

Department of Land, Water,
Environment and Planning

Yarra's Edge Marina - Movement Analysis

Movement and Berthing Analysis

Rev 1 Final | 20 September 2016

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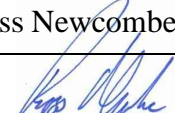


Arup
Level 17
1 Nicholson Street
East Melbourne VIC 3002
Australia
www.arup.com

ARUP

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		Signature			
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Executive Summary

The renewal of Fishermans Bend is the largest urban renewal project in Australia with plans to cater for 80,000 residents and generate jobs for 60,000 people by 2050. As part of the renewal, a bridge extending Collins Street, spanning the Yarra River to the west of the Yarra's Edge Marina, has been proposed to improve transport accessibility.

If constructed, this bridge is likely to impose height restrictions on vessels using Yarra's Edge Marina. This report analyses the vessels currently berthed at the Marina to determine the number of berthed vessels that would be impacted by various bridge heights. In addition, a video survey of river traffic was conducted over the course of nine days to determine peak travel periods and the daily variation in usage. An analysis of potential alternative berthing locations was then conducted to determine the favoured relocation region for vessels impacted by the new bridge.

It was found that were the bridge extension to be the same height as the Charles Grimes Bridge, a bridge east of the Marina, then less than 8% of berthed vessels would be able to pass comfortably during high tide. Allowing for a 500mm freeboard and at least a 200mm sea level rise by 2040, results suggest that the soffit of a bridge would need to be built at a minimum AHD height of 5.69m for 50% of berthed vessels to pass, and 9.35m for 70% to pass. Respectively, this corresponds to 55 or 24 of boats currently observed in the Marina being unable to access the Marina at all time for these bridge heights.

A Multi-criteria analysis was conducted considering cost, accessibility, planning risk, amenity of destination and facilities, capacity for additional berths, construction risk and exposure was conducted on eight potential alternative berthing locations for relocated vessels. Results of the analysis found three locations to be equally desirable: Yarra's Edge Pontoons (also known as River Homes), North Wharf and Victoria Harbour. It is therefore recommended that, were the bridge extension likely to proceed, investigations be focused on these locations to relocate impacted vessels.

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1 Background

The renewal of Fishermans Bend is the largest urban renewal project in Australia with plans to cater for 80,000 residents and generate jobs for 60,000 people by 2050.

As part of the redevelopment, there are plans to create additional transport links between Fishermans Bend and the city. One option under investigation is an extension of Collins Street in the form of a Bridge over the Yarra River. An impact associated with this new bridge is the likely imposition of height restrictions on the vessels accessing Yarra's Edge Marina. The location of the proposed bridge relative to Yarra's Edge Marina can be seen below in Figure 1.

Arup have been engaged by the Department of Land, Water, Environment and Planning (DELWP) to undertake a movement analysis of vessels using Yarra's Edge Marina. The purpose of the analysis is to assess the impact of various bridge heights on vessel access to the Marina, and identify possible new berthing locations within the vicinity of the Marina.

This study follows on from a previous study Arup conducted into Vessels in Victoria Harbour in 2015, which has been used to explore comparability of winter to spring activity and the related possibility of a growth assumption for Vessels in Yarra's Edge Marina.



Figure 1: Yarra's Edge Marina and Proposed Bridge Extension

2 Marina Overview

2.1 Survey Method

To understand the access requirements of Marina vessels, a survey of the boats berthed in the Marina was undertaken. Access to the Marina was not allowed, so the survey was undertaken using a combination of aerial imagery and photos taken by Arup from publically available locations surrounding the Marina. Photos were taken between the hours of 7:00am and 9:00am on three different occasions to ensure the majority of boats were surveyed (13/07/16, 20/07/16, and 02/08/16). These photos were used to estimate: boat type, maximum height (full mast), length, mast type.

Where identification of a boat model was possible, dimensions were taken from manufacturers specifications. Otherwise, dimensions were measured from the aerial photographs or estimated using long range photographs using known reference heights or dimensions. Given the nature of this measurement method, the accuracy of the survey is expected to be in the order of +/- 0.5m for length and beam, +/- 1m for the height of vessels smaller than 10m and +/-2m height of vessels greater than 10m tall (ie high-masted yachts).

For the purpose of this survey, the following definitions are used:

- Vessel length: is the total length of the vessel, including fixed appendages such as bowsprits and stern platforms. The length excludes temporary fixtures such as anchors and life boats or tenders.
- Vessel Height: is the height of the vessel from the waterline to the highest point with fixed equipment. This includes biminis, radars, running and anchor lights, wind sensors etc. Whip antennas are excluded as they are either very flexible or easily retractable.
- Vessel Beam: is the maximum width of the vessel as measured from the outermost points of the vessel.

In the case that a berth was empty, the berth was then cross checked against the Yarra's Edge Marina berthing lease page. If the berth was available for lease, then it was noted as empty and for sale.

Historical aerial imagery from google earth was also reviewed, giving an insight into harbour utilisation over time, and likely future usage. An aerial photo from each year since 2006 was reviewed and the total number of vessels berthed at the time of capture was recorded. The variable quality of the historical images meant that the type or length of the vessels could not be determined in most images, just whether the pen/berth is occupied or not.

A list of registered vessels from the Australian Maritime Safety Authority was also analysed, with the aim to obtain a distinct growth rate in vessels registered across Melbourne.

2.2 Historical Utilisation

Review of historical google earth aerials each year since 2006 indicate a steady growth in vessel berthing. Figure 1, below, shows the total number of vessels observed to be berthed within the marina from 2006 to 2016¹ against the marina capacity.

It is noted that each aerial shows a snapshot of conditions in the Marina, and therefore not all vessels using it will have been observed. However, it does indicate that Marina usage is generally increasing. In the observed period, the number of vessels using the marina increased at an average rate of 5% a year.

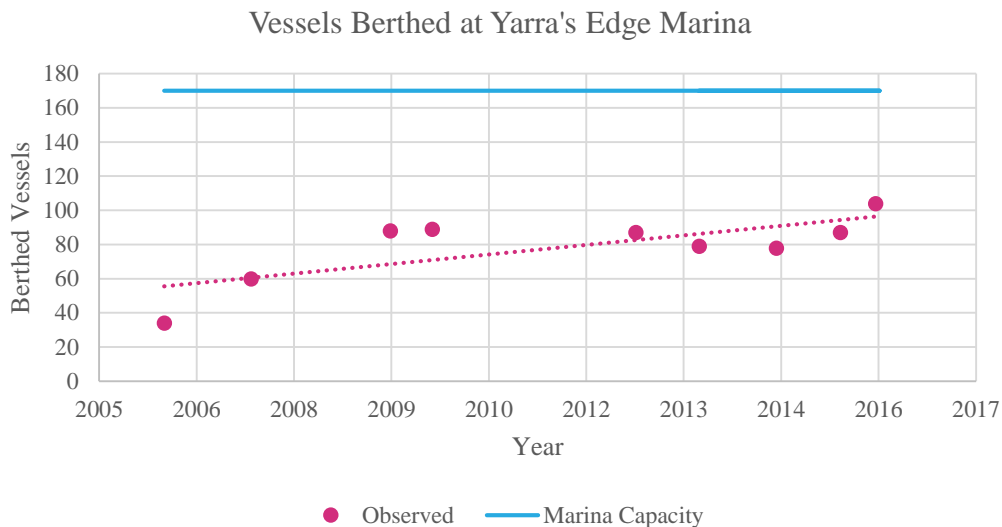


Figure 2: Observed and projected growth in Marina Vessels

2.3 Current Utilisation

From review of the photos and berthing lease advertisements, it is estimated that approximately 135 of the 150 available private berths are occupied. A distribution of the various boat types identified in Marina's private berths is shown in Figure 2. It is noted that more berths are thought to be occupied than identified from the aerial photography analysis above. This is a result of the photographic survey occurring across multiple dates, allowing for some vessels that were temporarily away from the marina to be recorded.

Review of boats in the Marina indicated that there were no vessels with easily lowerable masts. The relative height distribution of the surveyed vessels in private berths is indicated in Figure 3. The majority of boats berthed at the marina were observed to be between 1 and 5m, although there were also 16 sail yachts and 5 catamarans with masts estimated to be between 16 and 20m in height.

¹ Aerial imagery was not available for 2008 and 2011 and has therefore been omitted.

The distribution of vessel lengths can also be seen in Figure 4, with the majority of vessels using the marina being between 10 and 14m in length.

Figure 5 shows the the distribution of measured vessel beam lengths, from which it can be seen that the majority of vessels have a maximum width between three and five metres.

The distribution of mast types is shown in Figure 6. As mentioned previously, the vast majority of masts were observed to be fixed.

For a full breakdown of the individual boat characteristics and survey results, please refer to appendix A1.

