Disclaimer- This report was prepared for Sapere Research Group, to inform their work on the Upper North Island Supply Chain Strategy.

It does not represent the views of the Ministry of Transport.

Upper North Island Supply Chain Strategy

Infrastructure

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Glossary of Abbreviations

Abbreviation	Stands for
AC	Auckland Council
AT	Auckland Transport
AUP	Auckland Unitary Plan
BOPRC	Bay of Plenty Regional Council
CBA	Cost Benefit Analysis
GDP	Gross Domestic Product
MACA	Marine and Coastal Area (Takutai Moana) Act
MBIE	Ministry of Business, Innovation and Employment
MMH	Marsden Maritime Holdings Limited
MoT	Ministry of Transport (New Zealand)
NRC	Northland Regional Council
NZTA	New Zealand Transport Agency
POAL	Ports of Auckland Limited
PoT	Port of Tauranga Limited
RMA	Resource Management Act 1991
TEU	Twenty-foot Equivalent Unit
UNISCS	Upper North Island Supply Chain Strategy

Executive summary

This report accompanies the integrative report that summarises the findings of a collective of consultants led by Sapere Research Group (Sapere) in relation to the Upper North Island Supply Chain and the options for a full move of the freight operations of the Ports of Auckland Ltd (POAL). This study has been directed to consider five options for the relocation of the POAL freight task:

- Northport expansion
- Port of Tauranga expansion
- a shared increase in capacity at both Northport and Port of Tauranga
- a new port on the Firth of Thames, and
- a new port on the Manukau Harbour.

This report documents the work within the infrastructure workstream, with respect to matters of capacity and cost for port, rail and road infrastructure for each option. Sapere, as the lead consultancy, has been responsible for commissioning advice from technical experts, obtaining the necessary inputs, interpreting the findings, and preparing a set of infrastructure cost schedules and this report.

The period of analysis is 60 years, in line with that selected for the cost benefit analysis. This timeframe is appropriate given the long lived nature of the infrastructure assets being considered. The resulting set of infrastructure cost schedules are inputs into the cost benefit analysis workstream.

Forecasts of freight growth relate to the base case, in which POAL is assumed to be able to expand on the Waitematā Harbour to handle growth for 60 years. Containerised freight, comprising imports and exports, is of primary focus given volumes involved, land area needed, and the growth outlook. The forecasts were prepared for the period from 2018 to 2079, with a focus on two forecasts scenarios.

- Medium growth – a compounding annual rate of growth of 2.26 per cent. This is referred to as the calibrated forecast.
- Low growth – a compounding annual rate of growth of 0.75 per cent. This is referred to as the officials' agreed forecast.

Port infrastructure capacity requirements

Two sets of port consultants were commissioned to assess and advise on long-term port capacity and infrastructure costs: Advisian (marine and coastal engineers) and Black Quay (strategic and operational port planners). Their estimates of capacity, concept layouts and costings take into account the forecast freight task, existing infrastructure, scope for expansion and potential environmental constraints.

With respect to POAL, the findings are that the freight operations are constrained on several fronts, including container terminal capacity and the berths and channel access needed to accommodate larger container vessels. Plans to address these constraints rely on resource consents being obtained. Assuming the consents can be obtained, the container terminal may have capacity for around 30 years under the calibrated forecast for freight growth. After that, a substantial amount of land reclamation would be necessary. For comparative purposes, the base case assumes that POAL would be able to remain and expand on the Waitematā Harbour to accommodate the increasing volume of freight over 60 years, while acknowledging that POAL has a 30-year plan in place only.

With respect to existing port options, there would be insufficient capacity at either Northport or the Port of Tauranga to absorb all of the long-term freight task from POAL. Under the option of a shared increase in capacity, Northport and Port of Tauranga could accommodate the freight task at 60 years, at which point these ports would likely be at, or near, full capacity with little or no room to expand. It is possible that fewer containers could be handled at Northport, to create some room for growth, but those containers would instead need to be handled at the Port of Tauranga, which would also be approaching its practical limit. The new port options, on the Firth of Thames or the Manukau Harbour, would have sufficient capacity for the long term, to 60 years and well beyond. The concept design is for an island port, near to shore, that allows for capacity to be built in stages, expanding as needed.

The capacity conclusions from this work are detailed in the integrative report.

Landside infrastructure capacity requirements

The table below summarises the road and rail infrastructure requirements identified for each option.

Summary of landside infrastructure requirements

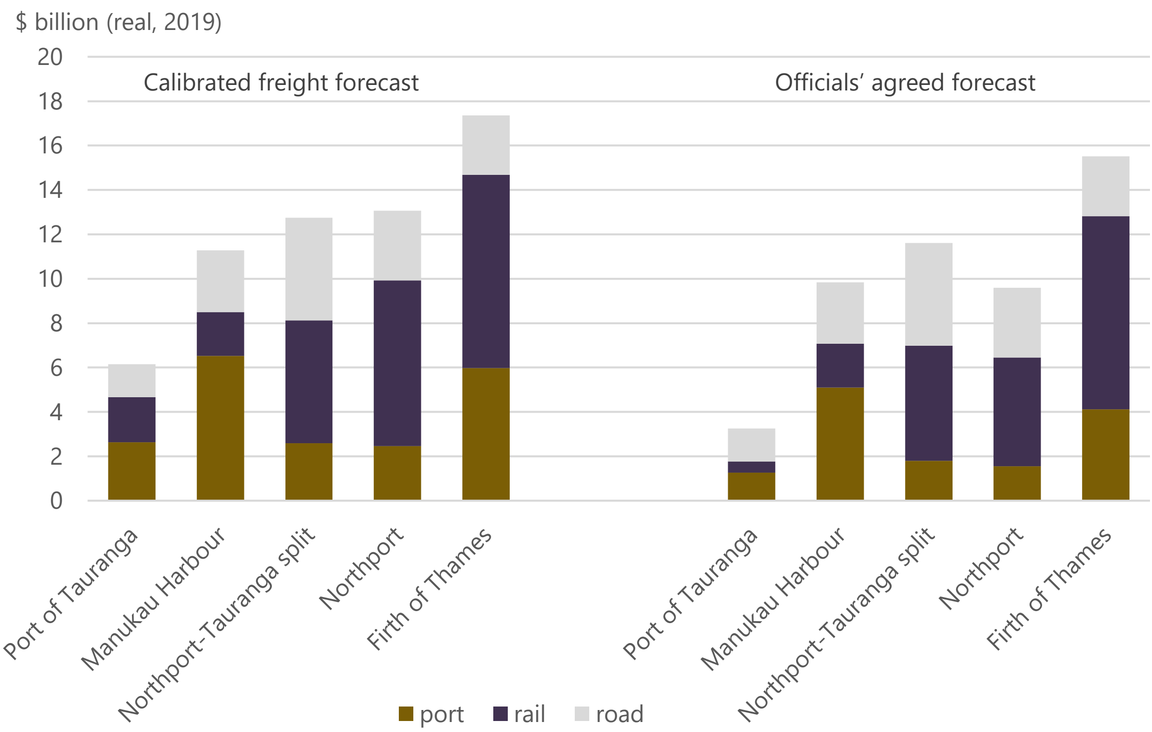
Option	Road infrastructure	Rail infrastructure
Northport	• Additional works along SH1 between SH15 and Te Hana are likely to be required, with safety improvements. • Corridor widening and rerouting at the Brynderwyn Hills would be needed and is assumed to be brought forward. • SH1 Warkworth to Wellsford project is assumed to be brought forward.	• Capacity additions on the North Auckland Line (rail loops). • Construction of: – the Marsden Point spur – a third main line from Swanson to Avondale, – a new line from Avondale to Southdown.
Port of Tauranga	• Additional works on SH1/ SH29 from south of Cambridge to Tauriko are likely to be necessary and are treated as being brought forward. • Additional works at the SH2/Dive Crescent interchange, adjacent to the Port operations at Sulphur Point.	• Capacity additions (rail loops) on: – the East Coast Main Trunk – the North Island Main Trunk (Whangamarino). • Construction of a fourth main line from Westfield to Pukekohe.
Northport and Port of Tauranga	• Additional works assumed to still be brought forward for traffic increases.	• Capacity additions scaled back to match each port's share of freight task.
Firth of Thames	• A new roading link from Mill Road to the Firth of Thames site will be required, with a bypass of Clevedon. An improved connection from Mill Road to the Southern Motorway is also likely to be necessary.	• Construction of a new line to a new port on the Firth of Thames, connecting from the North Island Main Trunk.
Manukau Harbour	• A new arterial standard roading link from Roscommon Road/Wiri Station Road is assumed to be required. An improved connection to SH20, in the form of an upgraded interchange at Lambie Drive.	• Construction of a new line to a new port on the Manukau Harbour, connecting from the North Island Main Trunk.

Summary of infrastructure cost estimates

Cost schedules for port, rail and road infrastructure for each option were prepared as an input into the cost benefit analysis. The figures are in 2019 dollars on a non-discounted basis.

The charts and table below summarise the cost estimates for each option, split out by port, rail and road infrastructure. The road costs for existing ports are largely treated as being brought forward, under the assumption they would otherwise occur later in the period of analysis. The figures on the left are for the calibrated freight forecast and those on the right are for the officials' agreed forecast.

Summary of infrastructure costs by option



Source: Sapere

Summary of infrastructure costs by option (real, 2019, $b)

Option	Calibrated freight forecast				Officials' agreed forecast			
	Port	Rail	Road	Total	Port	Rail	Road	Total
Port of Tauranga	2.6	2.0	1.5	6.2	1.3	0.5	1.5	3.3
Manukau Harbour	6.5	2.0	2.8	11.3	5.1	2.0	2.8	9.8
Northport and Tauranga	2.6	5.5	4.6	12.8	1.8	5.2	4.6	11.6
Northport	2.5	7.5	3.1	13.1	1.6	4.9	3.1	9.6
Firth of Thames	6.0	8.7	2.7	17.4	4.1	8.7	2.7	15.5

Source: Sapere

1. Purpose and scope

This section outlines the purpose and scope of this report.

1.1 Purpose of this report

This report accompanies the integrative report that summarises the findings of a collective of consultants led by Sapere Research Group (Sapere) in relation to the Upper North Island Supply Chain and the options for a full move of the freight operations of the Ports of Auckland Ltd (POAL).

This study has been directed to consider five options for the relocation of the POAL freight task:

- Northport expansion
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- a shared increase in capacity at both Northport and Port of Tauranga
- a new port on the Firth of Thames, and
- a new port on the Manukau Harbour.

This report documents the work undertaken within the infrastructure workstream, with respect to matters of capacity and cost for port, rail and road infrastructure for each option. It documents the steps involved in preparing a set of infrastructure cost schedules as inputs into the cost benefit analysis workstream.

1.2 Scope of this report

This report comprises the following elements.

- A summary of inputs from other workstreams, such as findings from the freight modelling and traffic modelling workstreams, that provide assumptions and context for this work.
- A summary of the specialist inputs and advice commissioned for this workstream, from a range of contributors with the necessary expertise and technical skills.
- Documenting the inputs, analysis and judgments involved in preparing a set of cost schedules for the port, rail and road infrastructure requirements for each of the specified options over the long term.
- Documenting the issues and conclusions with respect to current and potential future capacity, including possible constraints, under each of the specified options.

2. Approach

This section outlines the overall approach to this workstream.

2.1 Steps in the analysis

The preparation of the schedules of infrastructure costs generally involved the following steps.

- Identifying the current and planned infrastructure capacity for port, rail, road under each of the five options as well as in the base case.
- Considering the additional infrastructure capacity that would be required over the period of analysis for each option in the event of a full move of the freight operations of the POAL.
- Determining whether that additional capacity would trigger infrastructure costs that would not otherwise occur in the period of analysis and, if so, estimating those costs.

The schedules of infrastructure costs were prepared using today's dollars, on a non-discounted basis.

2.2 Period of analysis

The period of analysis is 60 years, in line with that selected for the cost benefit analysis. This timeframe is appropriate given the long lived nature of the infrastructure assets being considered.

2.3 Building on prior studies

The starting point has been the 2019 consultants' report to the UNISCS Working Group.[1] The approach is to build on that work, in terms of the identified infrastructure requirements, while accounting for two important differences: the scope of options and the period for analysis.

- This work examines new port options (Firth of Thames, Manukau Harbour) and existing port options (Northport, Tauranga), whereas the 2019 report focused on existing port options.
- The period of analysis for this work is 60 years whereas the 2019 report used 30 years.

The 2016 Port Future Study has also been drawn upon as a starting point for the new port options.[2]

2.4 The base case

In the base case, POAL is assumed to remain and expand on the Waitematā Harbour for 60 years for the purpose of estimating a counterfactual infrastructure cost so that the incremental cost of each option can be identified and compared. This assumption requires that constraints that POAL may face, with respect to its ability to expand, are put aside.

[1] EY (2019) *Economic Analysis of Upper North Island Supply Chain Scenarios*, 9 August 2019

[2] EY (2016) *Consultant's report to the Port Future Study*, June 2016

2.5 Options and sites

The options for expansions at the existing ports of Northport and Tauranga are similar to those considered in 2019. The options for a new port are based on the 2016 Port Future Study, which identified three sites on the Manukau Harbour and two sites on the Firth of Thames as potential locations. To keep the analysis manageable, the approach has been to focus on the site that was ranked highest in the 2016 study: Puhinui on the Manukau Harbour and Kawakawa Bay on the Firth of Thames. The sites of focus are intended to be representative of the general costs in each area. The potential feasibility of the other sites considered in 2016 is not being ruled out here.

2.6 Responsibilities

Sapere, as the lead consultant, has been responsible for the following.

- Commissioning advice from technical experts with relevant experience, outlined in Table 1 below, and working with them to provide the necessary inputs and interpret the findings.
- Preparing a set of infrastructure costs schedules, by drawing on cost estimates prepared by port and rail specialists and by benchmarking road costs against prior business cases.
- Documenting the above work and in this report.

Table 1 Technical inputs from expert contributors

Infrastructure	Contributors	Outputs
Port	Advisian	• Report on port capacities and infrastructure requirements at POAL, Tauranga and Northport.
	Black Quay Consulting	• Report on the long-term container vessel outlook. • Port Future Study recap and an assessment of port capacity at POAL and Tauranga. • A desktop review of the two alternative port options presented in the Port Future Study.
	eCoast	• Modelling report on the Manukau Harbour entrance with estimates of dredged channel infilling.
Rail	Rail Infrastructure Consultants (RIC) NZ	• Report on rail connections and routes for the new port options and the base case.
	Murray King & Francis Small Consultancy, KiwiRail	• A rail capacity model. • High-level estimates of rail infrastructure costs for Northport and Tauranga options.
	Murray King & Francis Small Consultancy and Richard Paling Consulting	• Rail market shares for each option.
Road	Flow Transportation Specialists	• Traffic assessment of each option, with infrastructure requirements identified.

Source: Sapere

3. Outlook for freight growth and vessel size

The outlook for the growth in freight volumes informs conclusions about the capacity of POAL and the infrastructure capacity needed for other port options to accommodate the future freight task.

3.1 Forecasting growth in container freight

Forecasts for freight growth at POAL use the Ministry of Transport freight model, as updated for the 2019 National Freight Demand Study. The forecasts relate to the base case, in which POAL is assumed to be able to expand on the Waitematā Harbour to handle growth for 60 years. Containerised freight, comprising imports and exports, is of primary focus given volumes involved, the land area needed, and the growth outlook. Three forecasts were prepared for the period to 2079, with 2018 as the base.

- Medium growth – a compounding annual rate of growth of 2.26 per cent. This is referred to as the calibrated forecast.
- Higher growth – a compounding annual rate of growth of 2.51 per cent. This is referred to as the calibrated (higher growth) forecast. It uses higher population and GDP growth rates.
- Low growth – a compounding annual rate of growth of 0.75 per cent. This is referred to as the officials' agreed forecast.

To put these rates in context, annual growth in container freight in the Upper North Island ports has averaged over 4 per cent across 2012 to 2019. This study focuses on the calibrated forecast (medium growth) as being the most plausible rate of growth for container volumes over the long-term. The decision to focus on the calibrated forecast takes into account port planning assumptions used in Australia and advice from a port planner with extensive international experience. Detailed analysis has been included for the low growth forecast at the request of officials.

Summary of freight forecast differences

The low growth forecast is based on officials' agreed assumptions for population and GDP growth and supply and demand drivers within the model. This results in a forecast of freight growth that is materially lower than in prior studies and lower than trend growth in the Upper North Island. The lower growth rate arises because the model assumes that domestic supply of goods grows in line with domestic demand and this results in low growth in import volumes.

