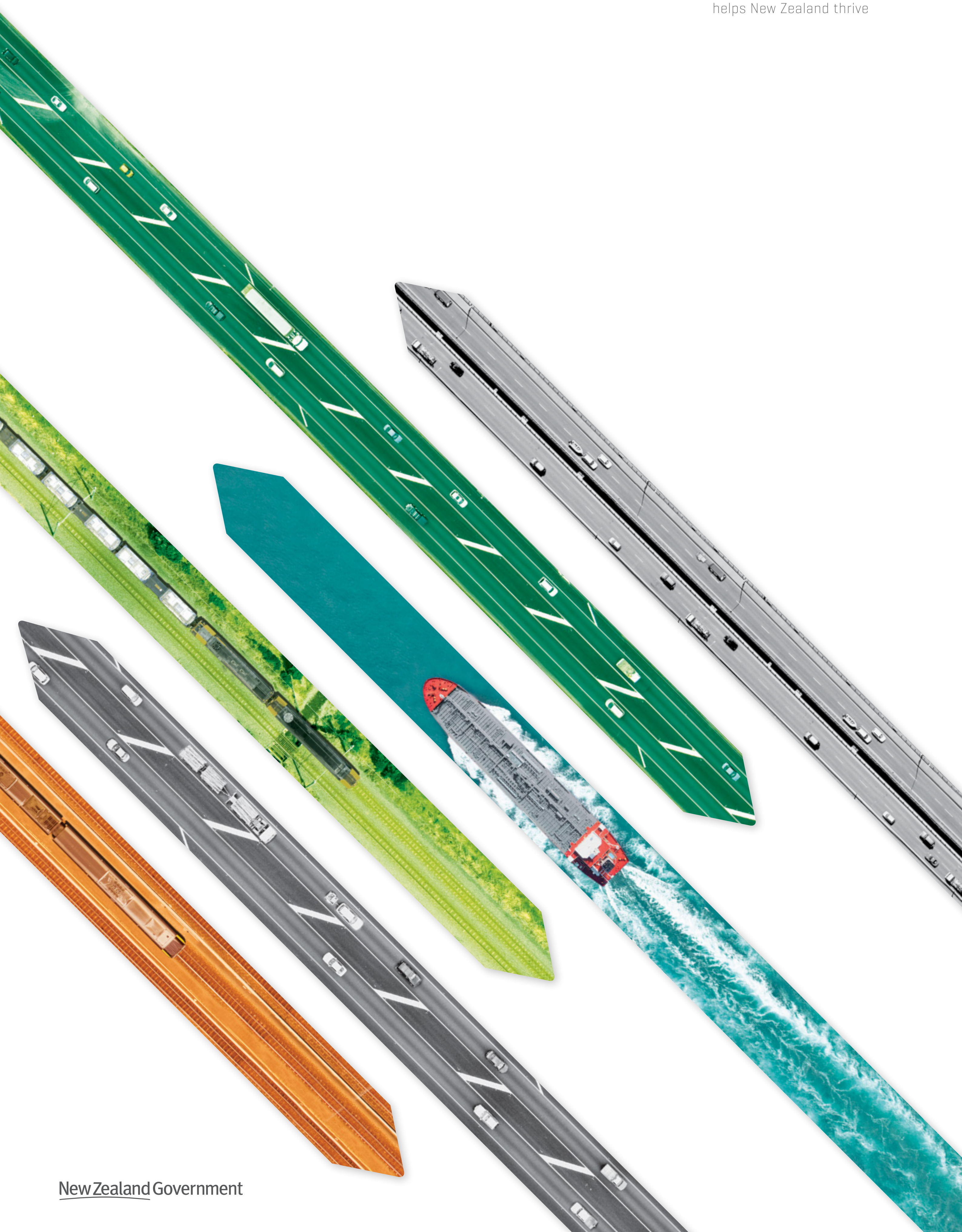
Future Freight Scenarios Study

November 2014

Ministry of Transport
TE MANATŪ WAKA

Ensuring our transport system helps New Zealand thrive



New Zealand Government

Contents

Glossary

Term	
CGE	Computable General Equilibrium
DNV	Det Norske Veritas
FEU	Forty foot equivalent unit container
FFSS	Future Freight Scenario Study
FIGS	Freight Information Gathering System
FMM	Freight Movement Model
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GTK	Gross tonne kilometre
IMEX	Import export container freight
LOA	Length overall
MoT	Ministry of Transport
MPI	Ministry of Primary Industries
NFDS	National Freight Demand Study
NTK	Net tonne kilometre
NZSC	New Zealand Shippers' Council
NZTA	New Zealand Transport Agency
OD	Origin/destination pairs
PCU	Passenger car units
RoNS	Roads of National Significance
T	tonne
TEU	Twenty foot equivalent unit container – TEU is also used as a unit of measure of the capacity of container vessels. For example a 4,000 TEU vessel – has capacity for up to 4,000 TEUs
VSA	Vessel Sharing Agreement
VKT	Vehicle kilometres travelled

1 Executive Summary

Why the Ministry of Transport commissioned this study

Transport is essential to New Zealand's ability to engage in international trade. The quality and frequency of international shipping services is critical to New Zealand's ongoing competitiveness in global markets.

In 2013 the Ministry of Transport commissioned Deloitte to undertake a study to examine the impact that larger container ships could have on the freight system. The study examines the likely impacts on freight costs and the wider economy from the range of choices that shipping lines, ports and/or exporters could make in the face of changes in international shipping and a growing freight task.

The New Zealand Productivity Commission in its report, International Freight Transport Services Inquiry (April 2012), noted a number of key coordination challenges that affect those who make investment decisions in the freight sector. These include: the number, type and location of ports; how to get the best out of larger container ships; how best to coordinate road and rail investments; and local and central government interactions in freight transport[1].

The effective operation of the supply chains that link exports and imports to their markets is critical to the efficient operation of international trade. These supply chains are complex and involve the co-operation of a number of organisations (in the shipping, ports, logistics, rail and road sectors) working in a co-ordinated way to ensure the smooth transport of goods from origin to destination.