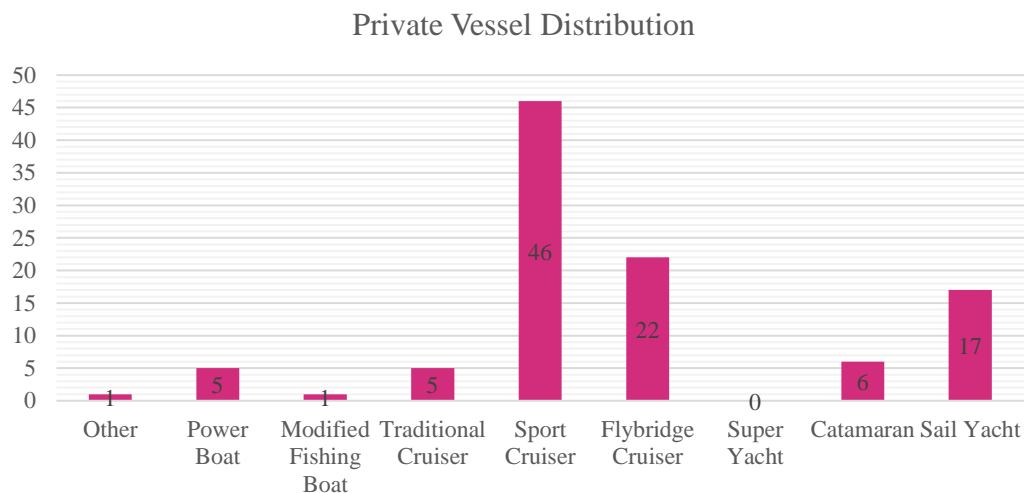


Figure 3: Distribution of Vessels in Private Berths

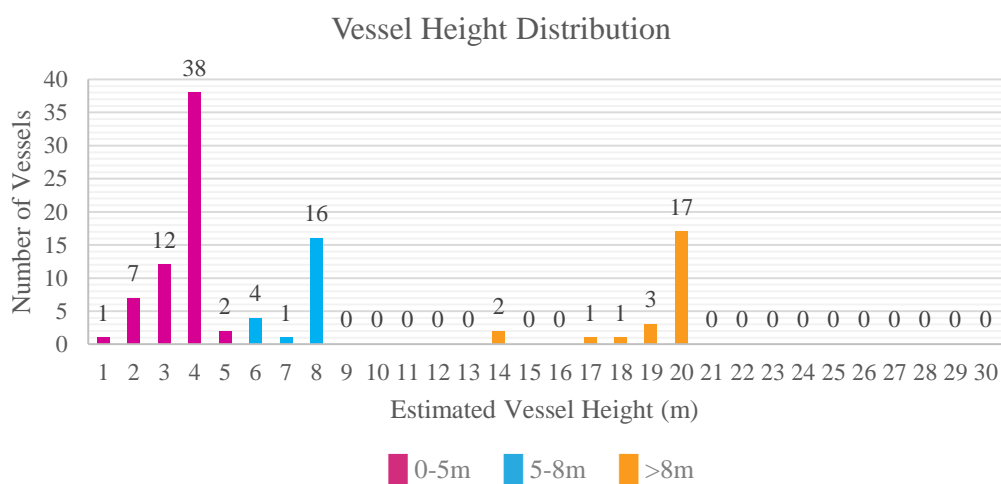


Figure 4: Distribution of Private Berthed Vessel Heights

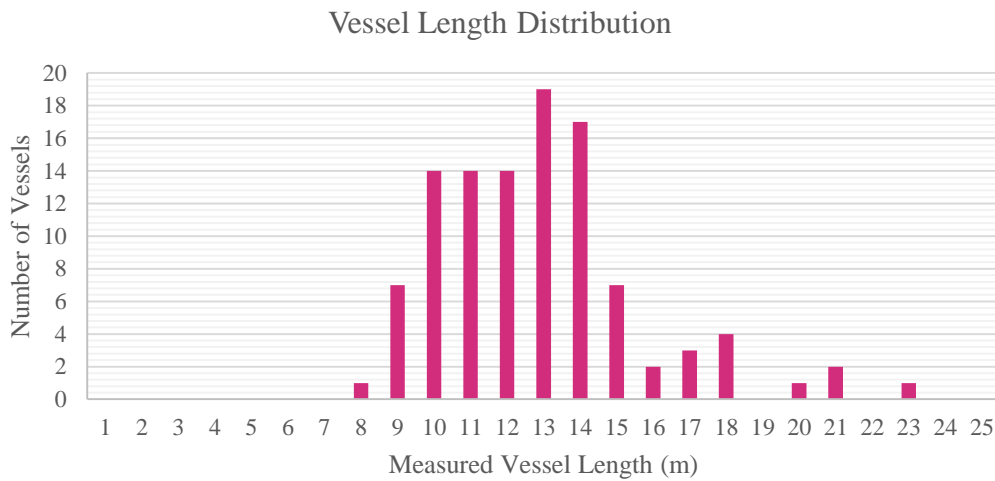


Figure 5: Berthed Vessel Length Distribution

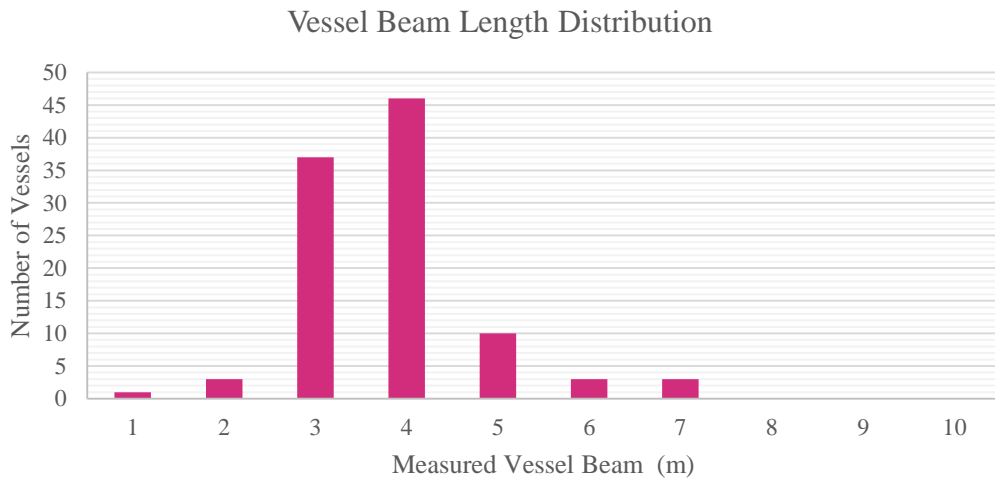


Figure 6: Berthed Vessel Beam Length Distribution

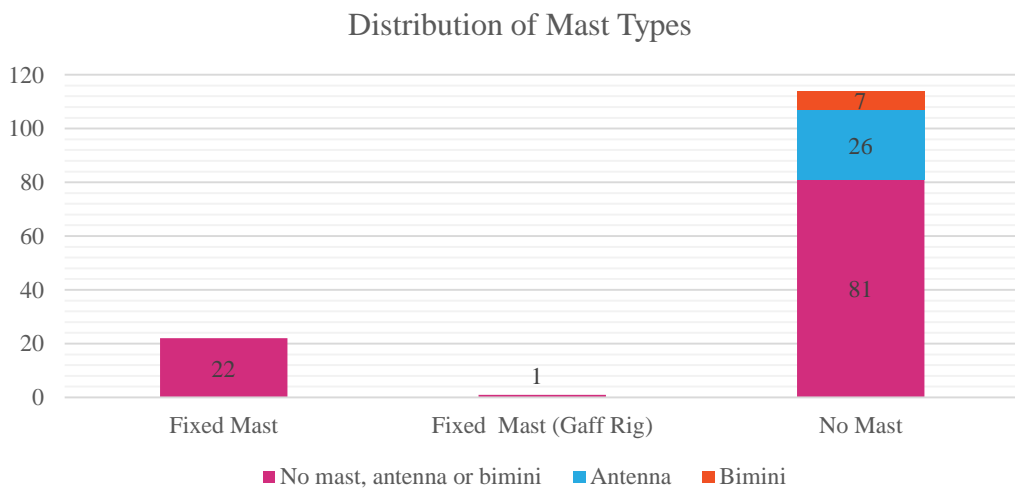


Figure 7: Berthed Vessels Mast types

2.4 General Vessel Usage: Registered Vessels

In addition to the analysis methods detailed previously, the Australian Bureau of Statistics' list of Registered Vessels (Victoria) was reviewed. Filtering for a home port of Melbourne, the annual yearly amount of new registered vessels was determined, as shown in Figure 7. This graph shows a distinct trend of slowing vessel growth in Melbourne.

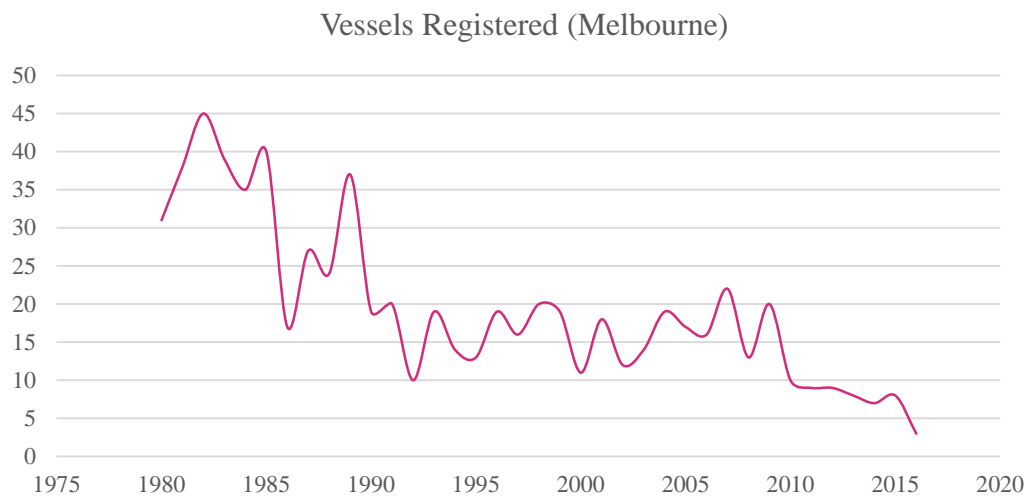


Figure 8: Number of New Vessels Registered in Melbourne (per year)

3 Movement Analysis

3.1 Survey Method

To understand the vessel movement requirements, a boat survey was conducted for Yarra's Edge Marina and Victoria Harbour using time lapse imagery. The method for recording and analysis is as follows:

Time lapse recording

Two SLR cameras were set-up by Cloud 9 photography in Victoria Harbour's old control tower. The cameras were directed perpendicular to the direction of vessel movements to Yarra's Edge Marina and Victoria Harbour respectively (See Figure 8).

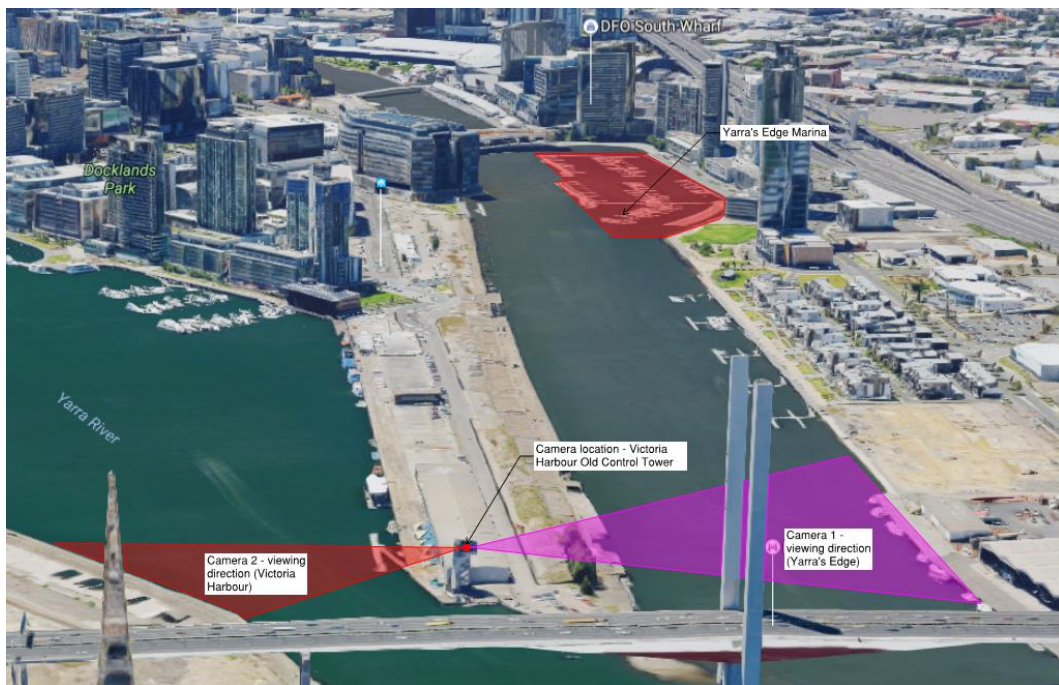


Figure 9: Camera set-up location

The cameras were set to operate simultaneously, capturing images every fifteen seconds. Camera operation commenced on 12:00am Saturday July 9 and continued until 12:00am Monday July 18 so that two weekend periods, and five week days were recorded.