The calibrated (medium growth) forecast adjusts the model's demand and supply drivers to better reflect trend import flows through the ports. The model treats the demand for, and supply of, manufactured and retail goods as being dependent on a weighted relationship to regional population and GDP growth. The adjustment is that the demand for manufactured and retail goods continues to grow strongly as the economy develops but the capacity to supply these goods domestically grows more modestly. The resulting imbalance is met by imports, as has been the case in New Zealand for some time. This outcome is consistent with the economy continuing to focus more on services with a reduced focus on manufacturing.

The high growth calibrated forecast is designed to test the impact of population and GDP growth being higher than in the calibrated forecast. It uses slightly higher, but still plausible, assumptions about long-run population and GDP growth.

Table 2 summarises the average annual growth rates of the forecasts over the 60-year timeframe. The average annual growth rates over 30 years are also shown, to enable a comparison with figures used in the 2019 consultants' report commissioned by the Working Group, which used a 30-year timeframe. This comparison shows that the calibrated forecast for this study has a similar annual rate of growth to the lower figures used in the 2019 consultants' report commissioned by the Working Group.

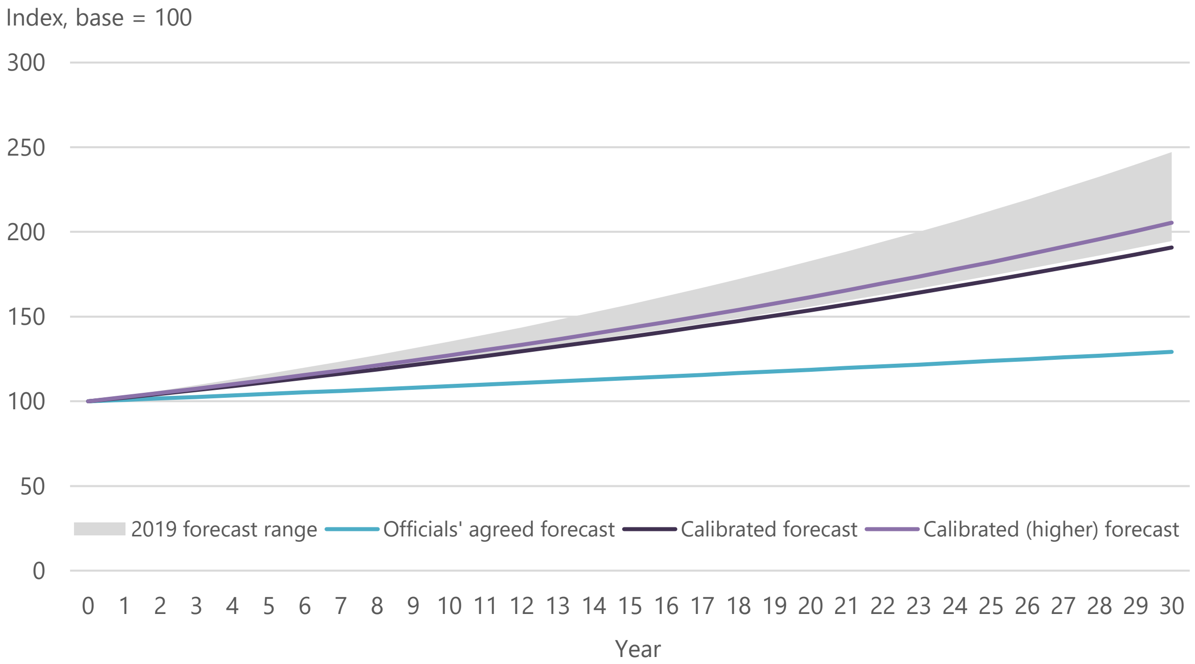
Table 2 Container freight forecasts for Ports of Auckland – compounding annual growth rates

Scenario	Over 30 years	Over 60 years
Officials' agreed forecast (low growth)	0.86%	0.75%
Calibrated forecast (medium growth)	2.18%	2.26%
Calibrated forecast (higher growth)	2.43%	2.51%
Working Group Consultants' report (2019) – low	2.24%	n/a
Working Group Consultants' report (2019) – high	3.06%	n/a

Sources: Freight modelling workstream outputs; EY (2019) consultants' report to the UNISCS working group – rates derived from the range of TEU volumes reported for 2018 and 2049.

Figure 1 compares the trend growth rate for each forecast, over 30 years, with a range derived from the figures in the 2019 consultant's report to the Working Group. Of note, the calibrated forecasts sit either side of the lower end of the forecast range for container freight used in the 2019 report.

Figure 1 Container freight forecast scenarios for Ports of Auckland – comparison of trend growth



Sources: Freight modelling workstream; EY (2019) with additional analysis by Sapere

3.2 Sizing the future freight task

The future freight task represents the volume that would need to be accommodated over 60 years, either at POAL or one of the port options. As well as the import and export of containers, the freight task also comprises bulk freight (i.e. importation or transhipment of cement, sand, grains and the export of scrap metal) and vehicle imports (all motorised vehicles). Results are shown for the medium and officials' agreed forecast and include transhipments.

Container freight is measured by twenty-foot equivalent units (TEU). Container freight grows to 3.84 million TEU in 2079 in the calibrated forecast, or 3.8 times the volume in 2020. Under the officials' agreed forecast, container freight reaches 1.53 million TEU in 2079, or 1.6 times the volume in 2020.

Table 3 Container freight forecasts for Ports of Auckland – size of future freight task

Forecast	**2020** million TEU	**2079** million TEU	**Ratio of 2020 to 2079**
Calibrated	1.01	3.84	3.8 times
Officials' agreed	0.99	1.53	1.5 times

Source: Sapere

Bulk freight, under the calibrated forecast, grows to 4.63 million tonnes in 2079, or 2.7 times the volume in 2020. Under the officials' agreed forecast, bulk freight reaches 2.67 million tonnes in 2079, or 1.6 times the volume in 2020.

Table 4 Bulk freight forecasts for Ports of Auckland – size of future freight task

Forecast	**2020** million tonnes	**2079** million tonnes	**Ratio of 2020 to 2079**
Calibrated	1.71	4.63	2.7 times
Officials' agreed	1.68	2.67	1.6 times

Source: Sapere

Vehicle imports are assumed to grow at the rate used for container imports in each forecast. Under the calibrated forecast, vehicle imports, reach 1.68 million in 2079, or 5.3 times that of 2020. Under the officials' agreed forecast, vehicle imports reach 0.48 million in 2079, or 1.6 times that of 2020.

Table 5 Vehicle import forecasts for Ports of Auckland – size of future freight task

Forecast	**2020** million vehicles	**2079** million vehicles	**Ratio of 2020 to 2079**
Calibrated	0.31	1.68	5.3 times
Officials' agreed	0.30	0.48	1.6 times

Source: Sapere

3.3 The container forecast is the most critical

Of these forecasts, the container forecast is the most critical, given POAL constraints and the outlook for growth. The container trade also requires considerable investment in berthage, automation and other infrastructure. In contrast, vehicles require a wharf to pull alongside, and yardage for temporary parking, but can be driven off and out of the way, promptly. To this end, we sought an external expert view on the long-term outlook for global and regional container trade. This view, in effect, points to use of the calibrated forecast (medium growth) over the officials' forecast (low growth) for this study.

Black Quay perspective on the outlook for container trade

Black Quay are specialist consultants, providing advanced port planning and specialist advisory services to clients around the world. The company has presence in Australia, the United States and the United Kingdom and planning studies delivered over the last five years include assignments in Australia, North America and the Middle East.

Black Quay regularly prepares global and regional forecasts of container trade, based on research into consumption, manufacturing and industrial trends. Outlooks for containerised trade for western nations over the last five years have generally followed an annual average growth rate of between 2.6 per cent and 3.4 per cent. Black Quay has not prepared forecasts for this study but offers the following high-level opinion.

Black Quay advises that global growth rates for container trade will likely reduce over time, as a result of the container market maturing and less potential for further products to be containerised. Balancing this, container consumption per capita in western countries is still growing and healthy growth is expected in the medium term. There is no reason to expect that New Zealand would be different.

Black Quay expects a generalised reduction for Australia from 2.6 per cent per year in the short to medium term, to between 2.0 per cent and 2.26 per cent per year in the long term. This view factors in near-term Covid19 impacts and reflects the growing reality of Australasia being connected to Asia from an economic perspective. Black Quay's view is that Asia will represent more than 90 per cent of Australasian trade in the medium term.

Black Quay considers that an annual growth rate of 1 per cent or less into the long term would be implausible and out of step with their port planning work elsewhere. In Black Quay's view, basing a regional port strategy for the long term on an annual container growth rate of 1 per cent or below would be high risk and would not appear to fully consider long-term population trends, consumerism trends, ageing and disruptive manufacturing techniques and the development of emerging industries.

Black Quay advises that it is important to identify the future freight volume at which a pre-determined long-term relocation plan would be triggered. This volumetric trigger approach acknowledges the uncertainty of long-run forecasts and allows for some flexibility to react to sustained upside or downside surprises in trend growth of freight.

Source: Black Quay memo, May 2020.

3.4 Outlook for larger container vessels

Container vessels continue to grow in size, driven by economies of scale and competitive pressures. Larger vessels mean larger loads, fewer visits and longer time to unload in port. The ability to accommodate these larger vessels is one dimension of port capacity, with the implications being:

- entrance channels need sufficient width and depth to enable access
- more depth necessary at vessel berths and in turning bays
- longer vessel berths needed alongside the wharves.

Cascading effects across the global container vessel fleet are likely to increase the upper end of the fleet visiting New Zealand, as well as the average vessel size. An outlook prepared by Black Quay concludes that vessels of 7,500 to 8,000 TEU added on New Zealand routes (after 2019), will gradually be replaced in the medium term (15-30 years) by vessels of 8,500 TEU and above, with a maximum size of 11,000 TEU. Longer term (30-50 years), a small number of dimension-specific 13,000 to 14,000 TEU vessels will be operated on the primary Australasian services and would represent a significant component of overall service capacity.

3.5 Implications for POAL

POAL is, currently, constrained to vessels under 6,000 TEU and this has likely contributed to low growth in container volumes and an increasing loss of market share to the Port of Tauranga, which can accommodate these larger vessels. As examples, Maersk first sent a 9,500 TEU ship to Tauranga in 2016 and has been making regular calls since, with a successful trial of an 11,300 TEU ship in 2017.

Black Quay concludes that POAL is currently at a critical disadvantage, relative to the Port of Tauranga, in accommodating larger container vessels. The POAL 30-year plan provides for the construction of a third berth for container vessels and for the entrance channel to be dredged in two phases. Those plans are contingent on obtaining resource consents. If both stages of POAL's planned dredging are consented, then visits of some 11,000 TEU vessels would become possible, however, it is Black Quay's view that access would be significantly limited in terms of specific vessel dimensions and operating parameters (i.e. weight limits and a limited tidal window).

POAL would still be at a disadvantage relative to the Port of Tauranga in future, in terms of channel depth. The extent of this disadvantage depends on the future size of vessels, but the disadvantage could become more apparent in the short to medium term. Should container vessels increase to 13,000 to 14,000 TEU in size, and up to 380m long and a 15.5m draft, access to POAL would not be possible without sizeable increases in channel depth and berth length beyond that allowed for in the 30-year plan and the current resource consent applications.

4. Port infrastructure requirements

This section provides an overview of the specified port options, with a focus on the capacity and infrastructure that would likely be needed to accommodate the long-term freight task.

4.1 Approach

Two sets of specialist consultants were commissioned to assess and advise on long-term port capacity and infrastructure costs: Advisian (marine and coastal engineers) and Black Quay (strategic and operational port planners). The approach was to allocate the options to these port consultants in line with their prior experience, with both being asked to independently examine capacity at POAL.

Advisian was commissioned to examine planned and potential capacity at POAL, the Port of Tauranga and Northport, and to identify and cost the infrastructure required for the forecast freight task. Consultants from Advisian and Sapere undertook site visits to the Port of Tauranga, Northport and POAL in February 2020. Each visit involved engagement with representatives of the port management team, a presentation on the current state and planned capacity developments and a guided tour of the port. The results of the capacity assessment undertaken by Advisian were reflected back to the ports, as an opportunity to identify any material issues of interpretation.

Black Quay was commissioned to provide a view on capacity at POAL, in light of information provided, and to revisit their work for the 2016 Port Future Study on the potential sites for a new port on the Manukau Harbour and the Firth of Thames. Black Quay reviewed the cost estimates for a new port at those sites, as prepared for the 2016 Port Future Study. That work assumed a container terminal capacity of 10 million TEU to accommodate the entire long-term freight task of the Upper North Island in the long term (i.e. the combined freight task of POAL and the Port of Tauranga). Black Quay provided advice on scaling back that capacity to 5 million TEU, to reflect the focus of this study being on the future freight task of POAL. This exercise involved differentiating between elements that are fixed and those that are scalable, while recognising that a new build involves cost loaded upfront.

In addition, a marine consultancy, eCoast, was commissioned to undertake detailed numerical modelling with respect to a dredged channel at the entrance to Manukau Harbour. The purpose was to provide an indication of sedimentation and the impact of extreme storm events on a dredged channel and to provide insight into the likely requirements for maintenance dredging.

The estimates of capacity, concept layouts and costings were prepared by the port consultants, taking into account the forecast freight task, existing infrastructure, scope for expansion and potential environmental constraints. The capacity plots for the existing ports are included as Appendix A.

Sapere combined the results into a schedule of port infrastructure costs for input into the cost benefit analysis, with some adjustments for consistency and completeness (e.g. allowing for planning costs), cost escalation (inflating 2016 estimates to today) and phasing over time.

A set of cost estimates were also produced for the officials' agreed freight forecast, by scaling back capacity requirements to reflect the relatively lower freight growth path under that forecast.

4.2 Ports of Auckland – the base case

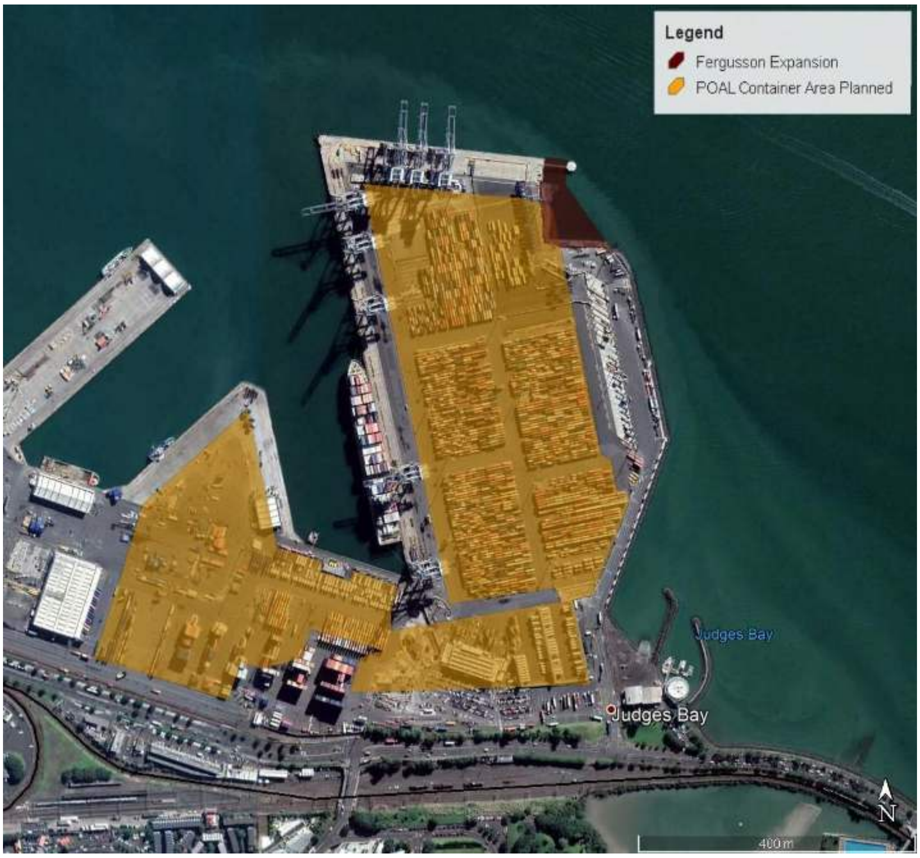
This section considers the capacity of POAL to accommodate the long-term freight task. The purpose is to assess when the freight operations of the port might need to move and determine a base case to inform the cost benefit analysis of the port options.

4.2.1 Plans to address constraints and increase capacity

The freight forecasts assume that POAL can remain and expand on the Waitematā Harbour to accommodate the increasing volume of freight over 60 years. However, the POAL freight operation is currently constrained on several fronts, including container terminal capacity and the berths and channel access to accommodate larger container vessels.