As 99.5 percent of New Zealand's trade by weight is shipped through seaports, the economy is heavily reliant on the international shipping industry. However, in terms of the global shipping industry, New Zealand is a relatively small market, geographically remote from the major trade routes. Furthermore the nature of New Zealand's containerised trade, including the imbalance between imports and exports, the relative density of exports compared to imports and the requirement of temperature control for many exports adds to the complexity and cost of the task.

The international shipping industry is facing many challenges including an oversupply of vessels at a time when demand has declined and costs are rising (particularly fuel). The industry is addressing these issues in a number of ways including introducing larger ships (to generate economies of scale), slow steaming, forming alliances, vessel lay-ups, and scrapping surplus vessels.

In particular the cost savings from introducing larger ships are significant. Research has shown that at 100% utilisation there is about a 10% saving in slot cost for each step-up in ship size. For example, the container (slot) cost for an 18,000 TEU vessel is 91% of the container (slot) cost for a 14,000 TEU vessel.

These changes will eventually affect New Zealand's freight system.

In the first instance there will be a need for investment in port infrastructure to accommodate larger vessels and the growing freight task. A shift to larger vessels may lead to fewer ships serving New Zealand's trade routes and calling at fewer New Zealand ports[2]. This brings with it choices for individual ports about their role in the network.

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[1] New Zealand Productivity Commission, 2012. International Freight Transport Services Inquiry April 2012 pg. 273.

[2] This practice may be required to maintain a volume of container transfers at each port stop and reduce travel distances and overall time spent in port to improve vessel utilisation and reduce costs for the shipping operators

The interconnectedness between ports and the landside road and rail linkages means changes in demand patterns and new investment in any part of the system presents a co-ordination challenge on a national scale. Tension can arise between overall efficiency and commercial drivers for individual players. This is increasingly complex when infrastructure owners are trying to maximise commercial returns for their individual investments rather than seeking to deliver the most efficient supply chain for exports.