Due to equipment faults, there were some periods which the cameras were unable to record. To avoid delay to the delivery of this report, gaps in footage were compensated for in three ways depending on the length of the gap. It is noted that the majority of missing footage was in the early morning, where no vessel traffic had previously been observed. The methods for substituting missing footage are summarised in Table 1 below.

The footage used for each day of recording is summarised in Table 2.

Table 1: Method for compensating for gaps in footage

Type of Gap	Compensation Method
Short gap (<4hrs)	Footage was shot for the same time period the following week (on the same day). This was combined with the existing footage for analysis.
Short Gaps in Footage around 12:00am (<1hr)	Gaps were not replaced, as no vessel traffic had been observed around this time on any day.
Long Gaps in Footage (>4hrs)	Completely new footage was taken the following week (on the same day) and used as a replacement.

Table 2: Footage used for each day

	Camera 1 (YE Marina)	Camera 2 (Victoria Harbour)
Day 1 (Sat 09/07)	All footage collected from 9/07/2016	All footage collected from 9/07/2016
Day 2 (Sun 10/07)	All footage collected from 10/07/2016 00:00 – 00:40 not captured or replaced	All footage collected from 10/07/2016
Day 3 (Mon 11/07)	11/07/2016 replaced with footage from 25/07/2016	All footage collected from 11/07/2016
Day 4 (Tue 12/07)	12/07/2016 footage used, 8:45 AM - 1:00 PM replaced with footage from 26/07/2016 00:00-01:15 not captured or replaced	All footage collected from 12/07/2016
Day 5 (Wed 13/07)	All footage collected from 13/07/2016 00:00-00:50 not captured or replaced	All footage collected from 13/07/2016
Day 6 (Thurs 14/07)	All footage collected from 14/07/2016	All footage collected from 14/07/2016
Day 7 (Fri 15/07)	All footage collected from 15/07/2016	All footage collected from 15/07/2016
Day 8 (Sat 16/07)	All footage collected from 16/07/2016	All footage collected from 16/07/2016
Day 9 (Sun 17/07)	17/07/2016 replaced with footage from 24/07/2016	All footage collected from 17/07/2016 00:00-03:00 not captured or replaced

Desktop review of footage

Time stamped video footage was provided at the end of the recording period and analysed. All vessels entering and exiting Yarra's Edge Marina and Victoria Harbour were classified and their heights estimated. This data formed the basis of the analysis, detailed in subsequent sections.

3.2 Victoria Harbour Movements

3.2.1 Survey Results and Findings

As a previous movement analysis was conducted for Victoria Harbour in October 2015, an opportunity existed for a comparison between years and seasons. Vessel movement into Victoria Harbour was therefore surveyed and used for comparison with the 2015 data.

Figure 9 and Figure 10 show the daily vessel volumes, as well as the distribution of vessel heights for the 2016 and 2015 survey periods respectively. For a full breakdown of different vessel types, please refer to Appendix A2. In each survey, vessel traffic can be seen to peak on weekends and in particular on Saturdays. It is noted that vessel traffic in 2015 was observed to be much higher than the 2016 survey period on all days. Reasons for this could be the favourable weather and the Spring Carnival weekend experienced during the 2015 survey period, which are likely to have encouraged private vessel usage. This is in contrast to the typical winter conditions experienced during the 2016 survey period.

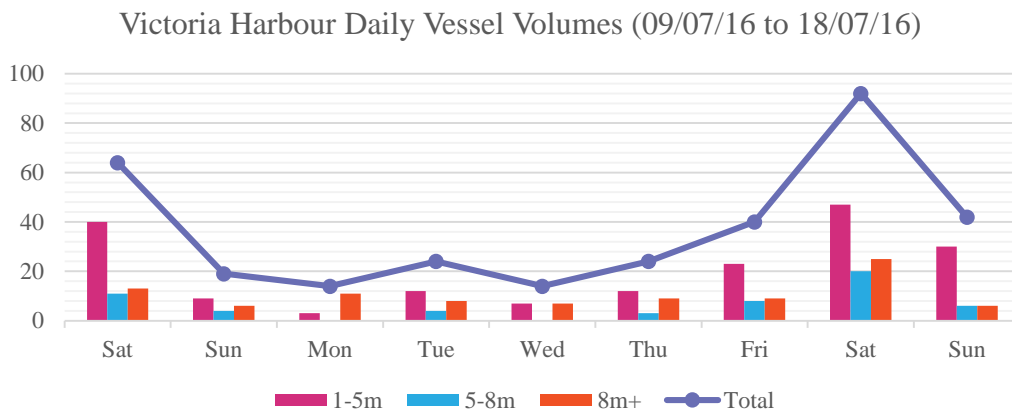


Figure 10: Victoria Harbour Daily Vessel Volumes (09/07/16 to 18/07/16)

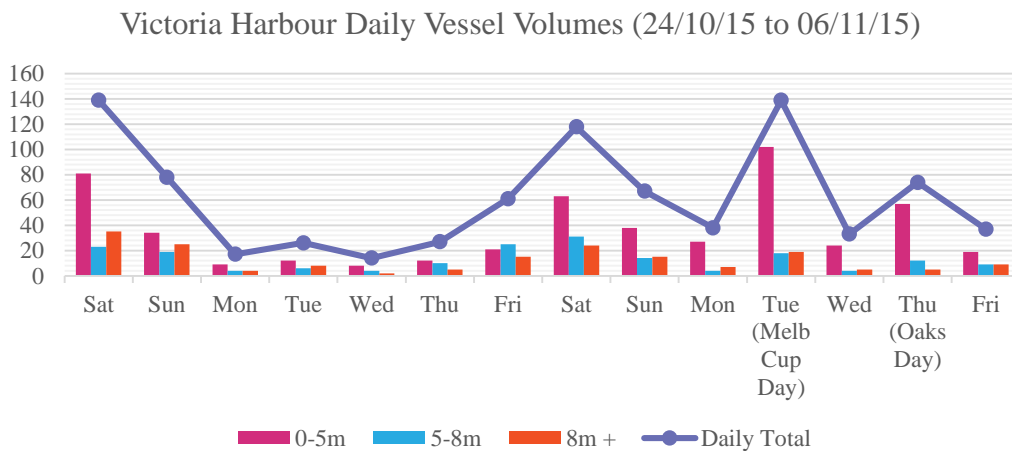


Figure 11: Victoria Harbour Daily Vessel Volumes (24/10/15 to 06/11/15)

In general, vessel traffic in spring 2015 was found to be higher than in winter 2016. Over the entire recording periods, the spring 2015 recorded an average daily vessel count of 58 compared to 37 in winter 2016. This suggests that vessel usage can vary by up to 50% between seasons, although caution must be taken when extrapolating results from only two survey periods.

Figure 11 and Figure 12 show a comparison between the mean daily weekday, and weekend vessel traffic between the 2015 and 2016 survey periods. For this comparison, Melbourne Cup day and Oaks day have been excluded from the analysis, as they are not expected to represent a typical weekday. It is noted that weekday traffic generally peaks in the mornings, between 8am and 11am on weekdays. Weekend traffic generally peaks later, between noon and late afternoon.

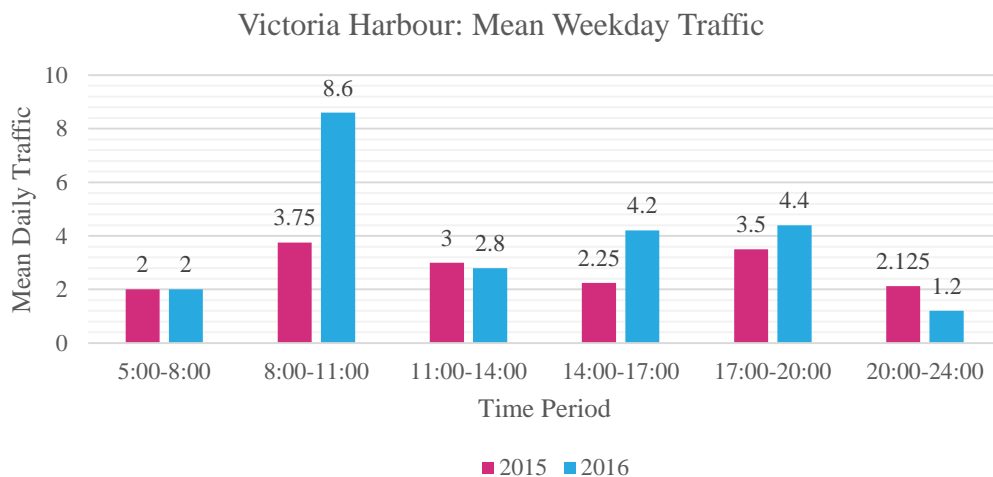


Figure 12: Victoria Harbour Mean Daily Weekday Traffic Distribution (Excluding Melbourne Cup Day and Oaks day)

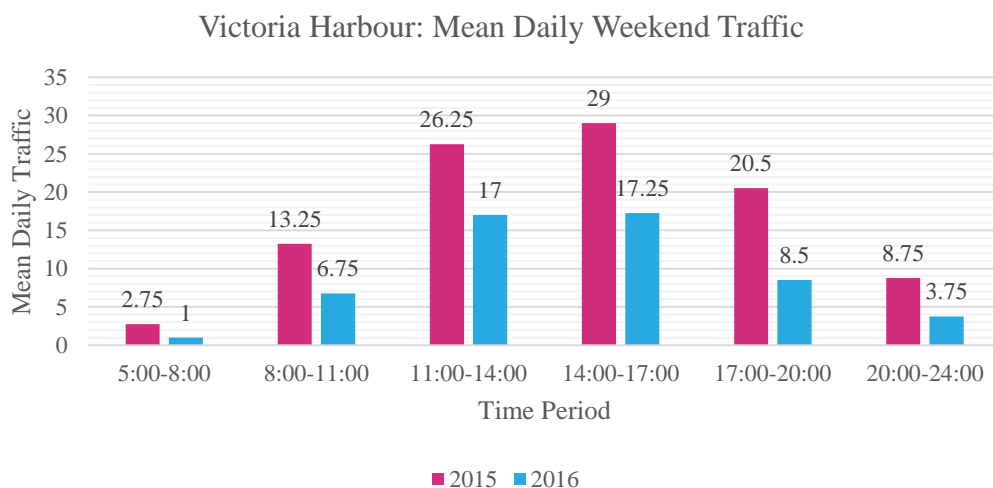


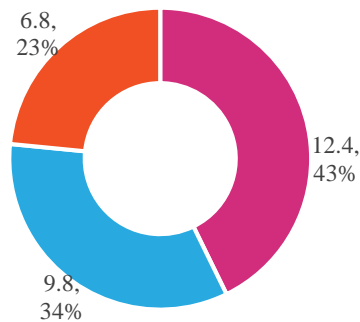
Figure 13: Victoria Harbour Daily Weekend Traffic Distribution (2015 vs 2016)

Of particular interest for this report is how the height of vessels using the harbour varies between studies. Figure 13 and Figure 14 compare the distribution vessel

heights over weekday and weekend periods respectively. From these, it is seen that high masted vessel traffic is larger in 2016, as a percentage of total traffic, for weekday periods, but reduced slightly on weekends. It is noted that vessels of 5m height fall into the 1-5m category, and 8m vessels into the 5-8m category.