The POAL 30-year plan provides for an increase in capacity at the Fergusson Container Terminal. The first stage involves constructing a third berth, automating the container yard and finishing some reclamation. A second stage involves relocating the administration block to extend the reefer space, constructing rail-mounted gantry and automating the rail yard. The 30-year plan also provides for the Freyberg Wharf to be converted to container terminal operations and for the channel to be dredged in two stages. Some of these steps require resource consents to be obtained (e.g. dredging work). Figure 2 shows the planned expansion of container operations: the Fergusson Container Terminal is on the right and the Freyberg Wharf is the triangular wharf.

Figure 2 Ports of Auckland plan for expanded container terminal operations



Source: Advisian

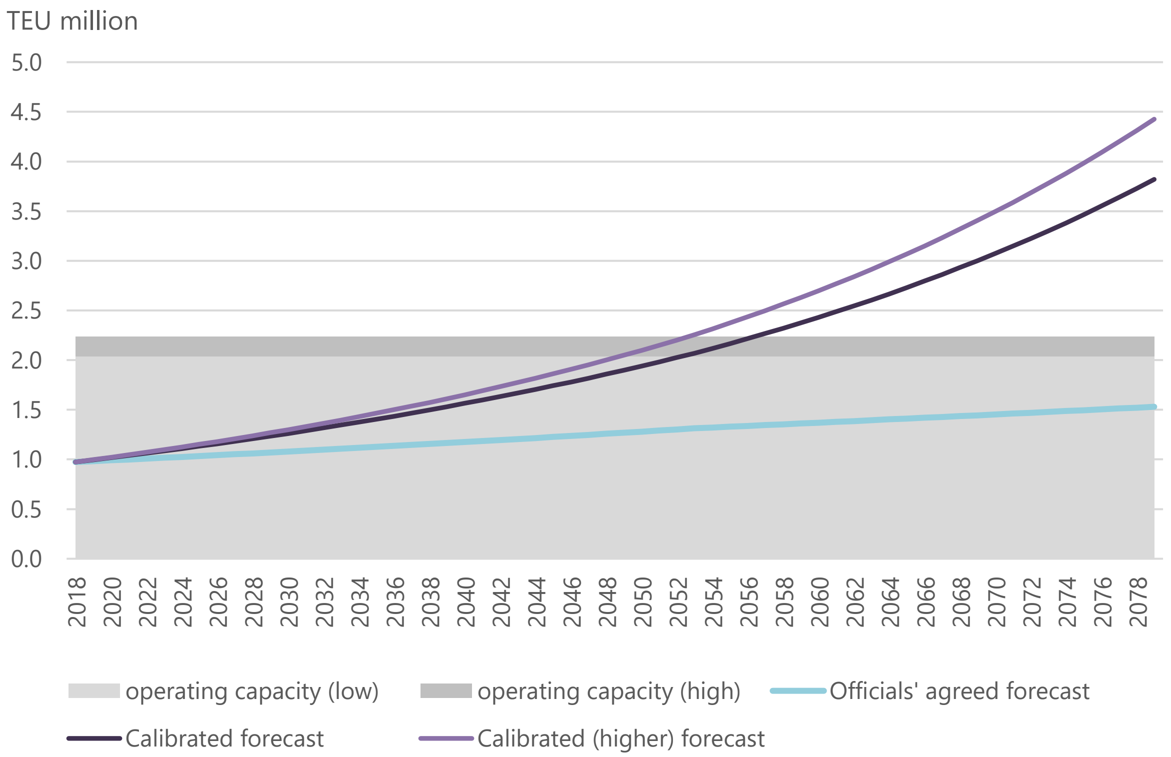
4.2.2 Thirty years of port capacity plausibly remains

The port consultants were asked to independently assess the POAL 30-year plan and to offer a view on future capacity to accommodate the container trade. The consultants differentiate between a peak or maximum capacity, at which a port can operate for short periods, and an effective or sustainable operating capacity. The latter is the level at which a port can operate reliably and economically, beyond which there are increasing risks from congestion for productivity, safety and profitability.

The port consultants recommended that the concept of operating capacity be adopted for port planning purposes. That is, it would be prudent to avoid using peak or best-case maximum capacities in planning for the long term. The views offered by the port consultants suggest a planning assumption of 2.04 to 2.24 million TEU per year for the future combined operating capacity of the Fergusson Container Terminal and the Freyberg Wharf.

The estimates of annual operating capacity can be compared with the freight forecasts to determine how long growth may be accommodated. Figure 3 plots the forecasts of TEU volumes per year against the low and high estimates of future annual operating capacity.

Figure 3 Freight forecasts with estimates of Ports of Auckland operating capacity



Note: Operating capacity shown represents future capacity under current plans; capacity in 2020 is approximately 1m TEU

Sources: Sapere; Port consultant estimates

The conclusion is that the POAL plan will enable sufficient operating capacity for approximately 30 years from 2020, with the range being 31 to 35 years of capacity, under the calibrated freight forecast (medium growth), depending on the estimate of effective operating capacity. The range is 28 to 32 years of capacity under the higher growth calibrated forecast.

This conclusion assumes that constraints, such as channel dredging to enable larger vessels to access the harbour entrance, will be addressed (i.e. that the necessary consents will be obtained). Under the officials' agreed forecast, using officials' agreed assumptions, there is sufficient long-run capacity, although, as noted above, this is less plausible.

4.2.3 The POAL base case as a baseline to test other options

At the heart of a robust cost benefit analysis is a base case against which to compare the proposed alternative options. This base case is sometimes referred to as the "counterfactual", "status quo", or "do minimum" scenario. The base case allows decision-makers to see the incremental effects of doing something by accounting for the likely effects of not doing anything.

Establishing the base case is not straightforward. The Treasury's guidance on cost benefit analysis notes that this is particularly difficult when the "do nothing" scenario is likely to evolve over the period of analysis. This study considered two base cases: constrained and unconstrained.

A constrained base case would involve limiting expansion, possibly in line with the POAL 30-year plan. The assumption would be that any necessary resource consents sought by POAL for major expansion would not be granted, for example, due to environmental and/or societal considerations. In contrast, an unconstrained base case assumes that POAL would receive necessary consents to expand as needed over the long term.

In practical terms, having two base cases would be analytically unwieldy and create confusion rather than clarity. In addition, the need for comparability with previous work, particularly the Working Group study, suggests a single base case.

4.2.4 A simplifying assumption of further port expansion to meet 60-year needs

This study uses an unconstrained base case, where POAL is assumed to be able to remain and expand on the Waitematā Harbour for the 60-year period of analysis. In effect, the constraints that have been previously identified around the ability of POAL to accommodate the future freight task have been put to one side, to assess the incremental impacts of the relocation of freight operations.

Accommodating the growth in container volumes out to 2079, as determined in the calibrated forecast, would require an expansion to the port precinct, beyond that envisaged for in the POAL 30-year masterplan. Marine and coastal engineers Advisian have concluded that this would involve substantial reclamation into the Waitematā Harbour.

This future reclamation may not necessarily extend beyond the north face of the Fergusson Wharf. Such an expansion could, potentially, involve extending the container terminal an estimated 800 metres east of the existing Fergusson North Wharf with an associated 24 hectares of reclamation to obtain enough berth capacity to service vessels until 2079. In effect, this would see the Fergusson

Container Terminal approximately doubling in size. Figure 4 shows what this scale of expansion could look like, for illustrative purposes. This does not represent a concept plan or a worked up plan or a proposal from POAL but, rather, highlights the extent of development that might be needed.

Reclamation is a controversial issue. This level of reclamation may prove very difficult to consent, particularly as expansion eastward will have coastal impacts on the sediment flow through the Waitematā Harbour, potentially causing siltation to occur around Mechanics Bay and Judges Bay. Such an expansion of the port precinct would also likely require the relocation of existing facilities at Mechanics Bay and Judges Bay.

Figure 4 A concept for required container terminal area, assuming unconstrained expansion to 2079

Source: Advisian *Note: This is not a plan or proposal from POAL*

Figure 5 shows the detail underpinning the cost estimate of the required port infrastructure for POAL in the modelled base case.

Figure 5 Cost estimate of port infrastructure for the base case

Base Case POAL			2020		2030		2040		2050		2060		2070		Notes and Assumptions
	Item	Unit	Amount	Cost	Amount	Cost	Amount	Amount	Amount	Cost	Amount	Cost	Amount	Cost	
Port	Dredging	m^3			2,500,000	$37,500,000			240,000	$3,600,000					[12]
	Reclamation	m^3							2,460,000	$110,700,000					
	Quay Wall	m							800	$126,700,000					
	Piled Wharf	m			450	$76,500,000	280	$49,300,000							New Berth and assumed refurbishment
	Wharf demolition	m			280	$32,220,000									Demolition of Marsden and B1
Container Facilities	Pavement and utilities	Ha					7.1	$39,050,000	23.4	$128,480,000					
	Quay Cranes	ea			2	$43,200,000			3	$64,800,000	4	$86,400,000	4	$86,400,000	
	ASC	ea													
	AutoStrad	ea	10	$46,000,000	10	$46,000,000	12	$55,200,000	16	$73,600,000	22	$101,200,000	22	$101,200,000	
	MHC						4	$30,000,000							
Log Facilities	Pavement	m^2													No Logs through POAL
Vehicles Facilities	Pavement	m^2													Assumed sufficient area
	Total (NZD)		**$46,000,000**		**$235,000,000**		**$174,000,000**		**$434,000,000**		**$188,000,000**		**$188,000,000**		**$1,265,000,000**
Comments					Development of southern Bledisloe Wharf. Fergusson North Wharf extension and Reclamation, & channel dredging New cranes		North Bledisloe Wharf Construction Freyberg Wharf development		Provision for expansion of the container terminal beyond current and planned footprint						

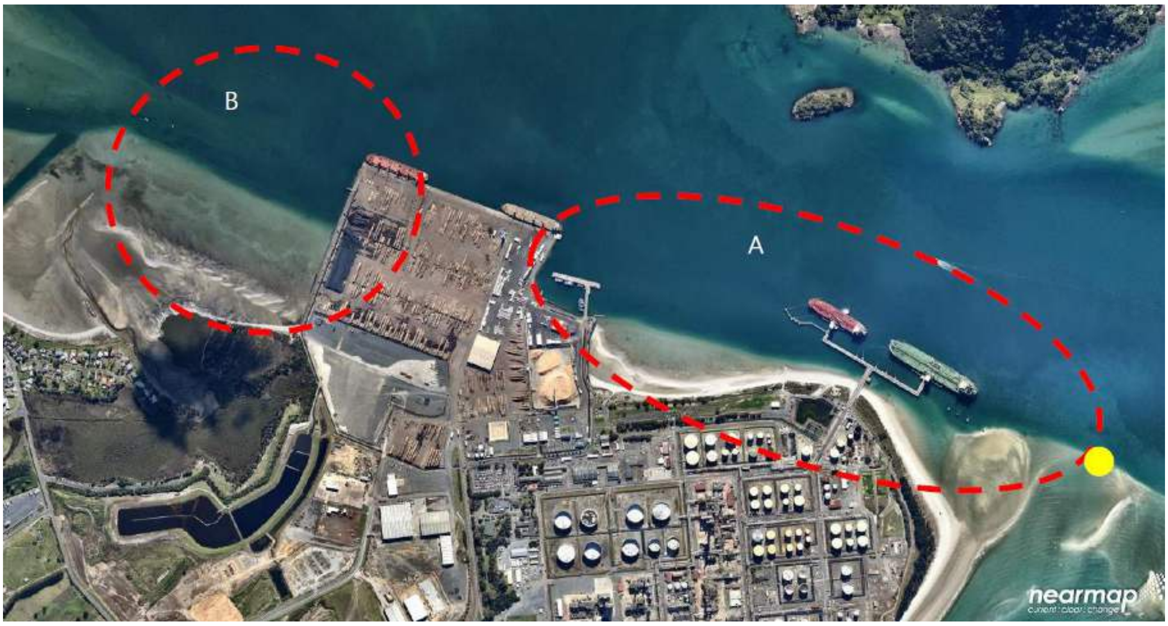
Source: Advisian

4.3 Northport option

Northport is located at Marsden Point, on the southern side of the entrance to Whāngārei Harbour. While Northport has some room to expand in a physical sense, identified environmental constraints to both the west and the east mean that the scope to expand the port is limited.

The areas to the east and the west of the Northport precinct were considered by Advisian in their assessment of the potential for Northport to expand to accommodate the future freight task of POAL, under the calibrated forecasts. Figure 6 shows these areas, labelled A and B. Area A is to the east of the existing wharves, where Northport has consent to extend the wharf by 270 metres and to undertake associated reclamation. Area B is to the west, where Northport has plans for a 300 metre expansion with reclamation.

Figure 6 Northport areas considered for potential expansion



Source: Advisian Note: Limit of eastward expansion is shown as yellow dot

Northport could provide sufficient berth capacity until around 2060, under the calibrated freight forecast, which is not materially longer than the estimated capacity remaining at POAL. Northport could comfortably accommodate container trade of 2.6 million TEU per year, if required to handle the POAL future freight task, whereas that task would reach 3.8 million TEU in 2079 under the calibrated forecast and 4.4 million TEU in 2079 under the calibrated (higher growth) forecast.

To accommodate the future freight task, marine and coastal engineers conclude that Northport would need a 2km long quay, involving dredging and reclamation that expands beyond identified constraints. To the west, those constraints include residential areas and wetlands associated with an estuary. To the east, expansion would need to be into the area occupied by Refining NZ's liquids berths and well beyond, with significant impacts on coastal processes that would affect the surrounding coastline and entrance channel. This would require detailed investigation to determine the extent of these impacts. Figure 7 shows what that scale of expansion would entail.

Figure 7 Northport expansion – concept layout for forecast freight task, 2079

Source: Advisian

Figure 8 shows the detail underpinning the cost estimate of the required port infrastructure.

Figure 8 Cost estimate of port infrastructure for the Northport option

Scenario C			2020		2030		2040		2050		2060		2070		Notes and Assumptions
	Item	Unit	Amount	Cost	Amount	Cost	Amount	Amount	Amount	Cost	Amount	Cost	Amount	Cost	
Port	Dredging	m^3			1,153,200	$17,298,000									
	Reclamation	m^3			7,020,000	$109,800,000									
	Quay Wall	m			2,590	$395,623,000									
	Piled Wharf	m													
	Wharf demolition	m			928	$91,872,000									
Container Facilities	Pavement and utilities	Ha			14.5	$79,986,000	3.9	$21,651,000	5.0	$27,503,000	6.9	$38,190,000	7.1	$39,127,000	
	Quay Cranes	ea			9	$194,400,000	2	$43,200,000	3	$64,800,000	4	$86,400,000	4	$86,400,000	
	ASC	ea			17	$343,400,000	4	$80,800,000	5	$101,000,000	7	$141,400,000	7	$141,400,000	
	Straddle	ea			34	$78,200,000	8	$18,400,000	10	$23,000,000	14	$32,200,000	14	$32,200,000	Assume average of 2 straddle per ASC
	MHC														
Log Facilities	Pavement	m^2			23.0	$126,500,000									Assume resurfacing due to change of operations
Vehicles Facilities	Pavement	m^2			13.3	$36,523,000									Assume resurfacing due to change of operations
	Total (NZD)				**$1,474,000,000**		**$164,000,000**		**$216,000,000**		**$298,000,000**		**$299,000,000**		**$2,451,000,000**
Comments			Assume no investment this decade beyond natural growth		Assume construction starts in this decade. Tug wharf and liquids berth demolition to allow for new commodities										

Source: Advisian

4.4 Port of Tauranga option

The Port of Tauranga is located on the south east side of Tauranga Harbour. The port has the largest container terminal operation at Sulphur Point, on the eastern side of the channel, with bulk freight, such as log exports, on the eastern Mount Maunganui side of the channel. The areas considered for possible expansion are shown in Figure 9.

Figure 9: Port of Tauranga areas considered for potential expansion

Source: Advisian

- Area A is to the south of the existing berths at Sulphur Point and Mount Maunganui and would enable expansion of the bulk and container terminals within existing port precincts and adjacent industrial areas. It will involve dredging the channel and berth pockets and relocating the marina. However, this expansion will not be possible until the airport either changes current flight operations, adjusts the location of the runway, or is relocated to outside of the city, due to air-draught restrictions surrounding the approach flight path.