For example, a transport operator is motivated to increase utilisation of its assets (by securing freight volume and revenue) which may not necessarily be the same as optimising the supply chain for an exporter. Furthermore, while increased activity in the transport sector contributes to higher GDP this does not necessarily result in optimum export competitiveness and supply chain returns.

The investment challenge could continue to be met as it has in the past, whereby decisions have been made on the best information available to the individual market participants. However, as recommended by the Productivity Commission, richer information shared between market participants involved in "facilitated discussions" will assist participants in coordinated and/or complementary investment decision making, and help to optimise supply chain costs for New Zealand as a whole.

Figure 1 Context for the Future Freight Scenario Study

It is within this context that the Ministry of Transport commissioned the Future Freight Scenarios Study. It sought a "whole of system" assessment of the impact of larger vessels and port hubbing.

To provide such an assessment the study identifies possible future port configurations and through freight movement model assesses the impacts of those configurations on freight flows within, to and from, New Zealand. It identifies where future freight flow bottlenecks may emerge and, as a result, where asset owners may need to direct future investment or make other changes in order to maintain the required level of service.

By doing so this study seeks to improve the understanding of the strategic choices New Zealand has, and the impact of these choices on the wider freight system and the international competitiveness of New Zealand's firms. It does not make recommendations about a preferred port network or a government policy stance on ports.

Approach used to provide a "whole of system" assessment

This study assesses and compares the impact of a number of possible future configurations of shipping fleets, port and port related infrastructure on:

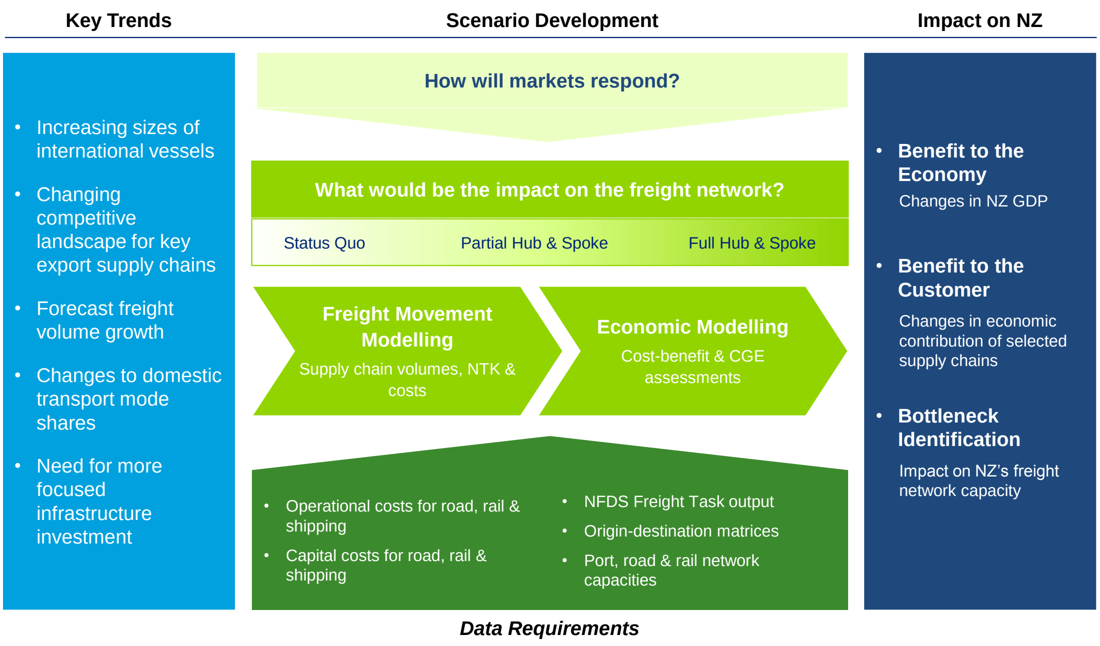
- The road, rail and coastal shipping networks
- Domestic and international transport costs for imports and exports
- The New Zealand economy.