Mean Weekday Boat
Traffic - Height
Distribution 2015

■ 1-5m ■ 5-8m ■ 8m+



Mean Weekday Boat
Traffic - Height
Distribution 2016

■ 1-5m ■ 5-8m ■ 8m+

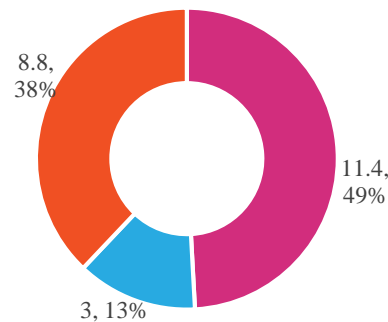
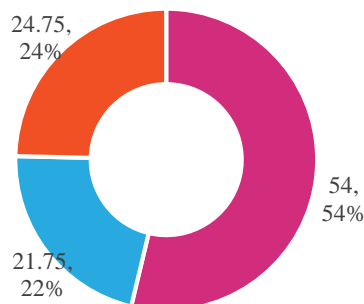


Figure 14: Weekday vessel height distribution (2015 vs 2016)

Mean Weekend Boat
Traffic - Height
Distribution 2015

■ 1-5m ■ 5-8m ■ 8m+



Mean Weekend Boat
Traffic - Height
Distribution 2016

■ 1-5m ■ 5-8m ■ 8m+

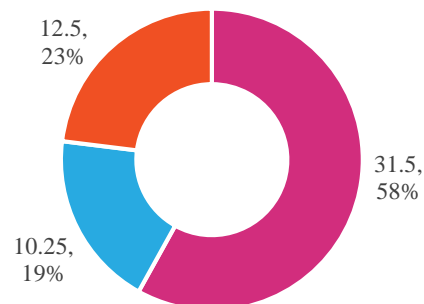


Figure 15: Weekend vessel height distribution (2015 vs 2016)

3.3 Growth Assumption

There have been four methods that have been used to give indications of future growth in vessel traffic for Yarra's Edge Marina. The following table gives a summary of all the review methods mentioned above, and their implication on the growth assumption.

Table 3: Results of each analysis method and associated implication on the growth assumption

Analysis Method	Results and implication on growth assumption
Review of historical marina aerals	Marina usage appears to be growing annually, suggesting that vessel traffic will also increase proportionally until all pens are sold and fully utilised.
Review of current marina utilisation	Review of the current marina found that it was nearing capacity, with 90% of the berths known to be occupied and the status of the remaining 10% unclear. Assuming the main source of vessel traffic to & from the marina are boats that berth there, this suggests that vessel traffic will not increase significantly in the future.
Review of Victorian Vessel Registration	New Victorian boat registrations for Melbourne ports have shown a downward trend since the 1980's. Currently new boat registrations are at their lowest. If this trend were to continue, boat traffic is not expected to change significantly in the future.
Survey of Victoria Harbour Boats	Video survey of vessels in Victoria Harbour marina showed a reduction in the total volume of vessels when compared with 2015. Noting the limitations of comparing these two survey periods, these results should not be used to draw conclusions at this time. It is noted that the primary intention of the survey was to identify the seasonality in vessel traffic so as to inform bridge height recommendations. Up to 50% more daily traffic was observed over the spring period compared to winter, however with only two comparison periods caution must be taken when applying these findings.

Given the findings indicated in Table 3 it is not possible to accurately determine a growth factor for vessel traffic. However the majority of the methods indicate that growth will not be significant for the Yarra's Edge Marina. As such, the following analysis of Yarra's Edge Marina is conducted on the raw survey findings only, with no additional growth factors applied.

3.4 Yarra's Edge Movement Analysis Findings

As with Victoria Harbour, the video survey of Yarra's Edge Marina found peaks in vessel traffic on weekends as shown in Figure 15. Figure 16 compares mean weekday and weekend vessel traffic toward Yarra's Edge Marina. It can be seen that vessel traffic generally peaks between 11:00am and 2:00pm on both weekend and weekdays. The peak period for vessels transiting the Yarra River is in the middle of the day, as opposed to morning and afternoon for Victoria harbour. This appears to be influenced by more passenger vessels (eg ferries and party

boats) operating out of Southbank than the recreational vessel based at Yarra's Edge Marina. The passenger vessels will typically take cruises towards the river mouth before returning. The exception are the large ferries that are constrained by the Grimes Bridge from using Southbank and therefore are based at Victoria Harbour.

There is a significant difference in the magnitude of vessel usage when comparing weekend and weekday periods. Weekend periods generally experienced much greater vessel usage than weekdays, with a much higher afternoon usage rate. Findings which are consistent with that of Victoria Harbour.

It is noted that all vessel traffic east of the Bolte Bridge was recorded, not just recreational vessel travelling to Yarra's Edge Marina. Some vessels may berth at the Riverhomes pontoons, however given the relative capacity of these pontoons the traffic attributable to this area is considered relatively minor.

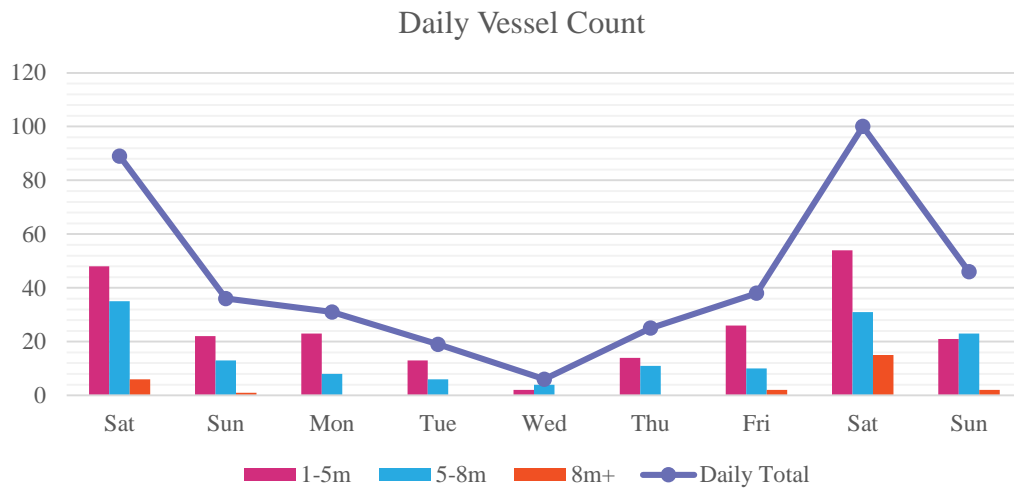


Figure 16: Daily vessel volumes

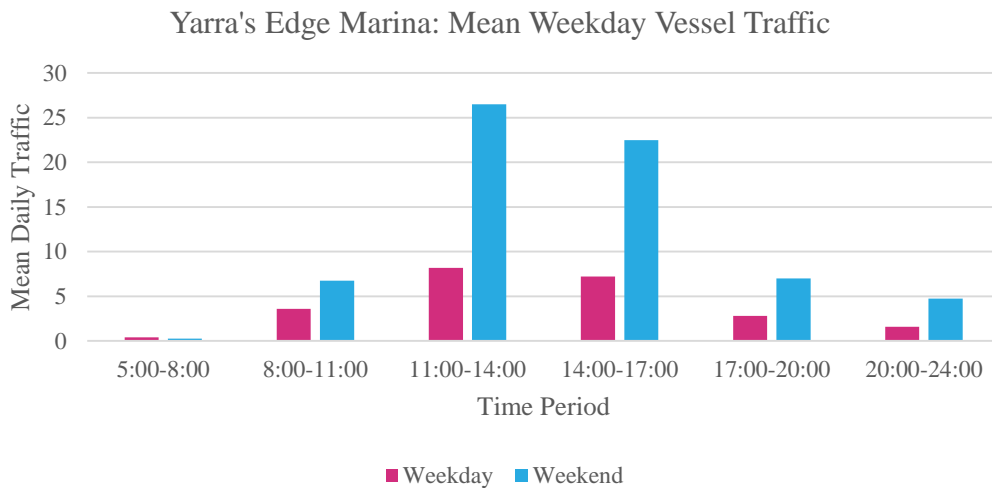


Figure 17: Distribution of mean vessel traffic over weekday and weekend period

In terms of the distribution in vessel types and heights, the surveyed traffic broadly matches the analysis of berthed vessels from Section 2. Figure 18 shows the distribution of boat types from the vessel survey.

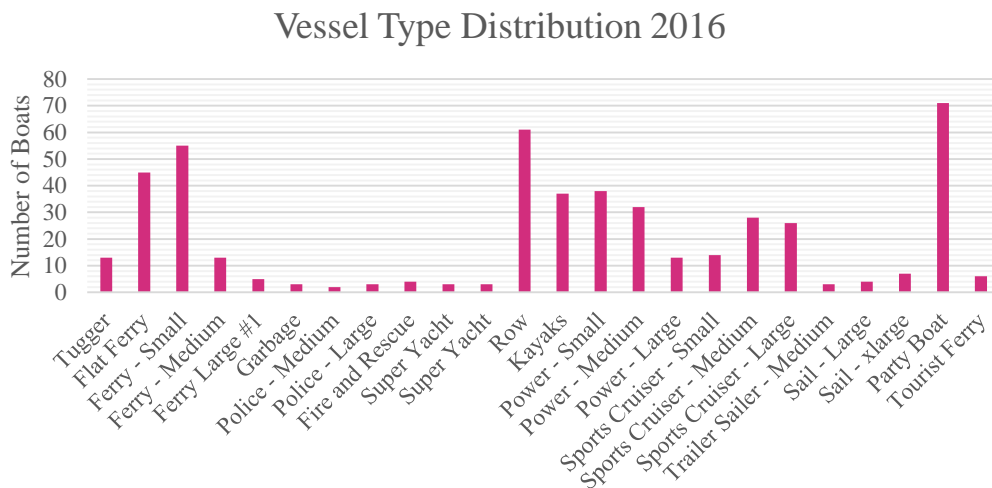


Figure 18: Total number of vessels observed, by type, over the survey period

Throughout the survey period, an average minimum temperature of 6.8°C and maximum of 14.3°C was experienced along with an average daily rainfall of 5.8mm. These conditions are not considered favourable for boating, and may have contributed to a lower vessel usage rate than a typical week.

Figure 19 and Figure 20 show the mean weekday and weekend distribution of various vessel heights. In general, most traffic on weekend and weekday periods are small, 1-5m high boats, with very few boats greater than 8m observed.

This indicates that yachts and high masted vessels are less likely to be used on weekdays compared to smaller vessels.

