risks impacting successful implementation

<table>
<tr><th>Key Risk</th><th>Key considerations</th><th>Components affected</th></tr>
<tr><td>Displaced trade needs a new home</td><td>• Capital cost
• Location?
– PoM? – space may not be available – vessel size constraints to Appleton.
– Hastings – use would comprise the stage 1 capacity for international containers
– Geelong? – potential channel restrictions</td><td>Berth & Yard capacity at Webb Dock</td></tr>
<tr><td>Stevedore buy-in is required</td><td>• Investment decisions needed and choice of system may be different.
• Productivity gain drivers?
• Interface with on-dock rail operations needs consideration</td><td>Swanson Dock berth & yard capacity</td></tr>
<tr><td>Governance & operational responsibility</td><td>• The on-dock rail facility – who runs port interface and inland terminals – how do they operate?
• Operational arrangements for the MIS system? Interface with ARTC, Metro and V Line is required.
• Road truck productivity improvements and shift to night time operations – whats the driver to make it happen?</td><td rowspan="2">Swanson & Webb Dock</td></tr>
<tr><td>Supply chain impacts</td><td>• Increased vessel calls due to port access constraints and resulting increase in cost for shipping lines
• Potential changes in industry structure, costs and operating practices in response to capacity challenges. Potential impacts include:
– Operating cost increase – out of hours working
– Need to expand staging areas – adding cost.</td></tr>
</table>

12. Capital cost estimates for selected capacity enhancement options

12.1 Modifications to Swanson Dock

Table 58 provides a summary of the cost estimates for the capacity enhancement options considered for Swanson Dock. The limitations set out in Section 1.4.2 apply.

Table 58 Cost estimates for capacity enhancement options identified for Swanson Dock ($ AUD)

Option	Construction cost (AUD$)	Equipment cost (AUD$)	Comment
Extend basin length & add 200 m quay length	170 M	40 M	Assumes 1 extra STSC & 3 Straddle carriers
Widen basin and reconstruct 1km quay length	600 M	80 M	Assumes 2 extra STSC & 6 Straddle carriers
Sims St intersection upgrade	70 M	-	Jacobs estimate
Provide an on-dock rail facility to 1M TEU capacity	70 M	-	Excludes other network connections / upgrades
Expand the footprint of Straddle Carrier operations	40 M	Incl. above	Assume 40 Ha pavement upgrade + new S/C equipment.

12.2 Modifications to Webb Dock

Table 59 provides a summary of the cost estimates for the capacity enhancement options considered for Webb Dock. The limitations set out in Section 1.4.2 apply.

Table 59 Cost estimates for capacity enhancement options identified for Webb Dock ($AUD)

Option	Construction cost (AUD$)	Equipment cost (AUD$)	Comment
Extend VICT by 90 m	45 M	15 M	Includes 1 extra STSC
Occupy WDW	270 M	230 M	Assumes new STSC's and S/C ops.
Occupy WDE (1/2/3)	620 M	260 M	Assumes new STSC & ASC operations
Create WDS	1,240 M	260 M	Assumes new STSC & ASC operations
On/off ramp upgrades	100 M	-	Assumes 2 x $50M per ramp
Freight link (road & rail)	3,500 M	-	Includes on-dock rail facility
New automotive facility	150 M	-	2-3 berth facility + landside areas
Channel modifications	60 M	-	Dredge swing basin for 14,000 TEU

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Appendices

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Appendix A - (Glossary)

The following is a Glossary of terms and abbreviations which have been used in the study and report.

ASC	Automated Stacking Crane which is a type of yard equipment for lifting containers.
BITRE	Bureau of Infrastructure, Transport, and Regional Economics (Australian government).
CAGR	Compound Annual Growth Rate which is expressed as a percentage.
CAPEX	Capital Expenditure.
CDP	Channel Deepening Project of the Port of Melbourne.
CLCS	Container Logistics Chain Study (2009) of the Port of Melbourne Corporation.
CPI	Consumer Price Index which is used to escalate costs in terms of inflation and as a deflator to calculate real cost levels.
CRMG	Cantilever Rail Mounted Gantry Crane which is a type of yard equipment for lifting containers to/from trains and trucks.
DC	Distribution Centre which is often the final destination of import international full containers.
DPW	DP World which is one of the Port of Melbourne's container stevedores operating the international container terminal at Swanson Dock West.
DTPLI	Department of Transport, Planning and Local Infrastructure (Victorian government).
EOI	Expression of Interest.
FTZ	Free Trade Zone which is often a Customs regulated manufacturing and logistics area close to a port operated under bonded (non-duty) conditions.
FY	Financial Year which runs from the 1st of July to the 30th June of the next year.
GT	Gross Tons which is a measure of a ship's internal volumetric capacity.
Ha	Hectare which is a land area of 10,000 square metres.
HGV	Heavy Goods Vehicle (a truck description used in the UK).
HPC	Hamburg Port Consultants who have been contracted by the GHD to provide terminal and yard capacity and productivity analyses as part of the Inland Ports Value Proposition Study.
HPFV	High Productivity Freight Vehicle which is also known as a Super B-Double truck.
ICTS	International Container Terminal Services which is a stevedoring company headquartered in the Philippines and operator of VICT.

ITV	Independent Transfer Vehicle which is a type of wheeled container yard equipment to transport containers.
Km	Kilometre.
LOA	Length Overall (in metres) which is measure of a ship's length.
LOS	Level of Service is a qualitative measure used to relate the quality of traffic service. LOS is used to analyze highways by categorizing traffic flow and assigning quality levels of traffic based on performance measure like speed, density,etc
M	Million.
MIRT	Metropolitan Intermodal Rail Terminal which is planned to be located at Port of Melbourne's Swanson Dock.
MIS	Metropolitan Intermodal System (Victorian government planning).
MoU	Memorandum of Understanding.
NY/NJ	New York / New Jersey (the Port Authority of).
PBLIS	Port Botany Landside Improvement Strategy as managed by Transport for NSW (previously managed by Sydney Ports Corporation).
PCP	Port Capacity Project of the Port of Melbourne.
PoMC	Port of Melbourne Corporation.
PRS	Port Rail Shuttle.
PV	Present Value which is a financial value as at the start year of the analysis after applying a discount rate to a set of financial values (benefits and costs) over a series of future years.
RMG	Rail Mounted Gantry which is a type of yard equipment for lifting containers to/from trains and trucks.
RTG	Rubber Tyred Gantry which is a type of yard equipment for lifting containers to/from trains and trucks.
ROCC	Rail Operations Coordination Centre.
RS	Reach Stacker which is a type of wheeled container yard equipment to lift and transport containers.
SC	Straddle Carrier which is a type of wheeled container yard equipment to lift and transport containers.
SDE	Swanson Dock East of Port of Melbourne.
SDW	Swanson Dock West of Port of Melbourne.
STSC	Ship To Shore Crane (gantry type) which is used to lift containers to/from berthed containerships.
TEU	Twenty-foot Equivalent Unit which is a standard unit measure of shipping containers reflecting the twenty-foot length of a container.
TGS	TEU Ground Slots.
TIA	Transport Integration Act 2010 (Victorian legislation).

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VBS	Vehicle Booking System which is provided by 1-Stop to manage container truck calls at Port of Melbourne's international container terminals.
VFLP	Victorian Freight and Logistics Plan.
VICT	Victorian International Container Terminal which is the Port of Melbourne's new Webb Dock international container terminal.
WAG	Westernport-Altona-Geelong oil and gas pipeline.
WIFT	Western Intermodal Freight Terminal which is planned for Melbourne to cater for inter-state rail freight.
Yr	Year.

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