- Area B is located to the west of the Sulphur Point container terminal and would involve constructing a new quay line where the boat ramp and marina are currently located. This will allow for connectivity to the existing container terminal. Significant dredging would be required to widen the creek to allow for a berth pocket sufficient for container vessels. It has been assumed that current flow through the creek would not be strong enough to flush sediment from the berths and therefore maintenance dredging would also be required. It is believed that there would not be significant impacts on existing coastal processes. The land is not owned by the port, and the expansion would involve the relocation of the marina and public boat ramp. For these reasons, this Area B is less desirable than Area A.
- Area C would involve reclamation to the north of the Sulphur Point to create additional hardstand and enable a continuous quay line. However, there is a channel that runs adjacent to the northern breakwater where strong currents from tidal flows are common. Expansion northward into the tidal channel would change tidal flow paths both to the northeast onto the Mount Maunganui foreshore and to the west into the estuary. Locally it would impact the entrance to the adjacent marina, possibly causing siltation and presenting a navigation hazard to recreational boating. Even with detailed modelling, there would still be a significant risk to existing coastal processes. Therefore, no reclamation north of Sulphur Point has been considered.
- Area D involves expanding the Mount Maunganui wharves north up to Pilot Bay. However, this is a popular tourist beach, which is quite shallow and with residential areas adjacent, thus requiring significant dreading and reclamation. Compared to Area A, Area C is less desirable due to the proximity of residential areas leading to significant consenting issues.

Marine and coastal engineers, Advisian, conclude that the Port of Tauranga would be able to accommodate its own long-term freight task, with capacity of up to approximately 5.0 million TEU. This would involve expansion within the existing port precinct, with the identified areas, beyond current expansion plans, being a northern berth on Sulphur Point and between the liquids berth and Mount Maunganui Wharves with associated terminal backing. It also assumes conversion to automated stacking cranes. This development would have little impact on current operations at the port or the surrounding infrastructure

To accommodate the freight task for the minimum test of 60 years, an additional 3.8 million TEU on top of its own long-term freight task, the Port of Tauranga would need significant expansion, into industrial areas on each side of the estuary channel. The necessary addition of berths and container facilities to the south and east of the port precinct would likely impact on flight paths from the nearby airport. The implication of this expansion is that the airport runway, bridge marina and highway would need to be relocated to accommodate the growth, triggering further infrastructure costs.

Marine and coastal engineers advise that the associated increase in shipping activity would be challenging, given tidal currents, with a risk of congestion affecting vessel operations and limiting port capacity. Even if this long-term capacity can be realised, Tauranga would have few remaining options, other than expanding to the west of Sulphur Point, into the reserve and marina.

Figure 10 Port of Tauranga expansion – concept layout for forecast freight task, 2079

Source: Advisian

Figure 11 shows the total development cost for the Port of Tauranga, which comprises expenditure that would occur in the base case as well as the additional expenditure that would be triggered by a relocation decision for the POAL freight task. These figures do not include the other infrastructure impacts, identified by Advisian, such as the relocation of nearby highway, marina, and airport runway. A high-level estimate of those additional infrastructure costs has been prepared by Sapere, involving benchmarking against costs drawn from similar construction projects and/or feasibility studies. The estimate of these additional costs totals $758 million and comprises marina relocation ($108 million), harbour bridge road realignment ($224 million), and airport relocation ($426 million). The top-down approach means that this figure is an approximation and may underestimate these costs.

Figure 11 Cost estimate of port infrastructure for Port of Tauranga option (total development cost)

Scenario B			2020		2030		2040		2050		2060		2070		Notes and Assumptions
	Item	Unit	Amount	Cost	Amount	Cost	Amount	Amount	Amount	Cost	Amount	Cost	Amount	Cost	
Port	Dredging	m^3	3,106,000	$46,590,000	610,500	$9,158,000	642,000	$9,630,000	2,547,257	$38,209,000					
	Reclamation	m^3							1,075,000	$16,125,000					
	Quay Wall	m	290.0	$48,798,000	370	$61,018,000	535	$86,221,000	1,600	$248,959,000					
	Piled Wharf	m													
	Wharf demolition	m							200	$19,800,000					
Container Facilities	Pavement and utilities	Ha	15.6	$85,983,000	8.3	$45,736,000	12.6	$69,081,000	12.1	$66,686,000	14.3	$78,621,000	14.6	$80,366,000	
	Quay Cranes	ea	4	$86,400,000	5	$108,000,000	8	$172,800,000	8	$172,800,000	9	$194,400,000	9	$194,400,000	
	ASC	ea	15	$303,000,000	8	$161,600,000	12	$242,400,000	12	$242,400,000	14	$282,800,000	14	$282,800,000	
	Straddle	ea													Assume Existing Straddle Fleet is sufficient to service ASC
	MHC														
Log Facilities	Pavement	m^2													Sufficient area and berths
Vehicles Facilities	Pavement	m^2													Cars to utilise existing pavement
	Total (NZD)		$ 571,000,000		$ 386,000,000		$ 580,000,000		$ 805,000,000		$ 556,000,000		$ 558,000,000		$ 3,456,000,000
Comments			Wharf not required now but will be built with ASC in southern yard to minimise destruction. Dredging includes channel deepening		Northern Berth		Southern Berth Expansion		Eastern Berth						

Source: Advisian

Figure 12 shows the base case cost estimate for the Port of Tauranga, which would be expected to occur in the absence of the port having to accommodate the forecast freight task of the POAL. The incremental infrastructure cost for this option is the difference between these base case costs and the total development cost outlined in Figure 11.

Figure 12 Cost estimate of port infrastructure for the Port of Tauranga option

Base Case POT			2020		2030		2040		2050		2060		2070		Notes and Assumptions
	Item	Unit	Amount	Cost	Amount	Cost	Amount	Amount	Amount	Cost	Amount	Cost	Amount	Cost	
Port	Dredging	m^3	3,106,000	$46,590,000					610,500	$9,158,000	148,000	$2,220,000			
	Reclamation	m^3													
	Quay Wall	m	290.0	$48,798,000					370	$61,018,000	370	$61,018,000			
	Piled Wharf	m													
	Wharf demolition	m													
Container Facilities	Pavement and utilities	Ha	12.6	$69,138,000	3.3	$18,358,000	4.2	$23,121,000	5.6	$30,689,000	7.4	$40,667,000	7.5	$41,482,000	
	Quay Cranes	ea			2	$43,200,000	2	$43,200,000	3	$64,800,000	4	$86,400,000	4	$86,400,000	
	ASC	ea	12	$242,400,000	4	$80,800,000	4	$80,800,000	6	$121,200,000	7	$141,400,000	7	$141,400,000	
	Straddle	ea													Assume Existing Straddle Fleet is sufficient to service ASC
	MHC														
Log Facilities	Pavement	m^2													Sufficient area and berths
Vehicles Facilities	Pavement	m^2													No Vehicles
	Total (NZD)		**$407,000,000**		**$142,000,000**		**$147,000,000**		**$287,000,000**		**$332,000,000**		**$269,000,000**		**$1,584,000,000**
Comments			Wharf not required now but will be built with ASC in southern yard to minimise destruction. Dredging includes channel deepening						Northern Breakwater Wharf		Mount Maunganui Terminal				

Source: Advisian

4.5 Northport and Port of Tauranga option

This option involves the POAL future freight task being split between Northport and the Port of Tauranga, with expansion occurring at both ports. It builds on the work undertaken for the options where either Northport or the Port of Tauranga accommodate that future freight task. The split is based on the principle of Northport being developed to have some critical mass across freight types.

The container freight was split according to the estimate of operational capacity at Northport. The geometry of Marsden Point and the risk of impacting on coastal processes mean that Northport has limited growth opportunity to the east. For this reason, the future berth capacity is capped at approximately 3.5 million TEU, which is larger than under the Northport option, due to half of the POAL bulk freight and vehicle trade tasks being assumed to be handled at the Port of Tauranga. The remainder of the container trade task is allocated to the Port of Tauranga.

It is possible that a different split may be more practical, or commercially viable, given the relative proximity of existing industry and distribution centres to the two ports.

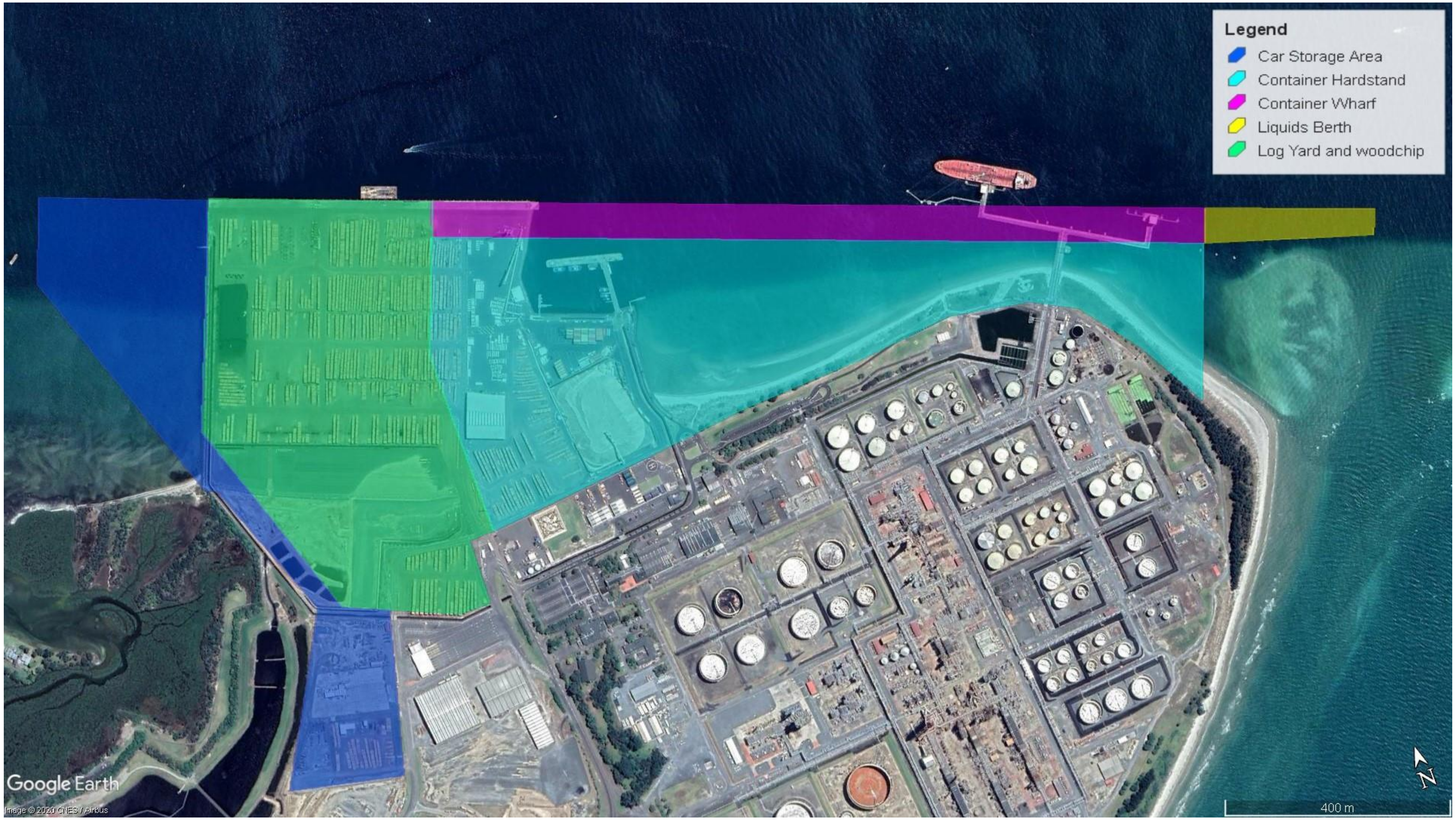
At the Port of Tauranga, the addition of part of the POAL future freight task, the long-term container throughput increases beyond the approximate capacity of 5 million TEU per year. Further growth would necessitate the addition of berths and container facilities to the south and east of the port precinct, as outlined above, and this would likely impact on flight paths from the nearby airport.

Under this shared increase in capacity, Northport and Port of Tauranga could accommodate the freight task at 60 years, at which point these ports would likely be at, or near, full capacity with little or no room to expand. It is possible that fewer containers could be handled at Northport, thereby creating some room for growth, but those containers would instead need to be handled at the Port of Tauranga, which would also be approaching its practical limit.

Marine and coastal engineers also advise that the relocation of part of the POAL future freight task to Northport and the Port of Tauranga will mean substantial shipping activity, which would be challenging given the tidal currents. Both Northport and the Port of Tauranga are estuary ports with natural navigation channels subject to strong currents. Such conditions make vessel navigation and turning difficult and can impact port capacity due to limitations on vessel sailing times. The risk of port capacity limitations due to navigation issues could be reduced through the use of larger tugs and possible channel modifications, although this would be subject to navigation and coastal process studies.

The total development cost to accommodate the POAL current and forecast growth through to 2079 is estimated at $2.590 billion. Under the assumptions of the freight split used here, this comprises expansion at Northport ($1.821 billion) and at the Port of Tauranga ($0.556 billion).

Figure 13 Northport expansion under split option – concept layout for forecast freight task, 2079



Source: Advisian

Figure 14 Port of Tauranga expansion under split option – concept layout for forecast freight task, 2079

Source: Advisian

4.6 Firth of Thames option

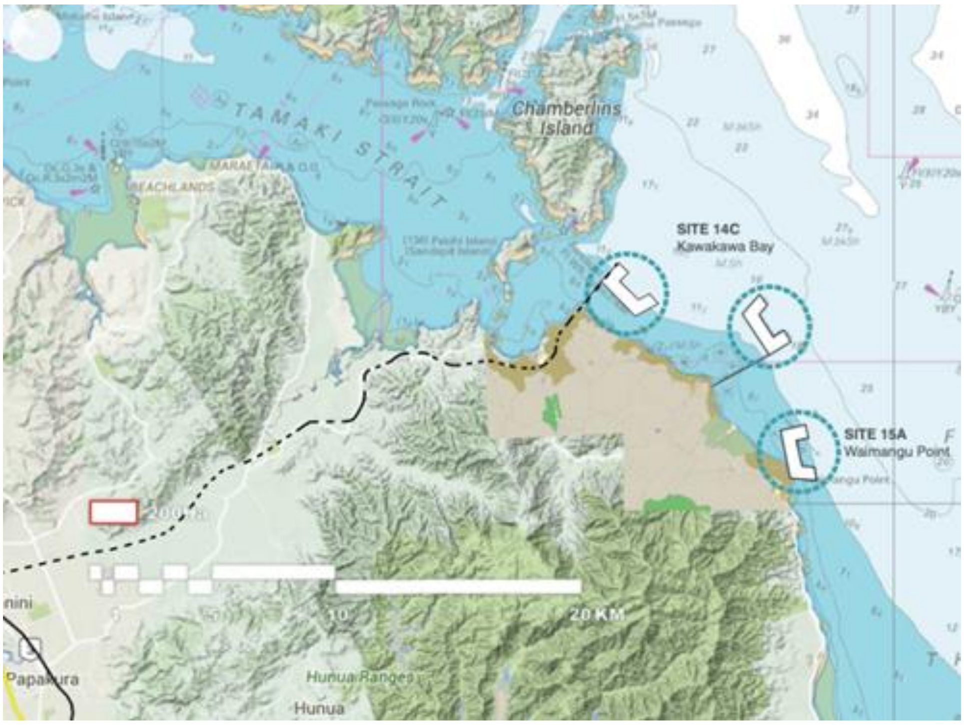
This option involves building a new port on the Firth of Thames to accommodate the POAL future freight task. The location is based on the 2016 Port Future Study, which identified sites with potential for an offshore island port connected by a short marine bridge, as shows Figure 15. The focus here is on Kawakawa Bay, as being representative of the costs involved. The other sites are not ruled out.

A new port on the Firth of Thames has some perceived advantages in that its east coast location would be close to current shipping routes and close to landside supply chains around South Auckland and the Bay of Plenty. There is sufficient natural depth and although the route has complexities, navigating large vessels into the Firth of Thames is likely to be straightforward. The port's C-shape design and breakwaters would provide protection from waves in a relatively unprotected environment. While this raises the construction cost, this is balanced by the lack of need for dredging.

Port planners Black Quay reviewed their basic theoretical footprint and construction rationale for this option, as prepared for the 2016 Port Future Study to capture the main cost implications. The concept is for an offshore island port that can be expanded over time to 10 million TEU per year, if required. Capacity and costs have been scaled back to 5 million TEU, more than needed for the forecast freight task of 3.8 million TEU in 2079. The theoretical footprint is based on productivity assumptions at the berth and the yard, aligning with the high productivity of modern container terminals.