Mean Weekday Height Distribution

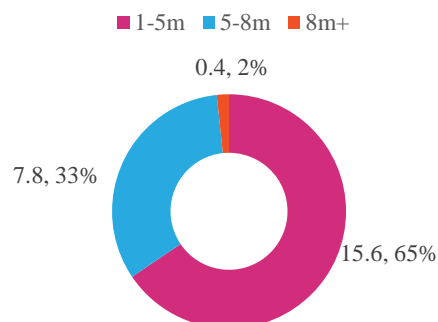


Figure 19: Mean height distribution of vessels over weekday period

Mean Weekend Height Distribution

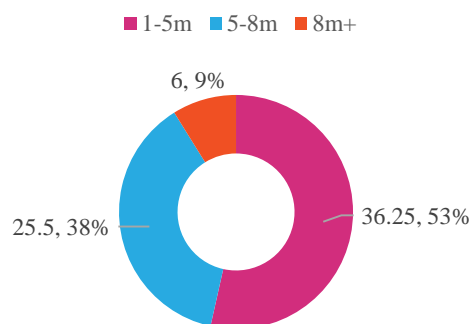


Figure 20: Mean height distribution of vessels over weekend period

4 Recommendation on Bridge Height

Using the vessel height distributions identified previously, a recommendation on the required bridge height can be made. Figure 21 shows the cumulative height distribution of vessels berthed in the Marina, against those recorded over the length of the video analysis. In general, these results indicate that smaller vessels are used more frequently within the marina.

It is noted that for this analysis small boats, such as kayaks and rowing boats are excluded from the cumulative height distribution as they have no impact on the bridge height recommendation.

Figure 22 shows the recommended bridge heights, to Australian Height Datum, for the vessels to pass. This is measured at highest astronomical tide, with a 500mm allowance for freeboard. The figure shows the bridge height required will change depending on whether the video surveyed vessel frequency is used, or the distribution of vessels within the Marina is utilised.

As a conservative estimate, the berthed vessel distribution has been adopted when determining bridge height. An allowance for 800mm sea level rise by 2100 has also been indicated on the figure (in line with Melbourne Water's *Planning for Sea Level Rise* documentation).

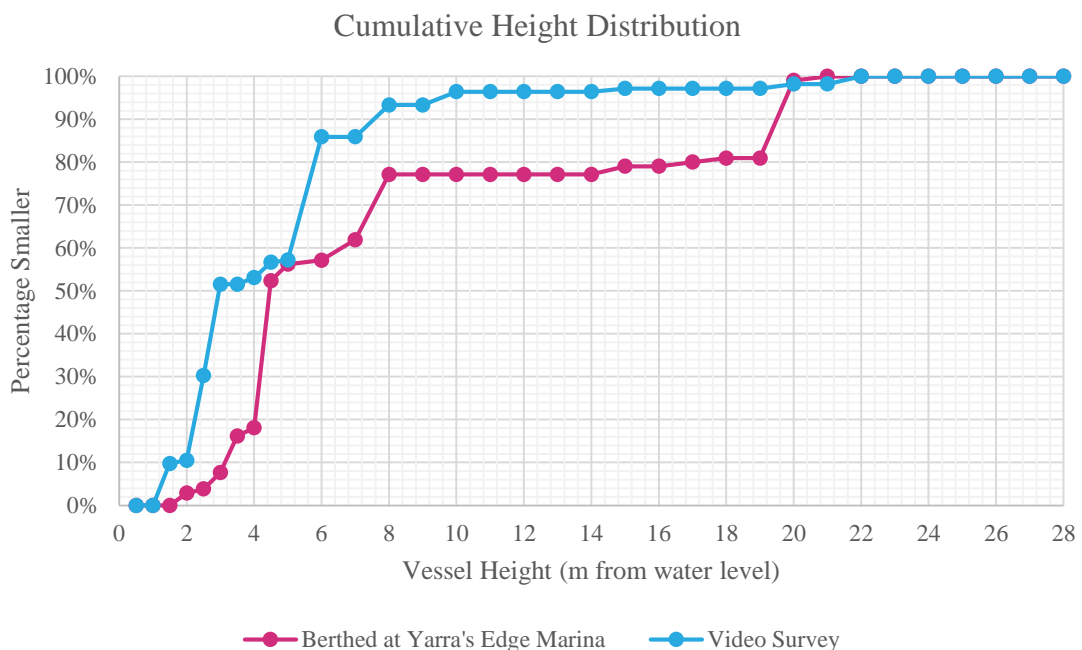


Figure 21: Cumulative Height Distribution of Berthed and Video Survey Vessels

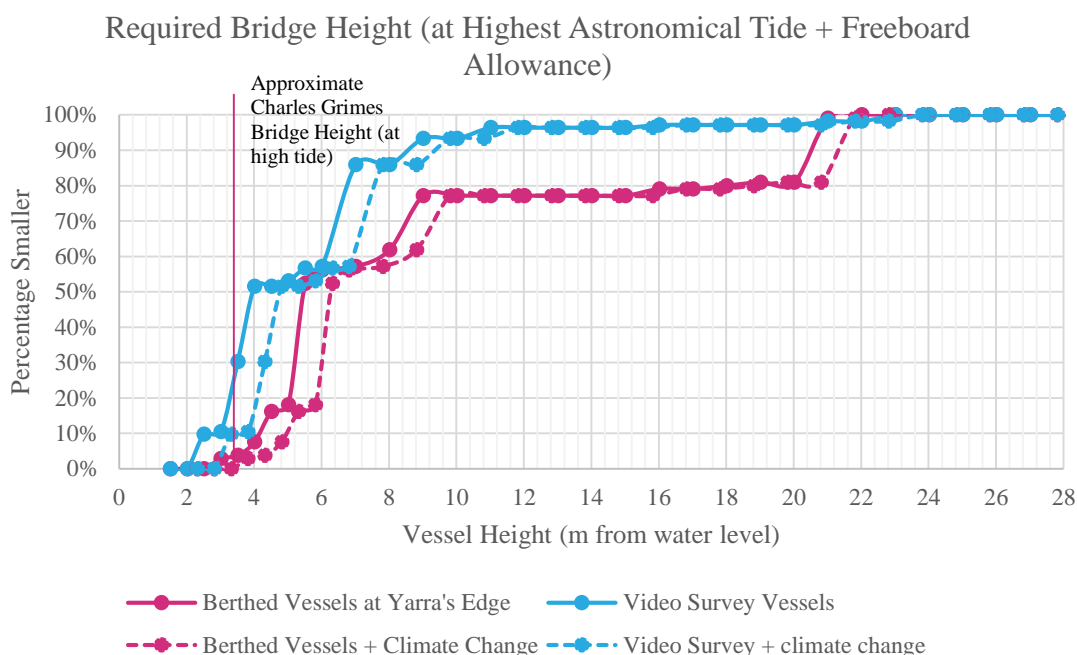


Figure 22: Required bridge height

Using linear interpolation of Figure 22, the minimum required bridge height was determined for 50%, 70%, 85% and 95% of the vessels to pass – shown below in Table 4. As noted previously, the given bridge height is from highest astronomical tide with an allowance for 500mm of free board. Additional influences on tide such as storm events and flooding are not included. The height recommendation similarly does not account for additional clearances required from the underside of the bridge. The 2040 and 2100 sea level rises account for a 200 and 800mm rise in water level respectively, as suggested by Melbourne Water.

Table 4: Recommended minimum bridge heights

% Passing	Minimum required bridge height (m) (AHD)	2040 Sea level (m) (AHD)	2100 Sea level (m) (AHD)
50	5.49	5.69	6.29
70	8.55	8.75	9.35
85	19.47	19.67	20.27
95	20.57	20.77	21.37

For context, if the bridge were to resemble the current Charles Grimes bridge (2.89m clearance at high tide), then only 7% of the berthed marina vessels will be able to pass.

4.1 Vessels Impacted

To further understand the impact of bridge height on the vessels using the Marina, a breakdown of the number of vessels impacted is given in Table 5. This table shows both results from the movement analysis and the static berthing analysis,

giving an indication of the number of vessels likely to be impacted by various bridge heights.

It is noted that this analysis is conducted assuming highest astronomical tide, a 500mm freeboard clearance and a 200mm allowance for rising sea level by 2040. Analysis is for July with no seasonal adjustments applied. As such, it is possible that number of vessels passing during average weekdays and weekends may be increased by up to 50% in spring and summer months.

Table 5: Volume of vessels impacted by various bridge heights

Bridge Height (m) (AHD)	Vessels able to pass – average weekday	Vessels able to pass – average weekday	Vessels able to pass – average weekend day	Vessels unable to pass – average weekend day	Number of Yarra's Edge Marina berthed vessels able to pass	Number of Yarra's Edge Marina berthed vessels unable to pass
5	13.2	10.6	33.75	27.2	20	85
6	15.2	8.6	36.25	25.2	56	49
7	21.8	2	46.25	17.2	60	45
8	23.2	0.6	54.75	10.4	63	42
9	23.2	0.6	54.75	10.4	65	40
10	23.4	0.4	61.75	4.8	81	24
15	23.8	0	64.25	2.8	81	24

4.2 Opening Bridge Option

One possible way to ensure vessel access to Yarra's Edge Marina is an opening span bridge. Figure 22 and Figure 23 below show the mean hourly vessel traffic that would pass under bridge unimpeded, or require the bridge to be opened, were the bridge to resemble the current Charles Grimes Bridge. This analysis assumes the vessel traffic distribution as observed in the video analysis, and may increase during the spring and summer months. As with previous analyses, rowing boats and kayaks have been excluded. Results shown are for high tide, with a 500mm freeboard allowance. No allowance for sea level rise has been incorporated into this result.

At this height, the bridge will on average requiring opening 2.8 times per hour during peak vessel periods on weekdays, and up to 7.75 times per hour on weekends. As noted previously, these periods do not correspond with peak commuting times.