In order to assess these impacts we have developed a number of scenarios based on alternative "international gateway" or "hub" port configurations. These scenarios are compared against the status quo (the current configuration) to identify where capacity constraints are likely to occur, what the economic cost or benefit of each scenario is likely to be and what the impact on selected export supply chains may be.

The focus of this study is on containerised trade. It does not assess the impact of changes to freight infrastructure on bulk or break bulk trade.

The following diagram outlines the process and key influences driving the analysis.

Figure 2 Outline of the analysis



The selection of the scenarios is critical to the analysis. They need to be sufficiently different to test the impact of changes compared to the status quo and to each other. They also need to reflect what is currently happening in the market. To do these things, five broad scenarios were selected to capture the spectrum of possible port development. These scenarios are described in Table 1. A number of combinations of New Zealand's ports were assessed in each of the five broad scenarios – giving 10 specific scenarios these are described in detail in Section 5.

Table 1 Scenario Description

Scenario	Description
Status Quo (Scenario 1)	A continuation of the current arrangements with all current container ports providing international services
Emerging Trends (Scenario 2)	Some trade consolidation of major ports in both islands with ports such as Nelson, Taranaki, CentrePort, PrimePort and South Port operating as feeder ports to the major ports – this represents the emerging trend in the market.
Partial Hub and Spoke (Scenarios 3,4,5)	Up to two international ports in each Island with all other ports being feeder ports to these international ports
Hub and Spoke (Scenarios 6,7,8,9)	One international port in each island with all other ports being feeder ports to these international ports
Single Hub and Spoke (Scenario 10)	One international port for the whole country with all other ports being feeder ports to this international port

Individual ports have been allocated to each of the five main scenarios in Table 1. Table 2 summarises the port combinations assessed in each scenario and the size of vessels serving the New Zealand trades. For each scenario, a number of other assumptions have been made including the throughput requirements for each port and the mode of transport used for the domestic transport task.

Table 2: The Scenarios in the Future Freight Scenarios Study

		Status quo	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10
Ports	**Hub**	Status quo All 10 container ports provide international services	Auckland Tauranga, Napier Lyttelton Otago	Auckland Tauranga, Lyttelton Otago	Auckland Tauranga, Lyttelton	Auckland Tauranga, Otago	Auckland Lyttelton	Tauranga, Lyttelton	Auckland Otago	Tauranga, Otago	Tauranga
	Feeder		All other ports are feeder ports	All other ports are feeder ports	All other ports are feeder ports	All other ports are feeder ports	All other ports are feeder ports	All other ports are feeder ports	All other ports are feeder ports	All other ports are feeder ports	All other ports are feeder ports
Vessel size (TEU) by trade	**Asia**	4,500	4,500	6,000 7,000 from 2017	6,000 7,000 from 2017	6,000 7,000 from 2017	6,000 8,000 from 2017	6,000 8,000 from 2017	6,000 8,000 from 2017	6,000 8,000 from 2017	6,000 8,000 from 2017
	North America	2,700	2,700	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037
	Europe	2,700	2,700	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037	2,700 incr to 6,000 by 2037
	Trans-Tasman	2,500	2,500	2,500 incr to 2,700 in 2021	2,500 incr to 2,700 in 2021	2,500 incr to 2,700 in 2021	2,500 incr to 2,700 in 2021	2,500 incr to 2,700 in 2021	2,500 incr to 2,700 in 2021	2,500 incr to 2,700 in 2021	2,500 incr to 2,700 in 2021

For each scenario, we have used models to generate estimates of volume, capacity and operational costs associated with handling New Zealand's international container freight task (including port, road, rail, coastal shipping and international shipping costs) from the origin through to the destination port of call. These outputs are used to identify local infrastructure bottlenecks and estimate capital investments required to provide additional capacity. The outputs of this modelling provide inputs for economic impact assessments and an assessment of impacts to cargo owners under each scenario.