A new road connection would be needed, likely a four-lane road from the Mill Road area with a bypass of Clevedon, with an improved connection from Mill Road to the Southern Motorway. A new rail line, connecting from the North Island Main Trunk, would traverse some complex topography near Kawakawa Bay that would require some high-cost tunnelling.

Figure 15 A new port on the Firth of Thames – potential sites (concept only)



Source: Black Quay

Black Quay reviewed the high-level estimate of costs for a new port on the Firth of Thames, as prepared in 2016, and concluded that work is still sound, in terms of providing a theoretical order of magnitude costs. The estimates had assumed a container terminal capacity of 10 million TEU, to accommodate the long-term freight task of the Upper North Island. As the focus of this study is on the future POAL freight task, Black Quay advised on scaling back this capacity to 5 million TEU for the calibrated freight forecasts that suggested annual container throughput of 3.7-4.3 TEU million by 2079. The capacity was also scaled back to 2 million TEU to account for the officials' agreed forecast that suggested annual container throughput of 1.5 TEU million by 2079. This involved differentiating between elements that are fixed and those that are scalable, while recognising that a new build involves cost loaded upfront. Figure 16, below, shows the scaling factors used to obtain the scaled cost for each element. Planning and approval costs were adjusted to reflect those in the planning evaluation report prepared by Mitchell Daysh for the land use workstream. The cost estimates were also inflated, to take account of construction costs increases. This inflation was done using a construction cost index published by NZTA. On the advice of Black Quay, a high-level estimate of equipment costs (e.g. cranes, straddles) for a new port was also added, for consistency with the estimates for other port options.

Figure 16 Cost estimate for a new port on the Firth of Thames

				Scale cost for 50% of capacity built		Scale cost for 20% of capacity built	
Firth of Thames				i.e. 5 million TEU		i.e. 2 million TEU	
Item	Unit	Quantity	Cost	Scaling factor	Scaled cost	Scaling factor	Scaled cost
Consulting & design	cost	cost	100,000,000	100%	100,000,000	100%	100,000,000
Approvals (including EIA)	cost	cost	50,000,000	fixed	7,000,000	fixed	7,000,000
Reclamation	$50/m3	37 million m3	1,850,000,000	70%	1,295,000,000	52%	962,000,000
Caisson perimeter	$200,000/ lin m	12,500m	2,500,000,000	70%	1,750,000,000	52%	1,300,000,000
Access bridge (x2)	$50,000/ lin m	3,500m x 2	350,000,000	covered in road & rail schedules		covered in road & rail schedules	
Pavement & drainage	$259/m2	2.65 million m2	662,500,000	70%	463,750,000	52%	344,500,000
Dredging (mobilisation)	cost	not required	-		-		-
Dredging (works)	$60/m3	not required	-		-		-
Terminal works	order of magnitude		1,000,000,000	70%	700,000,000	52%	520,000,000
Berth	$150,000/ lin m	2,200m	330,000,000	70%	231,000,000	52%	171,600,000
Tug berths and slips			50,000,000	70%	35,000,000	52%	26,000,000
Total			6,892,500,000		4,581,750,000		3,431,100,000
Cost inflation	2016jun to 2019dec	8.5%	583,528,386		387,897,161		290,481,574
Allowance for port equipment			1,000,000,000		1,000,000,000		400,000,000
Option development cost			8,476,028,386		5,969,647,161		4,121,581,574

Source: Black Quay; Sapere adjustments

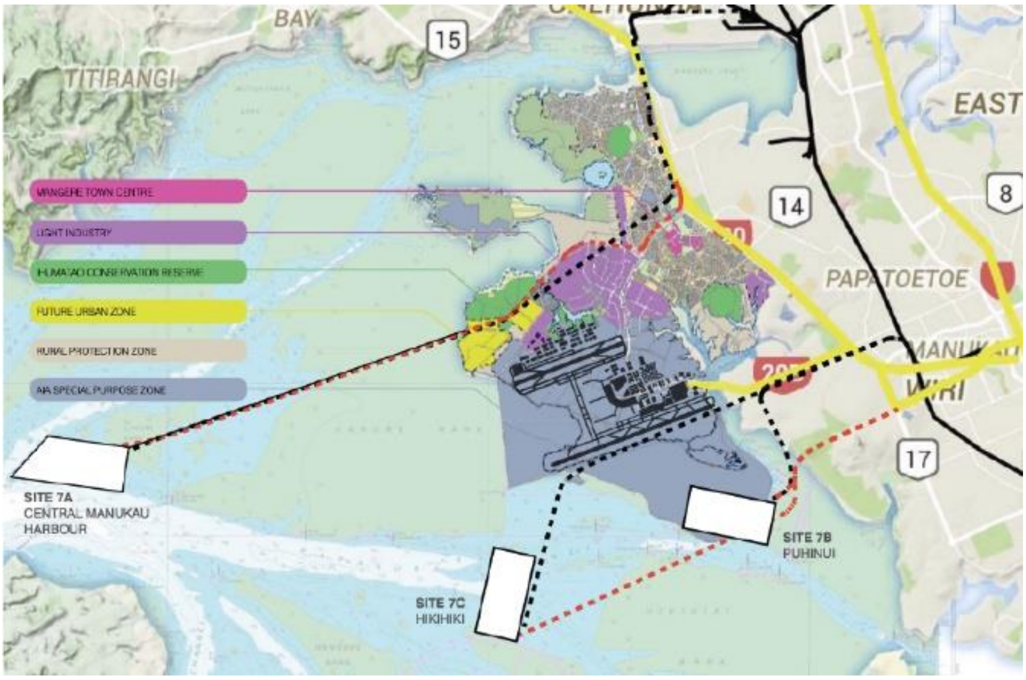
4.7 Manukau Harbour option

This option involves building a new port on the Manukau Harbour to accommodate the POAL future freight task. The location is based on the 2016 Port Future Study, which identified three sites with potential for an offshore island port connected by a marine bridge, as Figure 17 shows. The focus here is on the Puhinui site, as being reasonably representative of the costs involved. It is likely that the sites located further offshore would incur a higher construction cost, for example, for longer marine bridges. However, this would be offset by being closer to the natural channel inside the harbour, compared with Puhinui, which is closer to the east shore, and so requiring a large amount of upfront dredging in the inner harbour. Dredging channel through the entrance bar would be necessary.

Port planners Black Quay revisited the Manukau Harbour concept, as prepared for the 2016 Port Future Study, and reconfirmed that, in their view, it is feasible in principle as a new port, and potentially offers the best location. The close proximity of Manukau Harbour to the existing industrial area and distribution centres of South Auckland and to road and rail networks means that freight costs would likely be lower than other options. The expansion potential and ability to phase development would secure future port capacity needs for the Upper North Island. The concept is for an offshore island port that can be expanded over time to 10 million TEU per year, if required. Capacity and costs have been scaled to 5 million TEU, more than needed for the future freight task.

There is a perception that weather events and the bar at the Manukau Harbour entrance could make access uncertain. In Black Quay's view, shipping access to the harbour is a sound concept, taking into account that modern vessels likely to use a new port in the Manukau Harbour are significantly more advanced and manoeuvrable than those in the past. Tugboats could be stationed to escort ships through the entrance as a safety measure, if needed, and this is not uncommon at ports worldwide.

Figure 17 A new port on Manukau Harbour – potential sites (concept only)



Source: Black Quay

A further factor that has been raised is the sedimentation of the dredged channel. While maintenance dredging would be required, evidence prepared for this study suggests that a dredged entrance channel can be maintained. A marine and coastal modelling consultancy, eCoast, was commissioned to undertake detailed numerical modelling with respect to a dredged channel at the entrance to Manukau Harbour. The purpose was to examine the requirements for maintenance dredging and the stability of the entrance channel through the ebb-tidal delta (i.e. the Manukau Bar).

The eCoast report finds that annual dredge volumes would be the range of 142,000 m^3 to 214,000 m^3, with an average of 179,000 m^3. Those figures are comparable with annual dredge volumes at other ports around New Zealand, for example, Port Taranaki (145,000 m^3) and Port Otago (250,000 m^3).[3] With respect to this future state, of a dredged and maintained entrance channel, an indication from a marine insurance underwriter is that, in this scenario, it is unlikely that insurance considerations would be a barrier for shipping access.

Shipping line representatives concluded that, in terms of a new port, the Firth of Thames would be preferable and able to co-exist with the Port of Tauranga, from a shipping logistics perspective. However, it was acknowledged that a container port on the Manukau Harbour could work well for shipping routes from Australia and Asia. A first stop could be to deliver imports to Auckland at Manukau Harbour, then a vessel would head through Cook Strait to pick up exports from the South Island, and then back up to the Port of Tauranga as the last stop to pick up exports before departing New Zealand, as is currently the case, with the Port of Tauranga usually being the last port of call. Ultimately, shipping lines will call where the main ports are located, while preferring to take a lower cost option, where available.

Black Quay, in their review of new port options, noted that a detailed feasibility study had been called for in the 2016 Port Future Study and that may show that one of the sites within the Manukau Harbour proves to be a better option overall. In addition, a detailed study into the feasibility of the sites, and their orientation, would explore how they might be positioned to work around the airport flight paths and associated height restrictions. Known as the Obstacle Limitation Surface, the restriction extends out from the runway to ensure the safe operation of the airspace surrounding the airport. The restriction gradually eases as the distance increases. The potential for height restrictions was a consideration in the site selection in the 2016 study, with the Central Manukau Harbour and Hikihiki sites, in particular, being selected with this factor in mind.

[3] eCoast (2020) *Numerical Modelling of the Manukau Harbour Entrance: High-Level Estimates of Dredged Entrance Channel Infilling*.

Black Quay reviewed the high-level estimate of costs for a new port on Manukau Harbour, as prepared in 2016, and concluded that work is still sound, in terms of providing a theoretical order of magnitude costs. As with the cost estimate for the Firth of Thames, a series of adjustments were made for this study. Black Quay advised on scaling back the capacity assumption from 10 million TEU to 5 million TEU for the calibrated freight forecasts that suggested annual container throughput of 3.7-4.3 TEU million by 2079. The capacity was also scaled back to 2 million TEU to account for the officials' agreed forecast that suggested annual container throughput of 1.5 TEU million by 2079. This involved differentiating between elements that are fixed and those that are scalable, while recognising that a new build involves cost loaded upfront. The figure below, shows the scaling factors used to obtain the scaled cost for each element.

Planning and approval costs were adjusted to reflect those in the planning evaluation report prepared by Mitchell Daysh for the land use workstream. The cost estimates were also inflated, to take account of construction costs increases. This inflation was done using a construction cost index published by NZTA. A high-level estimate of equipment costs (e.g. cranes, straddles) for a new port was also added, for consistency with the estimates for other port options.

Figure 18 Cost estimate for a new port on the Manukau Harbour

				Scale cost for 50% of capacity built		Scale cost for 20% of capacity built	
Item	Unit	Quantity	Cost	Scaling factor	Scaled cost	Scaling factor	Scaled cost
Consulting & design	cost	cost	100,000,000	100%	100,000,000	100%	100,000,000
Approvals (including EIA)	cost	cost	50,000,000	fixed	7,000,000	fixed	7,000,000
Reclamation	$50/m3	21 million m3	1,050,000,000	70%	735,000,000	52%	546,000,000
Caisson perimeter	$200,000/ lin m	6,000m	1,200,000,000	70%	840,000,000	52%	624,000,000
Access bridge (x2)	$50,000/ lin m	700m x 2	70,000,000	covered in road & rail schedules		covered in road & rail schedules	
Pavement & drainage	$259/m2	2 million m2	500,000,000	70%	350,000,000	52%	260,000,000
Dredging (mobilisation)	cost	cost	20,000,000	100%	20,000,000	100%	20,000,000
Dredging (works)	$60/m3	35 million m3	2,100,000,000	adjusted	2,076,000,000	adjusted	2,052,000,000
Terminal works	order of magnitude		1,000,000,000	70%	700,000,000	52%	520,000,000
Berth	$150,000/ lin m	2,200m	330,000,000	70%	231,000,000	52%	171,600,000
Tug berths and slips			50,000,000	70%	35,000,000	52%	26,000,000
Total			6,470,000,000		5,094,000,000		4,326,600,000
Cost inflation	*2016jun to 2019dec*	8.47%	547,758,964		431,264,940		366,295,817
Allowance for port equipment			1,000,000,000		1,000,000,000		400,000,000
Option development cost			8,017,758,964		6,525,264,940		5,092,895,817

Source: Black Quay; Sapere adjustments

4.8 Summary of port infrastructure costs

Table 6 outlines the estimated costs for each option and the base case, as used in the schedule of port infrastructure costs for the cost benefit analysis. The cost estimates are on a real, non-discounted basis. Some of the expenditure that would occur in the base case is treated as being avoided under each option, as noted in the table.

The port infrastructure cost estimates for each option have been prepared with a capacity requirement that is derived from the calibrated freight forecasts. For the annual container volumes, this points to effective operating capacity of between 3.7 and 4.3 million TEU being required in 2079. In addition, capacity is required to handle the future bulk freight and vehicle freight task.

Those cost estimates were subsequently scaled to reflect the relatively lower freight forecast under the officials' agreed freight forecast, which suggested annual container throughput of 1.5 TEU million by 2079. Those scaled back estimates are necessarily less detailed.

Table 6 Cost estimates of port infrastructure requirements

Option	Calibrated freight forecast ($m)	Officials agreed forecast ($m)
Northport	2,454	1,559
Port of Tauranga Additional infrastructure costs Total	1,875 758 2,633	1,041 224 1,265
Northport and Port of Tauranga	2,596	1,803
Firth of Thames	5,970	4,122
Manukau Harbour	6,525	5,093
Base case *	1,274	462

Notes: *The avoidable component of the base case, applicable to each option, was estimated at $984 million for the calibrated forecast and $174 million for the officials' agreed forecast. Cost allowances for a design and approvals phase were added to the base estimates.

Sources: Advisian (existing port options); Black Quay (new port options); Mitchell Daysh (design and approval costs); Sapere (scaling, cost escalation, adjustments)

5. Rail infrastructure requirements

This section outlines the rail infrastructure required for each option over the long term.

5.1 Method

The following inputs were commissioned from technical experts.

- A rail capacity model and a set of high-level cost estimates for infrastructure for the Northport and Tauranga options.
- Cost estimates of new rail lines for the new port options of the Firth of Thames and the Manukau Harbour, as well as additional capacity for the base case.
- A set of assumptions about future rail market shares.

The inputs were included in a schedule of rail infrastructure costs with adjustments undertaken by Sapere to reflect the rail market share assumptions and the freight forecasts used.

5.1.1 Rail capacity model and cost estimates

The rail capacity model was developed by Murray King & Francis Small Consultancy and KiwiRail to determine the capacity requirements for the existing port options (Northport and Tauranga). The model combines assumptions about the long-term freight task, rail market share and train length, with information about distance to market and average speed, to produce an output in the form of the required number of trains per day. That output is translated into infrastructure requirements at Years 35 and 60, comprising passing loops, rail terminals and rolling stock, and costed using industry unit costs. The cost estimates are partly scalable in response to market share assumptions (as below). Requirements for additional main lines were also costed, using a high-level top-down approach.

5.1.2 Cost estimates for new lines

RIC NZ investigated the likely rail alignments required to connect the new port sites at the Firth of Thames and the Manukau Harbour to the existing rail network (mainlines), taking into account the future network operations plan. Each route was assessed on an indicative 3D basis. The resultant rail and civil works have then been priced using the NZTA Schedule of Elemental Prices, modified for this pre-feasibility level assessment. In addition, RIC NZ were asked to assess the potential cost of a third track on the North Island Main Trunk (NIMT) Eastern Line from Westfield Junction to POAL, if that should be required over the long term in the base case.

5.1.3 Rail market share assumptions

The assumptions for the future rail market shares are based on judgments by transport consultants, with consideration of the freight share that is likely destined for the local market or urgent in nature (and therefore unlikely to go by rail) as well the distance, speed and price of rail relative to road. The results are: Northport (50%), Tauranga (70%), Firth of Thames (50%), Manukau Harbour (10%), and the base case at POAL (25%). The technical report for the cost benefit analysis details these assumptions.

5.2 Base case

This purpose of this section is to identify major rail infrastructure additions that would be needed in the base case, in which POAL freight operations remain on the Waitematā Harbour over the long term.