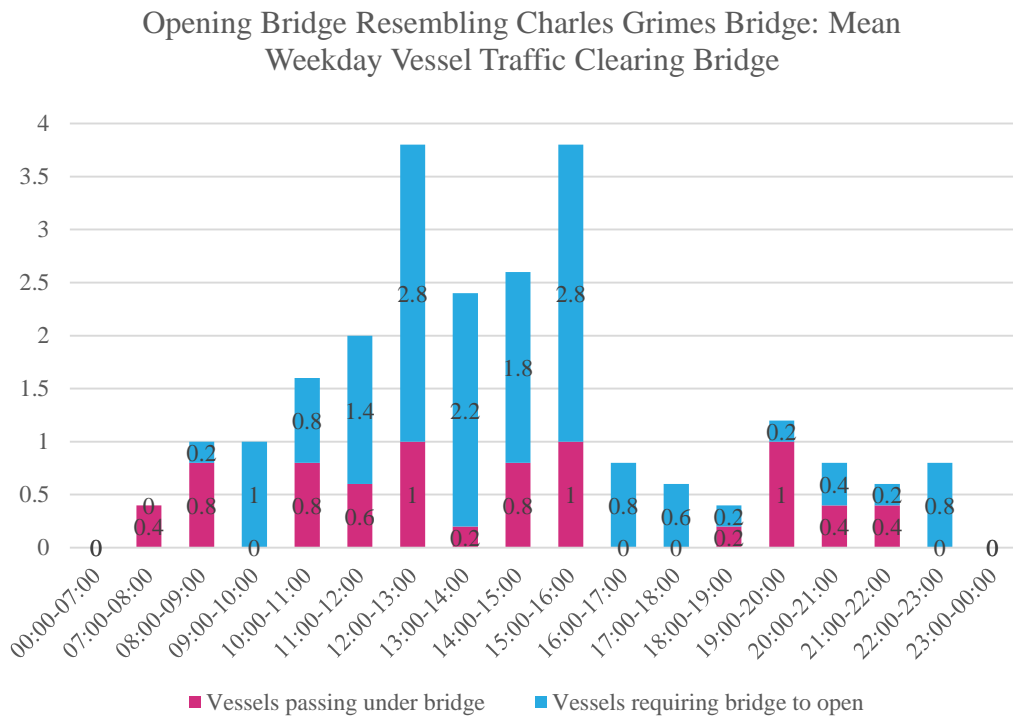


Figure 23: Mean Daily Weekday Vessel Traffic Clearing a Bridge resembling Charles Grimes Bridge

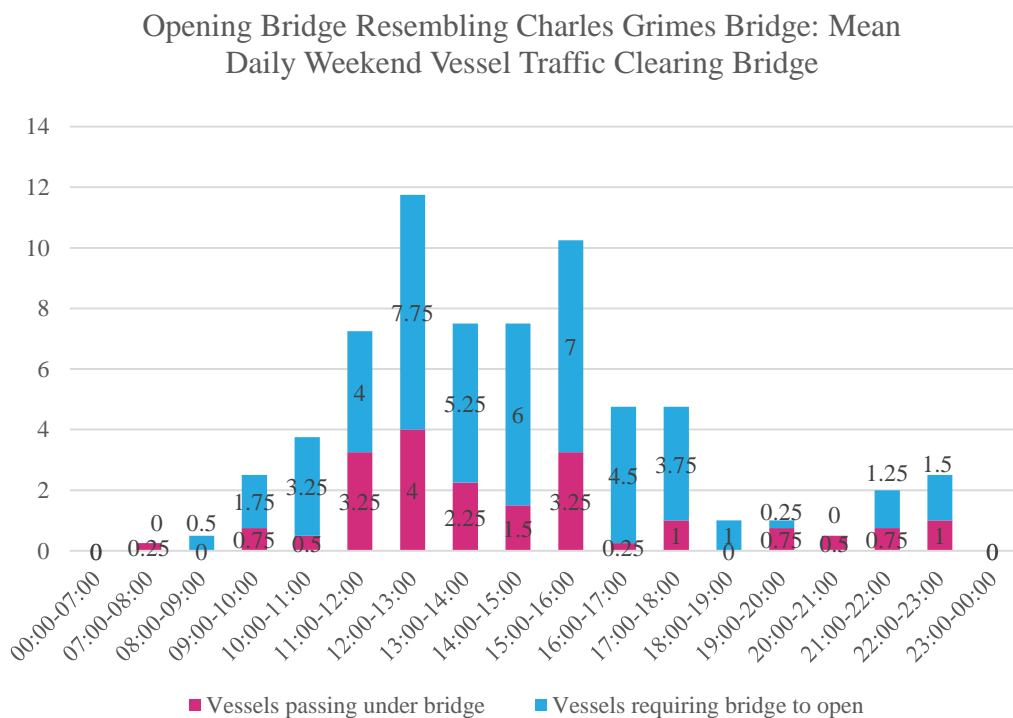


Figure 24: Mean Daily Weekend Vessel Traffic Clearing a Bridge resembling Charles Grimes Bridge

5 Potential Berthing Locations

Were the Collin's street extension to be constructed, it is likely that a number of the boats currently using the marina will require relocation. As such, a number of potential new vessel berthing locations was investigated. These locations can be seen attached as SK-001 and SK-002 in the appendix. A brief summary of each identified berthing location is given below in Table 5. These summaries are informed by a discussion held with the City of Melbourne on August 3.

Table 6: Overview of potential berthing locations

Location Number	Location Name	Description
1	Yarra's Edge Pontoons / River Homes	Pontoons along the south side of the Yarra are currently tied to the adjacent apartments. These pontoons do not extend over the entire waterfront, and as such there may be scope to develop additional pontoons along this region.
2	North Wharf / North bank	There are currently no boat berths along the northern bank of the Yarra. However it is understood that the City of Melbourne have plans to develop it into a commercial vessels and water ways regulatory centre.
3	Victoria harbour	The current Docklands Waterways Strategic Plan has zoned all regions of Victoria Harbour for future development. However, as some of these regions are marked for public and residential boats, there may be an opportunity to purchase or acquire some of these future berths for boats in the Marina.
4	Maribyrnong River Banks	The banks of the Maribyrnong river currently have some berths available. This is owned by the Port of Melbourne corporation, and much redevelopment would be required to make this a suitable berthing location. It is noted that the planned Western Distributor bridge along this region may impact on any relocations to this site.
5	Port Activities Centre	The port activities centre is currently vacant. It is possible to redevelop this site into a marina or share the space available between the two functions.
6	Pier 35	Pier 35 currently has a number of pontoons. It may be possible to extend these pontoons to the west to create additional berths. The extent of this possible development is limited by the path of vessels accessing Port of Melbourne.
7	#8 South Wharf	The disused cargo wharf has the potential to be redeveloped into a marina. However, it is possible that the turning movements of larger Port of Melbourne Vessels will encroach on this space.
8	Bolte West Precinct	Bolte West has been flagged for development into a Marine Precinct by the City of Melbourne – where fuelling and servicing of larger boats may occur. However, it may be possible to instead develop this location into additional berths.

5.1 Multi-criteria analysis

To determine the suitability of the locations detailed above, a multi-criteria analysis (MCA) was conducted. Six criteria were identified and a score from one to five was assigned for each location. The ranking schedule for each of these criteria are given in Table 5, while the ranking assigned to each location is shown in Table 6. Each ranking criteria was given a relative weighting based on relative importance. These weightings are also indicated in Table 6.

Results found that locations 1-3 (Yarra's edge pontoons, North Wharf/North Bank and Victoria Harbour) all scored very highly. Given the less than 5% difference between the weighted scores, they can all be considered equally preferred options.

The use of Maribyrnong River Banks is by far the least desirable outcome from this analysis. This is due to its poor surroundings, location and relatively high cost of development.

It is noted that these results are sensitive to the weighting assigned to each criterion and may require further refinement depending on DELWP's requirements.

Table 7: MCA grading criteria

Criteria (weighting)	Score				
	5	4	3	2	1
Cost (10%)	Approximately a quarter of the cost of upgrading option 1.	Significantly cheaper than upgrading option 1. Approximately half the cost.	Slightly cheaper than upgrading location 1.	Similar cost of upgrade to adjacent berths (Option 1: Yarra's Edge Pontoons)	Most expensive option
Accessibility (20%)	10 minute walk from current location	20 minute walk from current location	5 minute drive from current location	15 minute drive from current location	>15 minute drive from current location
Planning Risk (10%)	Easy to redevelop, little planning restrictions	Few planning restrictions, few barriers to land acquisition and relatively straightforward development process	Some planning restrictions, some difficulty in gaining approval and/or acquiring the land/lot	Very difficult to gain approval and/or acquire the land/lot from a private owner	Extremely difficult to gain approval and/or acquire the land/lot from a private owner

Criteria (weighting)	Score				
	5	4	3	2	1
Amenity of destination and facilities (25%)	Highly desirable destination – Adjacent to multiple accommodation, entertainment and restaurant options. Good marina facilities and security.	Desirable destination – Close proximity to accommodation, entertainment and restaurants. Good marina facilities and security.	Mediocre destination – Reasonable proximity to some accommodation, entertainment and restaurants. Adequate marina facilities and security	Unappealing destination – Limited accommodation, entertainment and restaurants. Deficient or crowded marina facilities and basic security	Undesirable destination – No nearby accommodation, entertainment or restaurants. No marina facilities and poor security.
Capacity for additional berths (15%)	Capacity for all Yarra's Edge Marina berthed vessels to be relocated	Capacity for 70% of Yarra's Edge Marina berthed vessels to be relocated	Capacity for 50% of Yarra's Edge Marina berthed vessels to be relocated	Capacity for 20% of Yarra's Edge Marina berthed vessels to be relocated	Capacity for 10% of Yarra's Edge Marina berthed vessels to be relocated
Construction Risk (10%)	Straight forward construction of very low complexity project, easily accessed by construction plant	Low complexity project, restoring previous infrastructure, all plant can access site easily	Some difficulty in construction, most construction plant can access site easily	Moderate to high degree of complexity, restricted access for construction plant	Development of completely new location, very restricted access for construction plant
Exposure (10%)	Limited wash experienced from Port of Melbourne Vessels and structures shielding of boats from one or more sides	Limited wash experienced from Port of Melbourne Vessels and/or structures shielding of boats from one side	Slight protection provided from wind and Port of Melbourne vessel wash	Within 500m of port of Melbourne Vessels and/or no structure or landform to shield from wind	Within 200m of port of Melbourne Vessels and/or no structure or landform to shield from wind

Table 8: MCA grading results

Criteria (weighting)	Location							
	1. River- homes	2. North Bank	3. Vic. Har.	4. Mari. River	5. Port Act. Cent.	6. Pier 35	7. #8 S. Wharf	8. Bolte W. Precinct
Cost (10%)	4	4	4	2	5	5	3	3
Accessibility (20%)	5	5	4	1	3	3	4	3
Planning Risk (10%)	3	2	3	1	1	3	1	2
Amenity (25%)	5	5	5	1	3	3	2	3
Capacity for Additional Berths (15%)	3	4	4	2	2	2	2	2
Construction Risk (10%)	4	4	5	3	3	4	3	3
Exposure (10%)	5	5	4	4	1	1	2	4
Weighted Score	4.30	4.35	4.25	1.75	2.65	2.95	2.50	2.85
Ranking	2	1	3	8	6	4	7	5

A1 Marina Survey Results

Table 9: Marina Boat Survey

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
1	Sport Cruiser	Unknown	4.5	15	3.7	-	No	No
2	Sail Yacht	Unknown	20.3	14	4.3	Fixed	No	No
3	Sail Yacht	Unknown	20	15	4.2	Fixed	No	No
4	Sail Yacht	Unknown	20	14	4.2	Fixed	No	No
5	Flybridge Cruiser	Unknown	6.3	13	4.2	-	Fixed	No
6	Sport Cruiser	Unknown	0.45	10	4.2	-	Fixed	No
7	Sport Cruiser	Unknown	4.9	10	3.4	-	Fixed	No
8	Flybridge Cruiser	Unknown	6.5	12	3.4	-	Fixed	No
9	Flybridge Cruiser	Unknown	6.8	10	5.64	-	yes	yes
10	Sail Yacht	Unknown	14.63	12	3.5	Fixed	No	No
11	Catamaran	Unknown	19.7	13	6.74	fixed	no	no
12	Flybridge Cruiser	Unknown	6.6	11	5.64	-	Fixed	No
13	Sail Yacht	Unknown	14.63	10	5	Fixed	No	No
14	Catamaran	Unknown	19.7	14	6.74	Fixed	No	No
15	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
16	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
17	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
18	Sport Cruiser	Unknown	4.5	21	5.3		Fixed	No
19	Modified Fishing Boat	Unknown	2.5	11	3.8	Fixed	No	No
20	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
21	Sail Yacht	Unknown	20	14	4	Fixed	No	No
22	Flybridge Cruiser	Unknown	8	13	4.15	-	Fixed	No
23	Power Boat	Unknown	2	9	3.1	-	No	Yes
24	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
25	Sail Yacht	Unknown	20	12	4	Fixed	No	No
26	Flybridge Cruiser	Unknown	8	13	3.4	-	No	No
27	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
28	Flybridge Cruiser	Unknown	8	12	4	-	No	No
29	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
30	Sport Cruiser	Unknown	4.5	10	3.5	-	No	No
31	Sport Cruiser	Unknown	4.5	11	3.4	-	No	No
32	Sail Yacht	Unknown	20	11	4.1	Fixed	No	No
33	Sport Cruiser	Unknown	4.5	11	4	-	No	No
34	Sport Cruiser	Unknown	4.5	10	4	-	No	No
35	Sport Cruiser	Unknown	4.5	11	3.7	-	No	No
36	Traditional Cruiser	Unknown	3.5	11	4	-	No	No

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
37	Sport Cruiser	Unknown	4.5	13	3.7	-	No	No
38	Sail Yacht	Unknown	20	13	4.2	Fixed	No	No
39	Sport Cruiser	unknown	4.5	14	3.6	-	No	No
40	Flybridge Cruiser	Unknown	8	12	4.1	-	No	No
41	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
42	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
43	Sail Yacht	Unknown	20	14	4.3	Fixed	No	No
44	Flybridge Cruiser	Unknown	8	16	4.3	-	No	No
45	Catamaran	Unknown	20	12	6.9	Fixed	No	No
46	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
47	Empty	Not For Sale	Empty	vacant		vacant	vacant	vacant
48	Sport Cruiser	Unknown	4.5	10	4	-	No	No
49	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
50	Sport Cruiser	Unknown	4.5	14	4.45	-	No	No
51	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
52	Flybridge Cruiser	Unknown	8	14	4.15	-	No	No
53	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
54	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
55	Flybridge Cruiser	Unknown	8	17	4.5	-	Fixed	No
56	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
57	Flybridge Cruiser	Unknown	8	15	4.5	-	Fixed	No
58	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
59	Catamaran	Leopard 45	20	13.6	7.3	Fixed	No	No
60	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
61	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
62	Flybridge Cruiser	Unknown	3.75	14	2.75	-	Fixed	No
63	Flybridge Cruiser	Unknown	8	15	4.2	-	Fixed	No
64	Sport Cruiser	Mustang	3.3	14	4.2	-	Fixed	No
65	Sport Cruiser	Unknown	3.3	9	4.2	-	No	No
66	Sail Yacht	Jeanneau Sun Odyssey 50Ds	19.6	15.07	4.49	Fixed	No	No
67	Flybridge Cruiser	Unknown	8	12	3.9	-	No	No
68	Sail Yacht	Unknown	20	13	4.02	Fixed	No	No
69	Sail Yacht	Unknown	4.7	14	4.2	-	Fixed	No
70	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
71	Sport Cruiser	Unknown	4.2	14.8	4.2	-	Fixed	No
72	Sport Cruiser	Unknown	4.2	18.61	4.3	-	No	No
73	Sport Cruiser	Unknown	4.5	10	4	-	No	No
74	Sport Cruiser	Unknown	4.5	11	4	-	No	No
75	Sport Cruiser	Unknown	4.5	13	4.2	-	No	No
76	Sport Cruiser	Unknown	4.5	9	4	-	No	No

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
77	Sport Cruiser	Unknown	4.5	14	4	-	No	No
78	Sport Cruiser	Unknown	4.5	11	4	-	Fixed	No
79	Sport Cruiser	Unknown	4.5	13	3.6	-	No	No
80	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
81	Sail Yacht	Unknown	20	13	4	Fixed	No	No
82	Flybridge Cruiser	Unknown	8	14	4.45	-	No	No
83	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
84	Sport Cruiser	Unknown	4.5	12	3.61	-	No	No
85	Empty	For Sale	Empty	vacant	vacant	vacant	vacant	vacant
86	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
87	Sport Cruiser	Unknown	4.5	13	3.9	-	No	No
88	Traditional Cruiser	Unknown	3.5	15	4.2	-	No	No
89	Catamaran	Unknown	20	17	7.5	-	Fixed	No
90	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
91	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
92	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
93	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
94	Sport Cruiser	Unknown	4.5	14	3.5	-	No	No
95	Sport Cruiser	Unknown	4.5	12	4	-	No	No
96	Sport Cruiser	Unknown	4.5	14	3.8	-	No	No

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
97	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
98	Sport Cruiser	Unknown	4.5	13	4.6	-	No	No
99	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
100	Traditional Cruiser	Unknown	3.5	13	4.03	-	No	No
101	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
102	Sport Cruiser	Unknown	4.5	10	3	-	Fixed	No
103	Flybridge Cruiser	Unknown	8	14	4.27	-		
104	Catamaran	Adventuresails.com.au	20	15	7.7	Fixed	No	No
105	Sport Cruiser	Unknown	4.5	10	3.27	-	No	No
106	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
107	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
108	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
109	Sport Cruiser	Unknown	4.5	13	3.73	-	No	No
110	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
111	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
112	Sport Cruiser	Unknown	4.5	9	3.5	-	No	No
113	Sail Yacht	Unknown	18	10	3.61	Fixed	No	No
114	Sail Yacht	Unknown	17	10	3.61	Fixed	No	No
115	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
116	Traditional Cruiser	Unknown	3.5	12	3.3	-	No	No

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
117	Power Boat	Unknown	2	11	4	-	No	No
118	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
119	Kayak	Unknown	1	9	1	-	No	No
120	Sport Cruiser	Unknown	4.5	11	3.5	-	No	No
121	Power Boat	Unknown	3.7	11	3	-	No	No
122	Sport Cruiser	Unknown	4.5	13	3.8	-	No	No
123	Sport Cruiser	Unknown	3.2	12	3.8	-	No	No
124	Traditional Cruiser	Unknown	2.7	9	3.2	-	Fixed	No
125	Sport Cruiser	Unknown	2.8	11	3.4	-	No	Yes
126	Sport Cruiser	Unknown	4.5	11	3.4	-	No	Yes
127	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
128	Sport Cruiser	Unknown	4.5	12	3.8	-	No	No
129	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
130	Sport Cruiser	Unknown	4.5	12	3.8	-	No	No
131	Power Boat	Unknown	2	9	2.6	-	No	Yes
132	Empty	Not For Sale	vacant	vacant	vacant	vacant	vacant	vacant
133	Empty	For Sale	vacant	vacant	vacant	vacant	vacant	vacant
134	Empty	Not For Sale	vacant	vacant	vacant	vacant	vacant	vacant
135	Power Boat	Unknown	2.7	8.12	2.26	-	No	Yes
136	Sport Cruiser	Unknown	3.5	12.6	3.8	-	Fixed	No

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
137	Sport Cruiser	Unknown	3.1	13	3.7	-	Fixed	No
138	Flybridge Cruiser	Unknown	4.8	21.5	5.3	-	Fixed	No
139	Flybridge Cruiser	Unknown	7	20	5	-	Fixed	No
140	Empty	For Sale	vacant	vacant	vacant	vacant	vacant	vacant
141	Empty	For Sale	vacant	vacant	vacant	vacant	vacant	vacant
142	Sport Cruiser	Unknown	5.1	13	3.7	-	Fixed	No
143	Sport Cruiser	Unknown	3	13	4	-	Fixed	No
144	Flybridge Cruiser	Unknown	8	17	5	-	Fixed	No
145	Sail Yacht	Chardonnay mast?	20	18	5.1	Fixed	No	No
146	Sport Cruiser	Unknown	5	18	4.5	-		
147	Flybridge Cruiser	Unknown	8	18	5	-	Fixed	No
148	Flybridge Cruiser	Unknown	8	16	5	-	Fixed	No
149	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
150	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
151	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
152	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
153	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
154	Empty	Not For Sale	Empty	vacant	vacant	vacant	vacant	vacant
155	Sail Yacht	Unknown	20	10		Fixed (Gaff Rig)	No	No
156	Flybridge Cruiser	Unknown	8	10		-	No	Yes

Berth #	Boat Type	Model Type (if known)	Max Height (m)	Length (m)	Beam (m)	Mast type	Antenna	Bimini
157	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
158	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
159	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
160	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
161	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
162	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
163	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
164	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
165	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
166	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
167	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
168	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
169	Empty	Unknown	Empty	vacant	vacant	vacant	vacant	vacant
170	Sail Yacht	Unknown	20	23			Fixed	No