5.2.1 Context

The context is that the Government has committed, via the New Zealand Upgrade Programme announced in January 2020, to improvements to the Quay Park to Wiri Corridor – the part of the rail network that connects POAL with its inland port at Wiri. The funded improvements will include works around Quay Park to improve rail access to POAL, additional capacity around the Westfield junction, and construction of a third rail line to ease the bottleneck between Westfield and Wiri.[4]

RIC NZ were asked to assess the cost of the third main line being extended along the section from Westfield to Quay Park, if that should be required in the period of analysis (60 years). The operational purpose of this third main line would be to separate the POAL freight traffic from passenger network traffic via a single bi-directional track devoted to freight.

There is significant cost associated with the Purewa Tunnel and, to a lesser degree, the widening of the causeway across Hobson Bay. This raises a question of whether a third line could be constructed in part, on either side of the tunnel, thereby avoiding the costliest section. In preparing the costing, RIC NZ noted that if a third main line from Westfield Junction to Quay Park were to be built, it would need to be continuous. The concept was considered in the process for the Auckland Rail Development Plan, prepared by Auckland Transport and KiwiRail in 2016. The operational advice was that would be little value in a discontinuous third track, as the freight traffic would need to utilise a freight path within the metro timetable irrespective where it connects to a two-track railway. Put another way, once the freight has found its path from the POAL, there is little benefit in getting offline to go back online due to 'passing' manoeuvres taking time and factoring in the distance from the POAL to Westfield.[5]

5.2.2 Case for inclusion

The decision taken to include this third line in the base case is a judgment that involves weighing up evidence. The scale of growth in the freight task, under calibrated forecasts, is a three-to-fourfold increase for POAL container volumes between 2018 and 2079. Under these circumstances, the traffic modelling points to congestion outcomes that may be unacceptable for truck movements, even with grade separation along Grafton Gully. These factors increase the likelihood of an increased market share for rail and the necessity of a full third main to increase rail capacity over the long term. This is allowed for in the third decade, in 2040s, of the base case.

Under the officials' agreed forecast, this third line is not included in the base case, as the forecast growth in container volumes is much lower.

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[4] See https://www.nzta.govt.nz/assets/Roads-and-Rail/20-011/NZ-Upgrade-Programme-Transport.pdf

[5] RIC NZ Ltd, *Advice Note*, April 2020, pp.16-17

5.3 Northport option

The section identifies rail infrastructure requirements for the Northport option over the long term.

5.3.1 Context

The starting point is the North Auckland Line business case (2019), which provides costings for line upgrades (e.g. replacing of end-of-life components, lowering tunnels for container freight) and a new rail spur to Marsden Point. Some of the line upgrades are already committed and it is assumed that the remaining upgrades would occur in the absence of an expansion at Northport, to accommodate existing freight flows. The Oakleigh to Marsden Point spur is contingent on a major expansion at Northport and the cost estimate has been included here.

The conclusion from transport consultants and planners is that a freight hub in North West Auckland does not make sense, given that most freight is destined for industry and warehouses in the south of Auckland, where inland ports and distribution hubs are located. It would mean that freight from Northport would be unloaded from rail and then moved onto roads to South Auckland, thereby adding to congestion through the city. This conclusion was reached following infrastructure workshops held with transport consultants and planners in February and March 2020.

Instead, the focus has been on costing a freight-focused rail route from the North Auckland Line through the city, which has been identified as being necessary, given long-term freight growth. This involves an additional track on the line from Swanson to Avondale, to separate freight from the metro passenger service, with a new line deviating from Avondale to Southdown, thereby circumventing the most heavily used section of the Auckland rail network.

5.3.2 Capacity additions

The rail capacity model determines passing loops, track costs for two terminals and rolling stock. As the North Auckland Line would have 186 km of single track from Swanson to Marsden Point, it was identified that an additional 13 passing loops would be needed over the long term, under the calibrated freight forecast, as shown in Table 7 below. There is also an allowance for a signalling system (and fibre optic cable) for the North Auckland Line, in response to increased frequency of use.

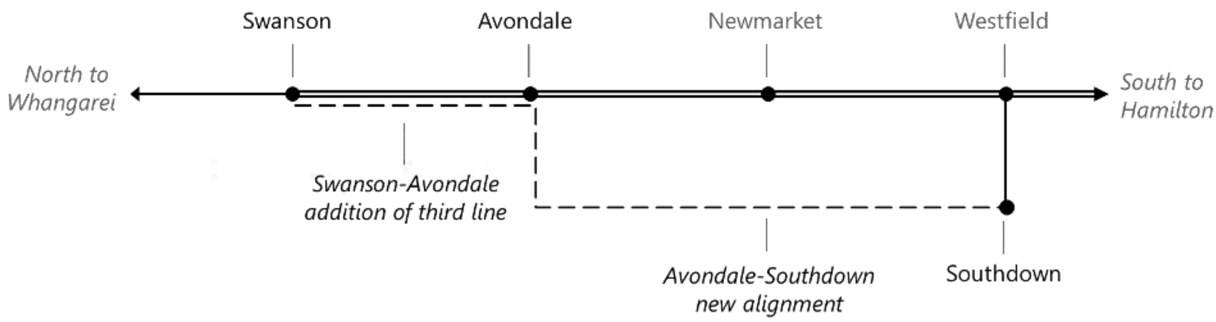
A third line from Swanson to Avondale for rail freight was identified as being necessary. This would run alongside the double-tracked section of the North Auckland Line, which will be heavily used by the metro (passenger) rail service as part of the Western Line service route following the completion of the City Rail Link in 2024. This section was considered to be somewhat scalable under the lower freight growth scenario of the officials' agreed forecast.

The new line from Avondale to Southdown would largely follow the designation in place, to allow freight trains to directly link with Southdown (location of Metroport) and the Westfield junction to destinations further south (e.g. Wiri Inland Port). The cost estimate was informed by an assessment of the expected alignment map, which provided length estimates of above ground track (8.2km), cut and cover (3.4km) and an allowance for a bored tunnel section (1.0 km). The cost is high, but factors in the need to work around the complexity of the terrain and existing road network. The costing was tested against assumptions used by RIC NZ for the lines to new ports and found to be reasonable.

For completeness, it is possible that further rail infrastructure requirements would be needed to the south of Westfield under this option, to enable improved access the inland hubs further south.

Figure 19 is an approximation of how these lines would fit together and is intended as a visual aid for the above description.

Figure 19 Representation of North Auckland Line (Auckland section) and additional lines



Source: Sapere (not to scale)

5.3.3 Cost estimates

Table 7 summarises the components comprising the estimated rail infrastructure cost for this option. The results for the calibrated freight forecast and the officials' agreed forecast are presented. The assumed rail market share is 50%.

Table 7 Cost estimates of rail infrastructure for Northport

Component	Calibrated freight forecast	Officials' agreed forecast
Outputs in 2079		
Total trains per day	37	14
Additional passing loops	13	7
Cost estimate ($ million)		
Passing loops	134	64
Signalling system	26	26
Rolling stock	439	162
Terminals at each end	40	17
Marsden Point spur	329	329
Swanson to Avondale third main	3,500	1,800
Avondale-Southdown line	3,000	2,500
Total cost	7,468	4,898

Source: Murray King & Francis Small Consultancy and KiwiRail; Sapere analysis

5.4 Port of Tauranga option

This section identifies rail infrastructure requirements for the Tauranga option over the long term.

5.4.1 Capacity additions

The rail capacity model determines the passing loops, track costs for two terminals and rolling stock. The East Coast Main Trunk component of the route involves 97 km of single track, from Hamilton to Tauranga. It was identified that 14 passing loops would be needed to be constructed or lengthened over the long term under the calibrated freight forecast, as shown in Table 8. In addition, the curves and grades of the alignment are gentler and so the travel time is shorter than for the North Auckland Line (in turn, affecting rolling stock requirements). The capacity of the Kaimai Tunnel was considered and the conclusions are that the existing signalling systems are adequate and that the combination of the existing tunnel and additional passing loops would provide sufficient capacity.

For the North Island Main Trunk component of the route, it is assumed that the planned third main line to the south will be used by existing freight, and its growth, and by express passenger services. Therefore the construction of a fourth main line is included in the cost estimate. This fourth main could also be used for future express passenger services, but for the purpose of this study, the conservative option is to attribute it the future rail freight task. In addition, there is a short single-track section to the south, through the Whangamarino Swamp and the lengthening of the one intermediate passing loop to 1500m has been allowed for. This would shorten the single-track sections either side to lengths comparable with those between Hamilton to Tauranga.

5.4.2 Cost estimates

Table 8 summarises the components comprising the estimated rail infrastructure cost for this option. The assumed rail market share is 70%.

Table 8 Cost estimates of rail infrastructure for Port of Tauranga

Component	Calibrated freight forecast	Officials' agreed forecast
Outputs in 2079		
Total trains per day	81	41
Additional passing loops	14	8
Cost estimate ($ million)		
Passing loops	108	44
Rolling stock	364	134
Terminals at each end	56	24
Fourth main South (NIMT)	1,500	300
Total cost	2,029	502

Source: Murray King & Francis Small Consultancy and KiwiRail; Sapere analysis

5.5 Firth of Thames option

This section identifies the rail infrastructure needed for the Firth of Thames option. The alignments discussed are indicative to provide a cost estimate and do not represent a detailed plan.

5.5.1 Areas examined

RIC NZ considered the potential rail connections and alignments for the Firth of Thames option. The site of focus for this study is at Kawakawa Bay. Three options for connection into the mainline at Papakura were considered, with the focus being on an option that would potentially be less disruptive to construct.

The route of focus features a grade separated junction and alignment through the existing industrial area in south Papakura, and then along the proposed Mill Rd corridor. This will require additional land and the grade separation of road connections with Mill Rd. The route then follows the Clevedon Valley out to Kawakawa Bay. At the Ness Valley, the geometry and civil scope becomes more complex, and as the route winds around Kawakawa Bay it requires three tunnels due to the topography. The assessment has assumed these tunnels to be straight for simplicity. Nevertheless, the tunnels add considerable cost. There would be relatively short marine bridge required to get out to the port operational area and this has been included in the cost estimate.

5.5.2 Cost estimate

Table 7 shows the cost estimate for the rail line to Kawakawa Bay on the Firth of Thames, along with the estimated track length. An allowance for the acquisition of a 20m wide corridor of land, for potential future double tracking, has been included in the cost estimate. The cost estimate is not considered to be scalable for the different freight forecasts. That is, the rail connection is assumed to be required under both freight forecasts.

Table 9 Cost estimates of rail infrastructure for Firth of Thames

Measure	Kawakawa Bay
Rail market share	50%
Overall track length (km)	33.0
Cost estimate ($ million)	8,535

Source: RIC NZ; Sapere

5.6 Manukau Harbour option

The purpose is to identify rail infrastructure needed for the Manukau Harbour option. The alignments discussed are indicative to provide a cost estimate and do not represent a detailed plan.

5.6.1 Areas examined

RIC NZ considered the potential rail connections and alignments for the Manukau Harbour option. The site of focus for this study is at Puhinui and access involves considerable complexity with respect to the existing road and rail networks and with respect to the current land uses.

The connection to the mainline is assumed to be just south of Wiri Station Rd. This is based on historic optioneering related to the 2016 South-western Multi-modal Airport Rapid Transit (SMART) study that investigated heavy rail to the airport. Among the connection options examined, this was the only practical solution. This assessment has not re-challenged this conclusion. Nevertheless, the area is complex geometrically and connectivity wise and the footprint would likely impact a number of existing industrial and freight properties. The route is similar to that investigated in the SMART study with a deviation adjacent the Wiri Oil Facility southwards towards the Papakura channel. A marine bridge for rail only has been included in this alignment.

5.6.2 Cost estimate

Table 10 shows the cost estimate for the rail line to the Puhinui on the Manukau Harbour, along with the estimated track length. An allowance for the acquisition of a 20m wide corridor of land, for potential future double tracking, has been included in the cost estimate. The cost estimate is not considered to be scalable for the different freight forecasts.

Table 10 Cost estimates of rail infrastructure for Manukau Harbour

Measure	Puhinui
Rail market share	10%
Overall track length (km)	5.2
Cost estimate ($ million)	1,944

Source: RIC NZ

5.7 Summary of rail infrastructure costs

Table 11 outlines the estimated costs for each option and the base case, as used in the schedule of rail infrastructure costs. The cost estimates are on a real, non-discounted basis. An allowance for design rolling stock was added to consultant estimates for the new port options and base case, for consistency reasons. Expenditure in the base case is treated as being avoided under each option.

The combined Northport and Tauranga option assumes that the future freight task would be split between these two ports. The assumption is that rail connections with both ports would be needed and that the identified infrastructure would be required to enable to ports to compete. Some of the necessary components are not suitable for scaling to the lower volumes that result from the freight task being split, such as the Oakleigh to Marsden Point spur and the Avondale to Southdown line. The capacity additions for the Northport and Tauranga routes, such as passing loops, are scaled.

Table 11 Cost estimates of rail infrastructure requirements

Option	Infrastructure component	Calibrated freight forecast ($m)	Officials' agreed forecast ($m)
Northport	Capacity additions *	639	269
	Marsden Point spur **	329	329
	Swanson to Avondale third main	3,500	1,800
	Avondale to Southdown new line	3,000	2,500
	Total	7,468	4,898
Port of Tauranga	Capacity additions *	528	202
	Westfield to Pukekohe fourth main	1,500	300
	Total	2,028	502
Northport and Port of Tauranga	Capacity additions *	596	248
	Marsden Point spur **	329	329
	Swanson to Avondale third main	1,800	1,800
	Avondale to Southdown new line	2,500	2,500
	Westfield to Pukekohe	300	300
	Total	5,525	5,177
Firth of Thames	New line to Kawakawa Bay	8,535	8,535
	Allowance for rolling stock	170	170
	Total	8,705	8,705
Manukau Harbour	New line to Puhinui	1,944	1,944
	Allowance for rolling stock	30	30
	Total	1,974	1,974
Base case	Quay Park to Westfield junction third main	1,219	-
	Allowance for rolling stock	80	-
	Total	1,299	-

Notes: *Capacity additions include an allowance for rolling stock as well as passing loops as signalling systems, as required.
**The government has committed $40m to buying the land to build a rail spur.

Sources: Murray King & Francis Small Consultancy and KiwiRail; (capacity additions, new lines for existing options); RIC NZ (new lines for new port options and base case); Sapere (scaling, adjustments); NAL business case.

6. Road infrastructure requirements

This section outlines the road infrastructure required for each option over the long term

6.1 Method

This work draws on the traffic modelling workstream, as outlined in the report by Flow Transportation Specialists. That work used a range of regional traffic models to determine the impacts of port-related traffic on the road network. For each option, the assumption was that a port would be served by rail, with consideration of the potential market share for rail. Table 12 sets out the forecasts of the daily truck movements to/from the port in each of the options. For Northport and the Port of Tauranga, these would be in addition to the existing movements to/from these ports. The differences between the two freight forecasts are more modest for Northport and the Port of Tauranga, due to the assumption that a higher proportion of container freight will travel by rail for these options.

The regional traffic models look out to 2048 rather than to 2079, which is the full period of analysis of this study. The identified road infrastructure requirements are therefore, necessarily, for a shorter period of 28 years rather than 60 years. This limit applies to all of the options being examined.

The traffic modelling focused on two issues in particular.

- Traffic modelling in Auckland under redevelopment scenarios. That is, determining the extent to which road infrastructure projects might be avoided in the event of POAL freight operations and associated truck movements being relocated out of central Auckland.
- Identifying new or expanded road infrastructure that would likely be required for each option. The regional traffic modelling identifies areas where substantive works would be required rather than issues on local roads or at particular intersections. Therefore, the road capacity requirements should be seen as being at a fairly high level.

High-level cost estimates for the road infrastructure requirements were prepared by Sapere. This involved reviewing work done for the 2019 study, examining and benchmarking against relevant programme business cases, as well as discussions with NZTA about the scale, status and delivery timeframes for certain projects that are likely to occur in the period of analysis.

Table 12 Number of trucks per day forecast in 2053

Option (relocation of truck movements)	Calibrated freight forecast	Officials' agreed forecast
Base case (POAL site)	5,725	3,975
Northport	3,825	3,350
Port of Tauranga	3,825	3,350
Firth of Thames	5,725	3,975
Manukau Harbour	5,725	3,975

Source: Flow Transportation Specialists (traffic workstream report)

6.2 Traffic modelling under redevelopment scenarios

Two redevelopment scenarios were tested to determine the traffic generating potential, relative to the base case where the POAL freight activities remain at the current location. The first scenario is outlined in Table 13 (i.e. with 5,800 apartments, and hotel, commercial, retail businesses for a total of almost 14,000 employees). This builds on work undertaken for the 2019 study that considered mixed-use development for the waterfront. The second scenario is set to 50% of that development, without the hotel element (i.e. 2,900 apartments, commercial/retail for a total of almost 7,000 employees).