A2 Vessel Distribution – Victoria Harbour

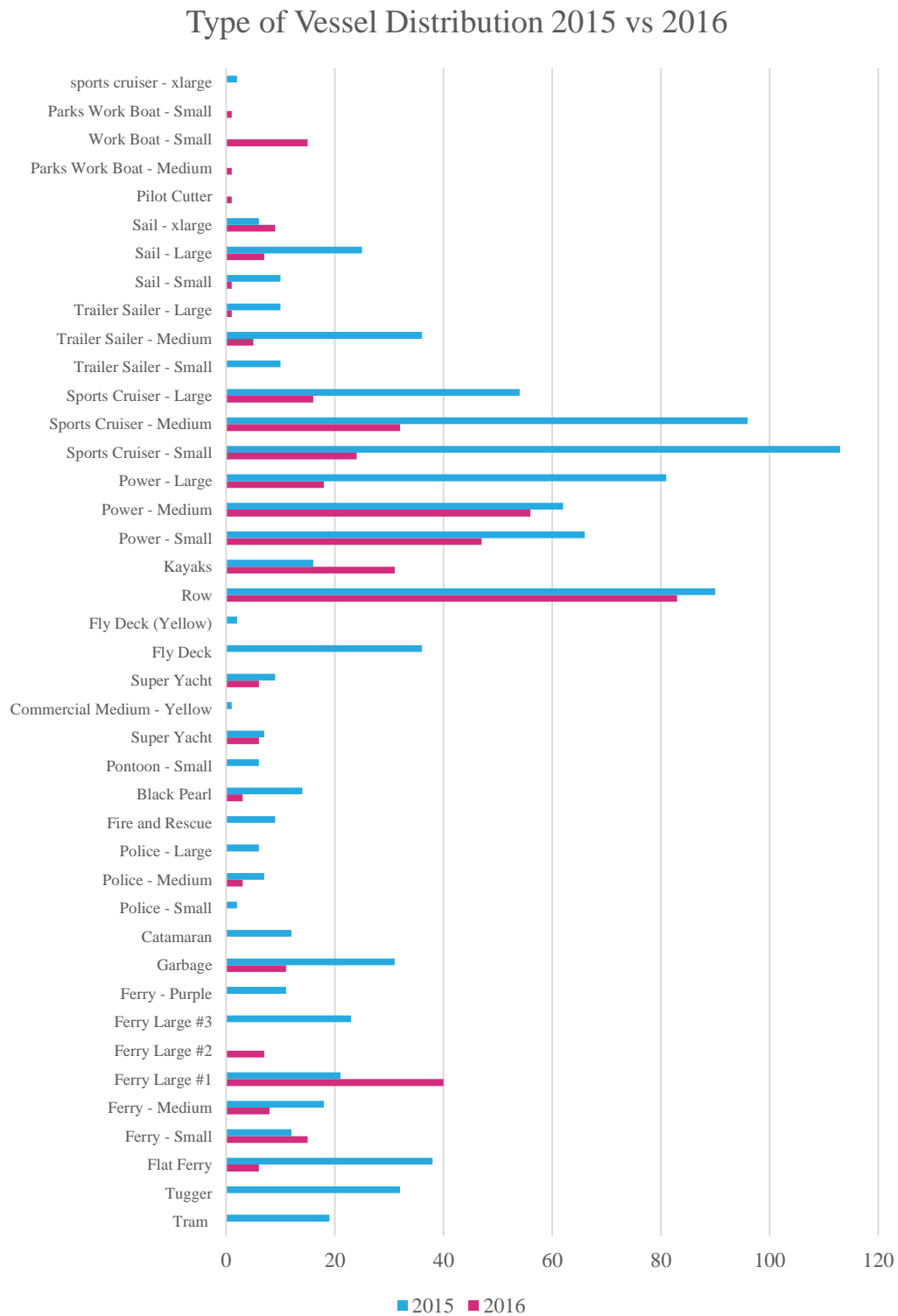
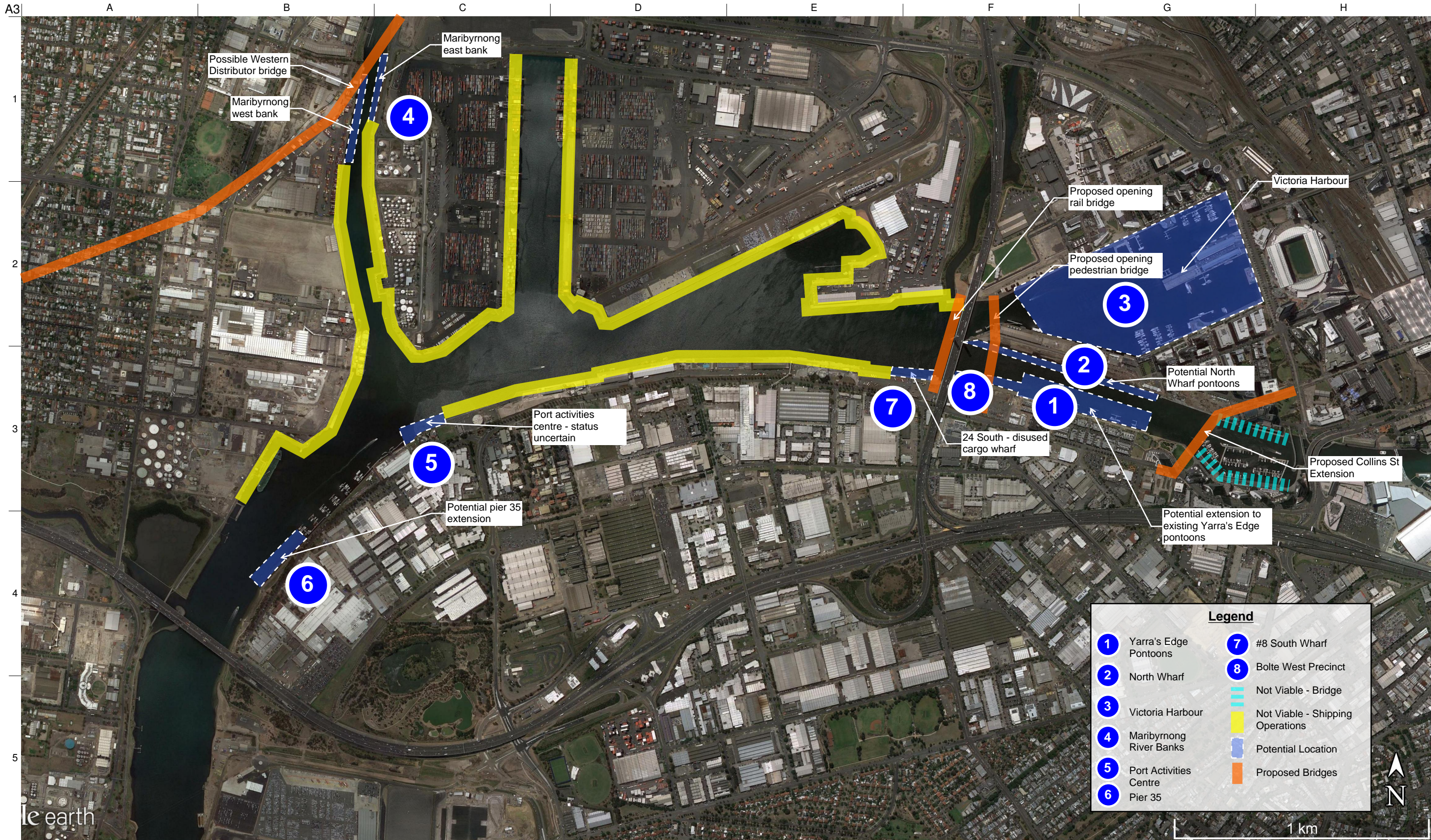


Figure 25: Vessel distribution in Victoria Harbour 2015 v 2016

A3 Potential Berthing Locations (Sketches)



Issue						Issue					
Date						Date					
By						By					
Chkd						Chkd					
Appd						Appd					
P1 15/09/16 MTO IR RN						P1 01/08/16 MTO IR RN					

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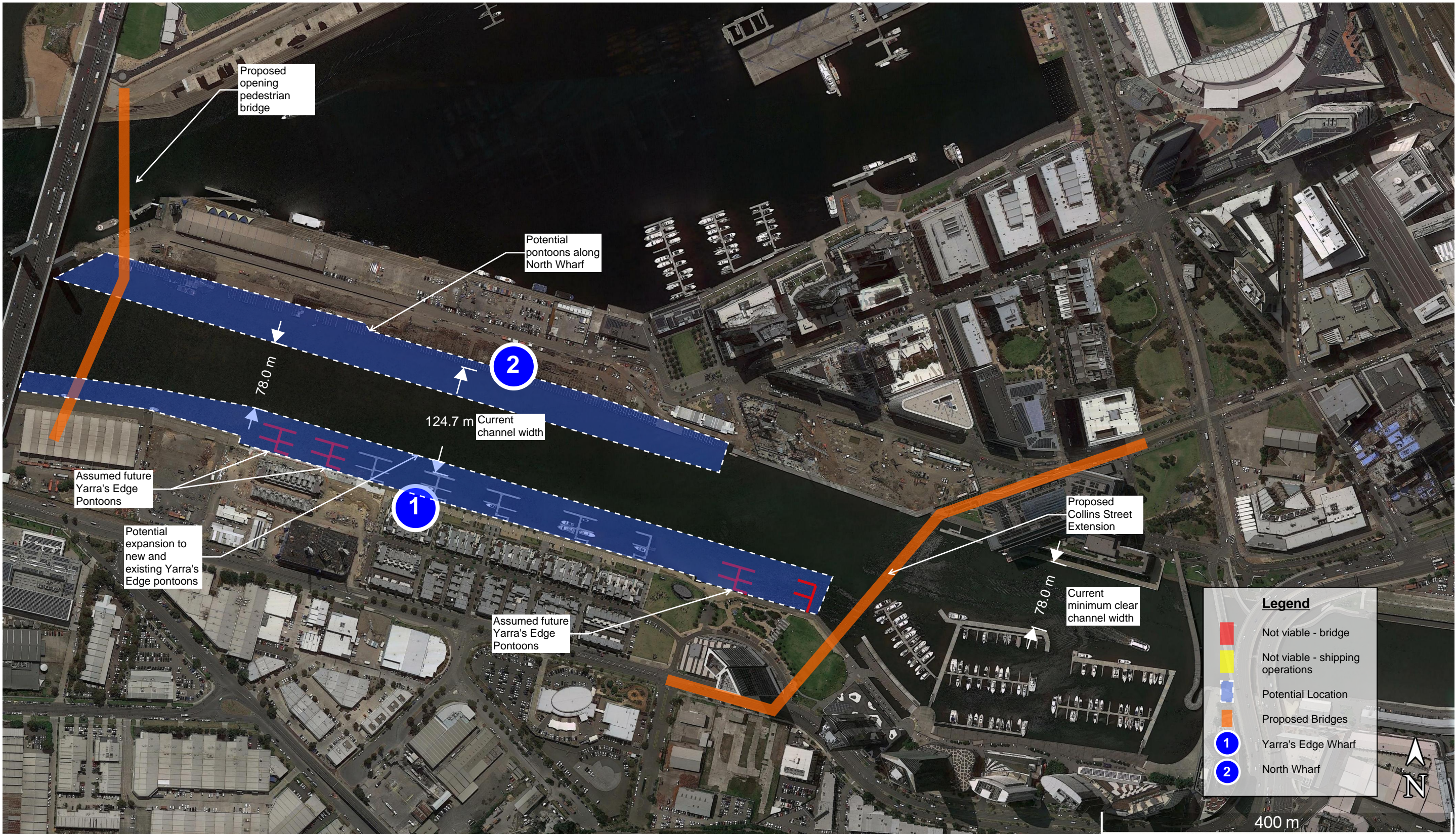
Level 17, 1 Nicholson St
Melbourne, Victoria, 3000
Tel +61(03)9668 5500 Fax +61(03)9663 1546
www.arup.com.au
Arup Pty Ltd
ABN 18 000 966 165



Job Title
Yarra's Edge Marina - Movement Analysis
Client
Department of Land, Water, Environment and Planning

Potential Berthing Locations - Port

Scale at A3
See scale bar
Discipline
Maritime
Drawing Status
For Information
Job No
Drawing No
250429-C-SK-001
Issue



Issue	Date	By	Chkd	Appd
P1	15/09/16	MTO	IR	RN
P1	01/08/16	MTO	IR	RN

Issue	Date	By	Chkd	Appd
P1	15/09/16	MTO	IR	RN
P1	01/08/16	MTO	IR	RN

ARUP

Level 17, 1 Nicholson St
Melbourne, Victoria, 3000
Tel +61(03)9668 5500 Fax +61(03)9663 1546
www.arup.com.au

Arup Pty Ltd
ABN 18 000 966 165

Job Title
Yarra's Edge Marina - Movement Analysis

Client
Department of Land, Water, Environment and Planning

Potential Berthing Locations - Yarra's Edge

Scale at A3
See scale bar

Discipline
Maritime

Drawing Status
For Information

Job No	Drawing No 250429-C-SK-002	Issue
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