Table 13 Waterfront redevelopment land use assumptions

Category	Gross floor area or apartments	Employees or residents
Residential	5,800 apartments	11,600 residents
Commercial	227,500[2]	11,380 employees
Hotel	600 rooms	included above
Retail	20,200m^2	2,525 employees

Source: Warren and Mahoney (2019); adapted by Flow Transportation Specialists and Sapere

These scenarios were tested using standard traffic models under two freight forecast scenarios, where, in the base case, port traffic activity increases in line with the calibrated freight forecast or with officials' agreed forecast. Cars and light goods vehicles have less effect on the operation of the road network than a large truck. Therefore, all vehicles have been converted to passenger car units (PCUs) using a standard factor of 2 or 3 for large trucks (with cars being 1 PCU). The model horizon extends to 2048 and results are shown for that year.

The vehicle movement results are shown in Figure 20 below. The modelling indicates that the total PCUs under the lower intensity redevelopment scenario would be similar to what would otherwise occur under the base case with the calibrated freight forecast scenario for POAL. However, under the higher intensity redevelopment scenario, which is also highly plausible, the total PCUs would be significantly greater in number than what would occur under the calibrated freight forecast scenario for POAL. It should be noted that the higher intensity redevelopment scenario does not represent an upper bound for the level of redevelopment intensity that could occur.

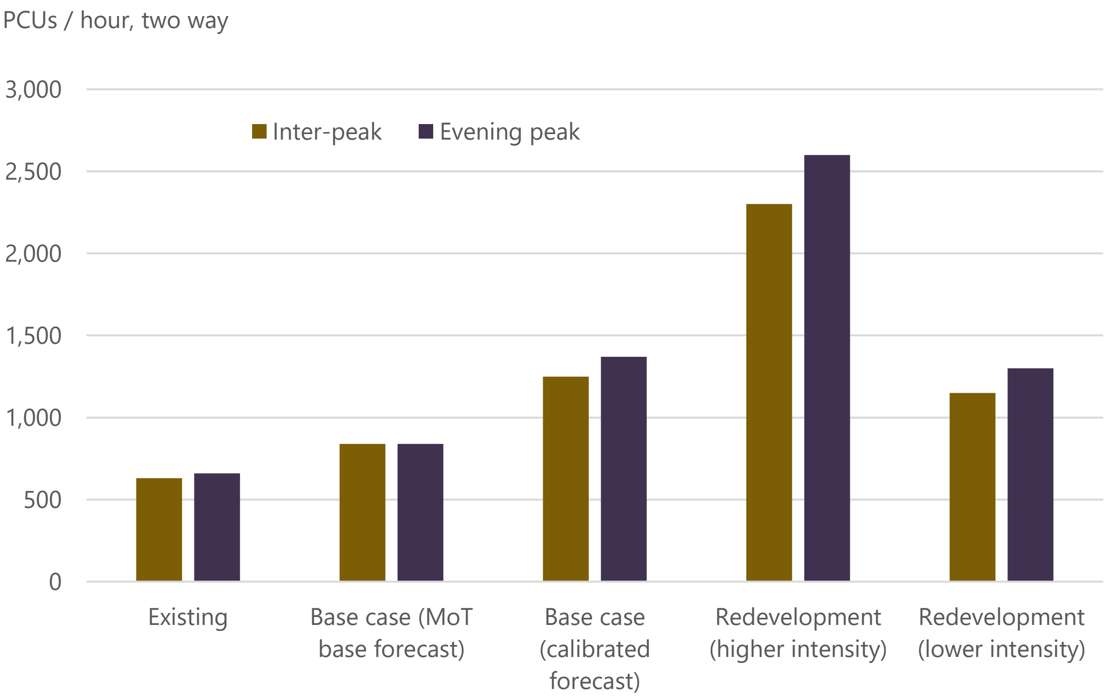
These results arise even with the assumption that significant proportions of residents and employees would be likely to travel by modes of transport other than the private car to and from this central Auckland site. It should also be acknowledged that traffic associated with the POAL operations are relatively consistent throughout the day, whereas traffic associated with the redevelopment scenarios will be more heavily concentrated toward the weekday morning and evening peaks.

The results of these forecast flows associated with the POAL site have been assessed in the Auckland City Centre SATURN model. This model has a furthest horizon year of 2036, so this year has been used for the assessment. The Auckland Transport Alignment Project (ATAP) assumption, that improvements would eventually be made along Grafton Gully intersections, has been included in the model.

Table 14 summarises the average travel speeds within the model under the above redevelopment scenarios. The key finding is that average travel speeds in the Auckland city centre are likely to be lower under the higher intensity redevelopment scenario than what would otherwise occur in the base case (calibrated freight forecast). These are averages within the model, so the results may under-represent the extent of congestion in particular areas. However, the results indicate the extent to which the higher intensity redevelopment scenario will lead to lower vehicle speeds in the city centre.

The key finding of the above modelling work is that congestion is unlikely to improve in the event of a move and may be worse, depending on the intensity of development. The conclusion is that **no planned road infrastructure projects are avoided** under the options in this study.

Figure 20 Movements from POAL site in passenger car units, 2048



Source: Flow Transportation Specialists; Sapere chart

Table 14 Average Travel Speeds in the Auckland CBD, 2036 (km per hour)

Scenarios	Morning peak	Inter-peak	Evening peak
Existing	22.4	34.1	18.9
Base case (officials' agreed forecast)	17.6	28.2	14.5
Base case (calibrated freight forecast)	16.9	27.8	13.8
Redevelopment (higher intensity)	16.3	25.8	12.7
Redevelopment (lower intensity)	17.2	27.5	14.2

Source: Flow Transportation Specialists

6.3 Road infrastructure required for existing ports

The road infrastructure identified in the traffic modelling work as being necessary for the existing port options, of Northport and the Port of Tauranga, were similar to those identified in the 2019 study. The results are sensitive to assumptions about when a road infrastructure project might otherwise occur, as it is clear that government priorities change over time. The approach here is to use the currently available information about the likely timing, drawing on documentation and discussions with NZTA.

6.3.1 Northport option

The traffic modelling identified that additional works along SH1 between SH15 and Te Hana would be be required, with safety improvements and corridor widening or rerouting at the Brynderwyn Range. The assumption was that an upgrade of SH1 from Warkworth to Wellsford would be completed.

The Whangarei to Auckland Programme Business Case (2017) is the starting point. The government has confirmed the Warkworth to Wellsford upgrade and the Marsden Point route. It is assumed that the remaining Brynderwyn Range section, which provides for a western bypass of the current SH1 through Brynderywn Range, would be the final section to be completed in this 30-year Programme. This third-decade project is assumed to occur in the 2040s in the absence of a port relocation decision, and to be brought forward by 10 years to the 2030s in the event of a relocation decision. The costs were adjusted by Sapere on the basis of general advice from NZTA with respect to cost benchmarks and potential alignments.

In addition, the upgrade of SH1 from Warkworth to Wellsford is currently not expected to begin before 2030, based on current priorities. The necessary property acquisition and substantial earthworks would mean a ten-year construction period and so this would imply project completion around 2040. The assumption used here is that a decision to relocate the POAL freight task to Northport would bring this project forward by a decade, to around 2030. The cost estimate is based on the mid-point of the estimated cost range in the Detailed Business Case (2019).

Within Auckland, it is assumed that the outcomes of the Additional Waitematā Harbour Connections project will be driven by a range of factors, including resilience, and less about Northport truck traffic. The western ring route is assumed to be an option for trucks bound for South Auckland.

Table 15 summarises the cost estimates for these road infrastructure projects.

Table 15 Cost estimates for road infrastructure for the Northport option

Road infrastructure project	Assumption	Cost estimate ($m)
Various upgrades of SH1 including the Brynderwyn Range section (western bypass)	Cost brought forward	1,241
Upgrade of SH1 from Warkworth to Wellsford	Cost brought forward	1,900
Total		3,141

Source: Sapere, with reference to Programme and Detailed Business Cases

6.3.2 Port of Tauranga option

The traffic modelling identified that additional works on SH1 and SH29 from south of Cambridge to Tauriko are likely to be necessary. Additional works at the SH2/Dive Crescent interchange, adjacent to the Port of Tauranga operations at Sulphur Point were also identified as being required. These requirements are similar to those identified in the 2019 study.

The approach here is to examine previous costings for upgrades to three sections of the route: SH1 from Cambridge to Piarere, SH29 from Piarere to Tauriko, and the Tauriko network plan. This includes the addition of passing lanes, likely to be required due to steep gradients around the Kaimai Ranges, and given the scale of the additional truck traffic.

A recent re-evaluation of interregional projects concluded that supporting growth within Tauranga's Western Corridor and addressing safety are higher priorities than improving freight access. Therefore, the assumption here is that these long-term upgrades would need to be brought forward by a decade, to the 2030s, in the event of a decision to relocate POAL freight operations to the Port of Tauranga. The previous costings are adjusted to allow for cost escalation, and to account for some of the road safety elements being prioritised and committed sooner.

In addition, an allowance is made for the urban upgrades adjacent to Port of Tauranga, including the additional works at the SH2/Dive Crescent interchange. This allowance is for upgrades, currently not planned, such as grade separation and widening, to provide for a large increase in truck numbers. The approach here is to use the estimate identified in the 2019 study. This is treated as a new cost that would not otherwise occur in the period of analysis.

Table 16 summarises the cost estimates for these road infrastructure projects. These are a mix of costs being brought forward by 10 years and new costs.

Table 16 Cost estimates for road infrastructure for the Port of Tauranga option

Road infrastructure project	Assumption	Cost estimate ($m)
Additional works on SH1/ SH29 from south of Cambridge to Tauriko	Cost brought forward	1,091
Additional works at the SH2/Dive Crescent interchange, adjacent to the Port operations at Sulphur Point	New cost	400
Total		1,491

Source: Sapere, with reference to Programme and Detailed Business Cases

6.4 Road connections required for new ports

A road connection would be needed for either of the new port options, on the Firth of Thames or the Manukau Harbour. The traffic modelling work identified the following requirements.

- Firth of Thames option – an upgraded roading link from Mill Road to the Firth of Thames site at Kawakawa Bay will be required, likely with a bypass of Clevedon. An improved connection from Mill Road to the Southern Motorway would also be likely to be necessary.
- Manukau Harbour option – a new arterial standard roading link from Roscommon Road/Wiri Station Road is assumed to be required, out to the Manukau Harbour site at Puhinui. Also, an improved connection to SH20, likely an upgrade to the interchange at Lambie Drive.

The assumption has been that a four-lane arterial road, of two lanes each way, would be needed to separate port-related truck traffic and other vehicles. The costing approach has necessarily been high level and has involved benchmarking against the costs per kilometre of road construction in comparable business cases with differing complexity in terrain (e.g. Waikato Expressway sections, Puhoi to Warkworth). The results should therefore be seen as estimates that are designed to give a sense of the plausible scale of cost involved. More detailed assessments would be needed to inform costings for planning purposes and could identify some additional requirements.

The results are shown in Table 17, along with the assumptions of distance and cost per kilometre. The cost per kilometre used is a judgment, and reflects the mix of terrain in the Firth of Thames option and the relative complexity of the urban environment in the Manukau Harbour option. An allowance for a connection to the existing road network has been included, with the assumption of an upgrade to an existing motorway interchange. This has been costed at $50 million after a discussion with NZTA. Provision has also been made for land acquisition and marine bridges, taking into account length and land use, and the standard industry rates used by RIC NZ in the rail infrastructure cost estimates.

Table 17 Cost estimates for road connections to new ports

Component	Firth of Thames	Manukau Harbour
Assumptions		
Total distance (km)	31.0	4.5
Cost per km ($ million)	27.8	27.8
Cost estimate ($ million)		
Road construction	863	125
Connection to network	50	50
Provision for land acquisition	1,209	96
Provision for marine bridges	564	499
Total cost	2,687	770

Source: Sapere with input from Flow Transportation Specialists (modelling stream) and NZTA (business cases)

6.5 Summary of road infrastructure costs

Table 18 outlines the estimated costs for each option, as used in the schedule of road infrastructure costs. The cost estimates are on a real, non-discounted basis.

The first column shows the cost estimate for each option. For the existing port options, the majority of these costs are treated as projects that would be brought forward by a decade or so, rather than wholly new costs that would not otherwise occur in the timeframe for this analysis. This means that in the cost benefit analysis, the economic cost for these projects is for the time value of money only. For the new port options, the costs are treated as new costs under the assumption that these projects would not otherwise occur in the analysis timeframe.

The combined Northport and Tauranga option assumes that the future freight task would be split between these two ports. The assumption is that the road infrastructure identified for each port would be required to enable to ports to compete and so the same projects are included in the combined Northport and Tauranga option.

These estimates were prepared under the calibrated freight forecast scenario. The connections to the new port options are not considered scalable under the officials' agreed forecast. That is, these projects would still be required to a similar standard under a lower forecast of freight volume growth. Similarly, for the existing port options, the brought forward nature of most of these projects meant that it was not considered necessary for the cost estimates to be scaled.

The long-term growth in freight and the related truck traffic around the inland ports in South Auckland will likely need to be addressed through roading improvements, given existing pressures on the road network in this area. This is a legitimate issue that has been raised by Auckland Transport. Although the traffic modelling is not sufficiently fine-grained to identify these pressure points, it is acknowledged that these are costs that would likely occur under all of the options assessed here.

Table 18 Cost estimates of road infrastructure requirements

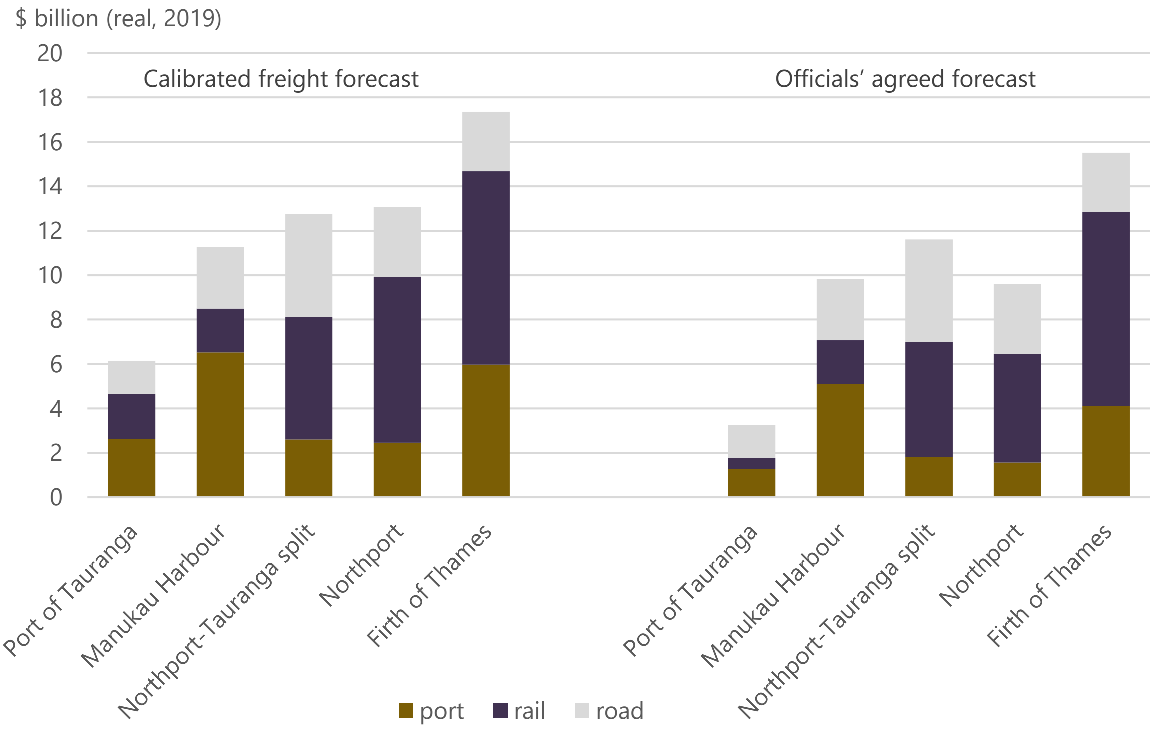
Option	Cost estimate ($m)	Treated as brought forward ($m)	Treated as new cost ($m)
Northport	3,141	3,141	-
Port of Tauranga	1,491	1,091	400
Northport and Port of Tauranga	4,632	4,232	400
Firth of Thames	2,687	-	2,687
Manukau Harbour	770	-	770

Sources: Sapere with input from Flow Transportation Specialists (modelling stream) and NZTA (business cases)

7. Conclusions

Cost schedules for port, rail and road infrastructure for each option were prepared as an input into the cost benefit analysis. The figures are in 2019 dollars on a non-discounted basis. Figure 21 and Table 19 summarise the cost estimates for each option, split out by port, rail and road infrastructure. The road costs for existing ports are largely treated as being brought forward, under the assumption they would otherwise occur later in the period of analysis. The figures on the left are for the calibrated freight forecast and those on the right are for the officials' agreed forecast.

Figure 21 Summary of infrastructure costs by option



Source: Sapere

Table 19 Summary of infrastructure costs by option (real, 2019, $b)

Option	Calibrated freight forecast				Officials' agreed forecast			
	Port	Rail	Road	Total	Port	Rail	Road	Total
Port of Tauranga	2.6	2.0	1.5	6.2	1.3	0.5	1.5	3.3
Manukau Harbour	6.5	2.0	2.8	11.3	5.1	2.0	2.8	9.8
Northport and Tauranga	2.6	5.5	4.6	12.8	1.8	5.2	4.6	11.6
Northport	2.5	7.5	3.1	13.1	1.6	4.9	3.1	9.6
Firth of Thames	6.0	8.7	2.7	17.4	4.1	8.7	2.7	15.5

Source: Sapere

Table 20 summarises the road and rail infrastructure requirements identified for each option.

Table 20 Summary of landside infrastructure projects

Option	Road infrastructure	Rail infrastructure
Northport	• Additional works along SH1 between SH15 and Te Hana are likely to be required, with safety improvements. • Corridor widening and rerouting at the Brynderwyn Hills would be needed and is treated as being brought forward. • SH1 Warkworth to Wellsford project is assumed to be brought forward.	• Capacity additions on the North Auckland Line (rail loops). • Construction of: – the Marsden Point spur – a third main line from Swanson to Avondale, – a new line from Avondale to Southdown.
Port of Tauranga	• Additional works on SH1/ SH29 from south of Cambridge to Tauriko are likely to be necessary and are treated as being brought forward. • Additional works at the SH2/Dive Crescent interchange, adjacent to the Port operations at Sulphur Point.	• Capacity additions (rail loops) on: – the East Coast Main Trunk – the North Island Main Trunk (Whangamarino). • Construction of a fourth main line from Westfield to Pukekohe.
Northport and Port of Tauranga	• Additional works assumed to still be brought forward for traffic increases.	• Capacity additions scaled back to match each port's share of freight task.
Firth of Thames	• A new roading link from Mill Road to the Firth of Thames site will be required, with a bypass of Clevedon. • An improved connection from Mill Road to the Southern Motorway is also likely to be necessary.	• Construction of a new line to a new port on the Firth of Thames, connecting from the North Island Main Trunk.
Manukau Harbour	• A new arterial standard roading link from Roscommon Road/Wiri Station Road is assumed to be required. • An improved connection to SH20, in the form of an upgraded interchange at Lambie Drive.	• Construction of a new line to a new port on the Manukau Harbour, connecting from the North Island Main Trunk.

The following assumptions were used for the phasing of costs in the infrastructure schedules.

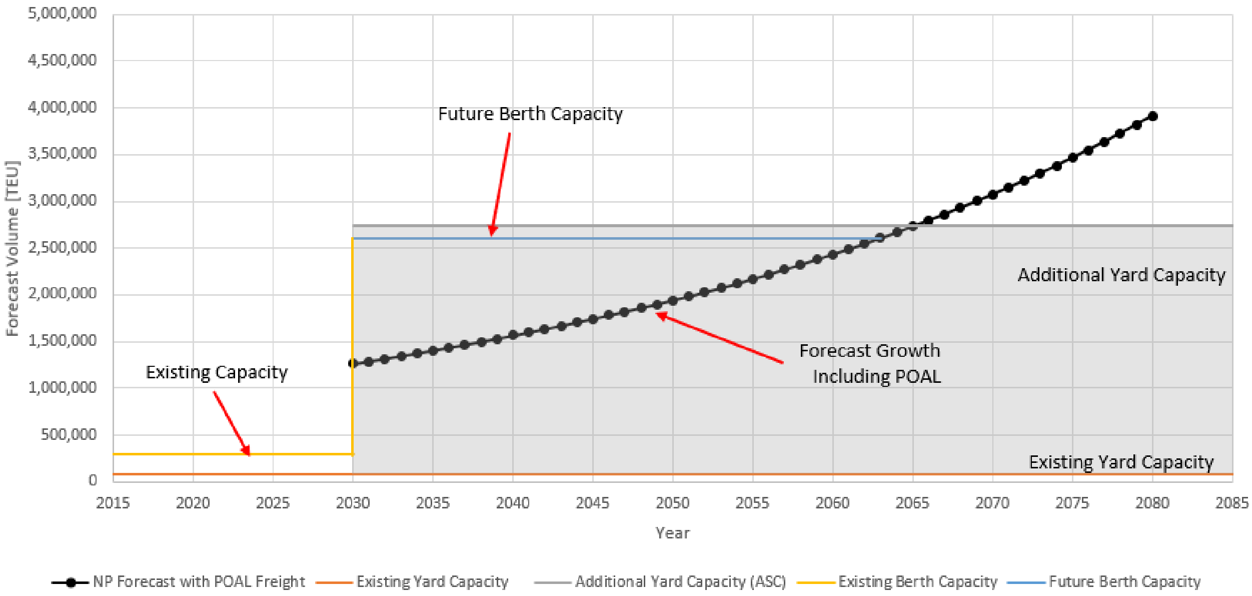
- Planning and approval costs are allocated to the 2020s and spread evenly over the decade.
- Upfront infrastructure costs are allocated to the 2030s, with the assumption being that new port capacity (or a new port) would be ready for operation no later than 2040. Incremental expenditure for infrastructure expansion, as required, is added over subsequent decades.
- Given the above timings, the avoided base case costs (i.e. in the counterfactual) is that expenditure that would otherwise be expected to occur after the 2030s.

These assumptions are be applied to all options, for modelling simplicity and to enable comparability. Timeframe assumptions are explored as a sensitivity test in the cost benefit analysis.

Appendix A: Port capacity plots

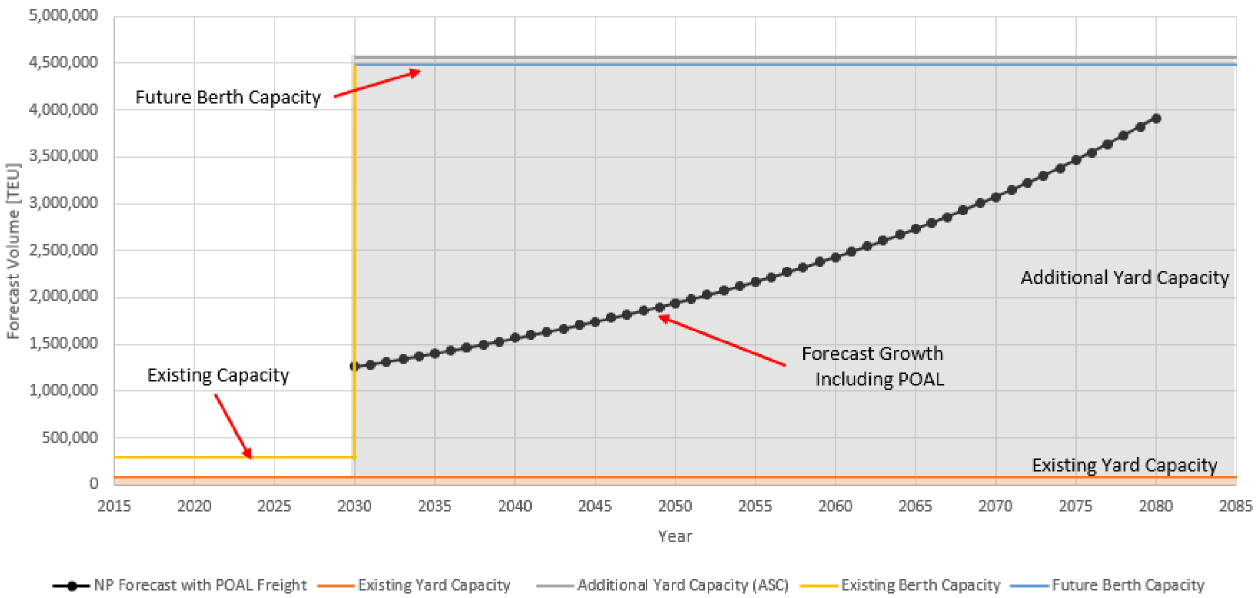
The following capacity plots for the existing port options were prepared by Advisian for this report, using the calibrated (medium growth) freight forecast for container volumes.

Figure 22 Capacity plot for Northport expansion option



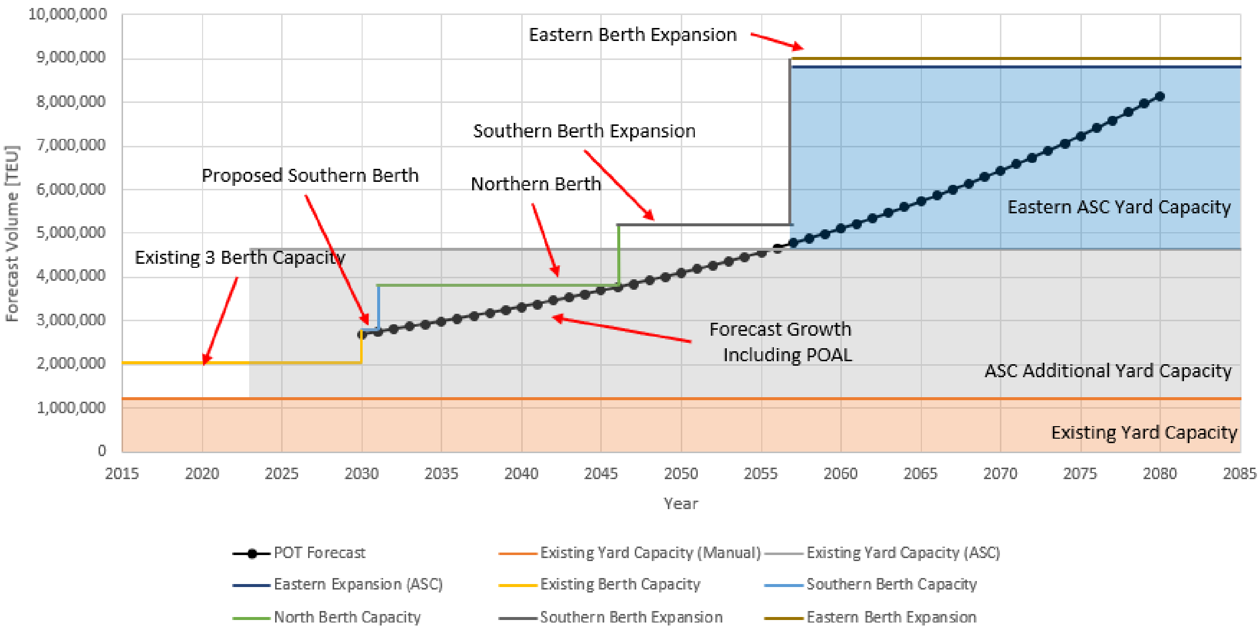
Source: Advisian

Figure 23 Capacity plot for Northport expansion option – additional expansion to the east and west



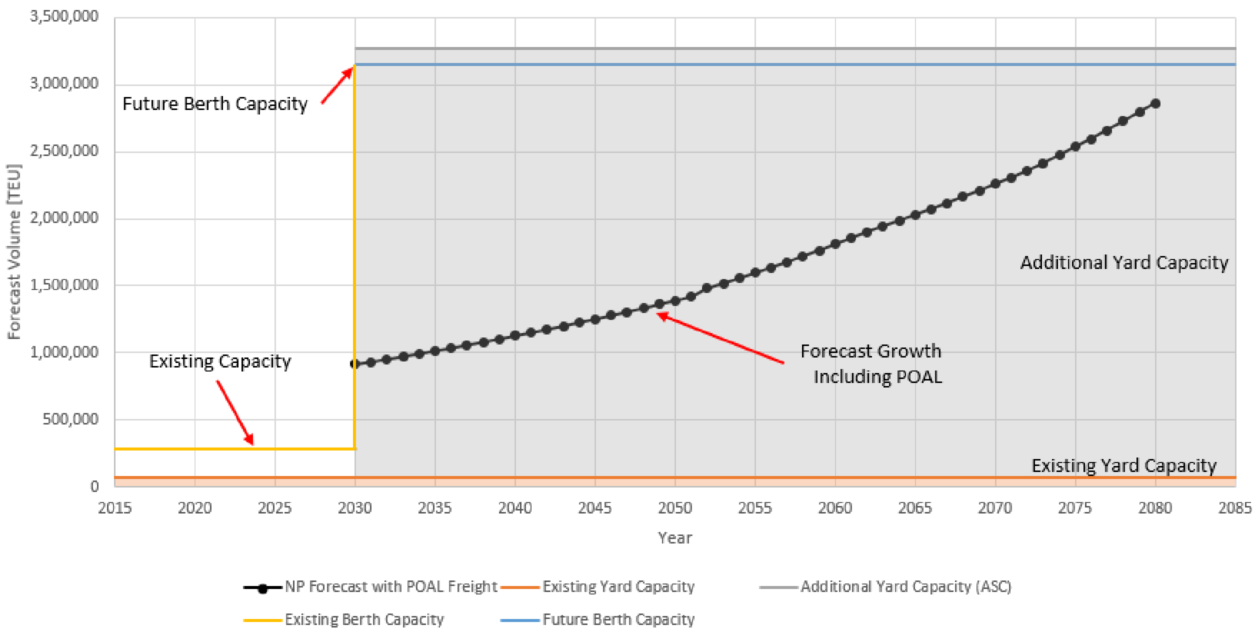
Source: Advisian

Figure 24 Capacity plot for Port of Tauranga expansion option



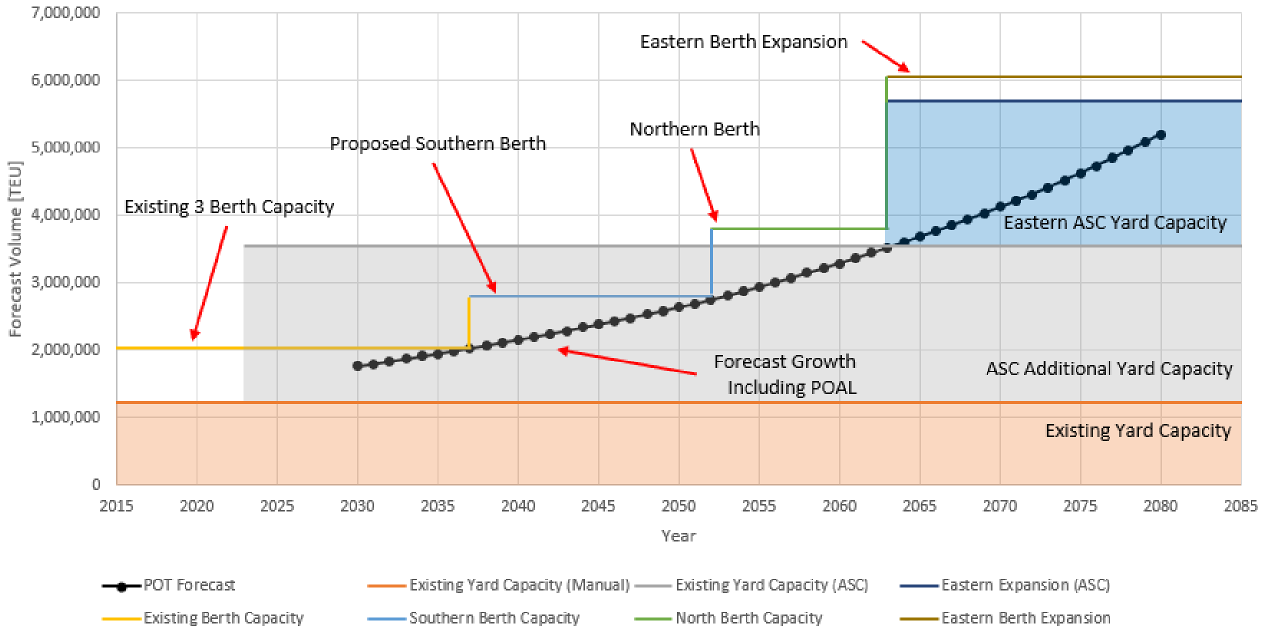
Source: Advisian

Figure 25 Capacity plot for Northport – shared expansion option



Source: Advisian

Figure 26 Capacity plot for Port of Tauranga – shared expansion option



Source: Advisian

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