Key outputs that have been generated include:

- Present Value (PV) of domestic transport operating costs – which includes road, rail, coastal shipping, and intermodal operating costs
- PV of total operating costs – which includes road, rail, coastal shipping, intermodal and port handling and international shipping costs
- PV of capital costs –which includes upgrades to ports, road and rail infrastructure but excludes capital cost for new rail rolling stock, coastal vessels and trucks. It excludes port operating equipment, other than container cranes. Costs associated with these items are assumed to be covered by operating cost unit rates.

All PVs are evaluated between 2017 and 2046 based on a discount rate of 6% with 2017 adopted as the base year.

The key tool used in the analysis is a Freight Movement Model (FMM), which was developed specifically for this project. This model serves two purposes it:

- Identifies freight movement patterns and highlights where capacity constraints may arise as volumes increase
- Estimates the capital and operating costs associated with these movements.

Where constraints are identified, the model applies capacity upgrades (based on a set of "reference" projects) to alleviate the bottleneck. This analysis assumes that further investment will be required beyond current planned investments to address the major bottlenecks caused by the additional freight movements generated under each scenario. Our analysis has been informed by the types of investments considered by Kiwi Rail and the NZ Transport Agency to be "fixes" for these bottlenecks on the road and rail networks.

Due to the complexity of the task it has not been possible to evaluate capacity and identify the most appropriate engineering solutions for specific bottlenecks for individual ports or the road and rail networks. The model assumes that the capacity upgrades to road, rail and port infrastructure used in the model are all technically and financially feasible. No assessment has been made of the ability for these capacity upgrades to be made at the appropriate time.

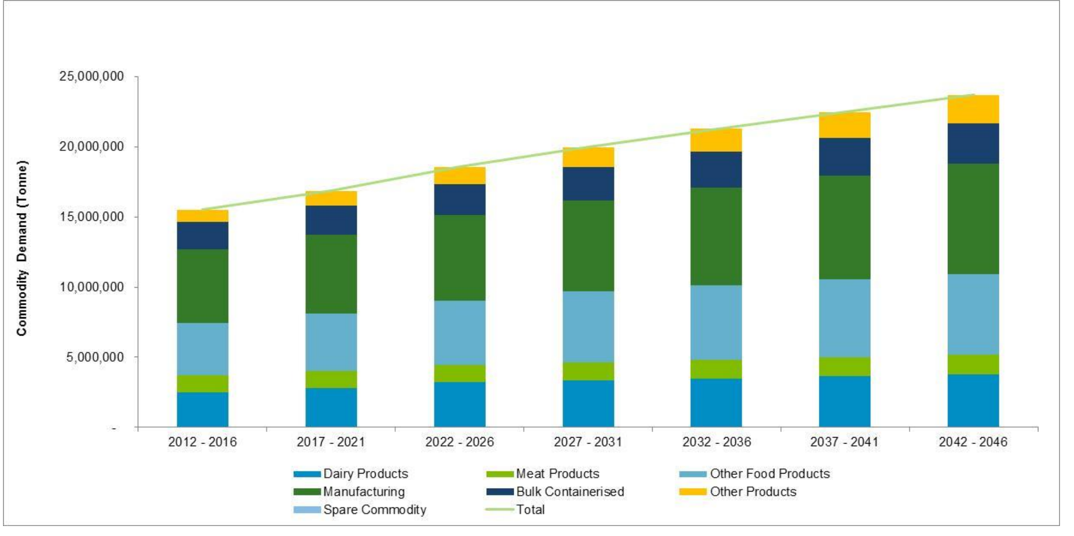
The outputs generated by the FMM have been used to compare each scenario against the Status Quo, the impact on selected supply chains and the possible impact on the economy as a whole (in terms of changes in Gross Domestic Product). This process has utilised economic modelling tools, such as cost benefit analysis and computable general equilibrium modelling.

The study has been informed by a strong evidence base. It has drawn on the work undertaken for the National Freight Demand Study (2014) (NFDS) and publically available data such as the Freight Information Gathering System (FIGS). We have also made extensive use of data from the shipping, ports, and road and rail sectors.

These data sources have been complemented by information gained from consultation with all of New Zealand's ports, the shipping lines, KiwiRail and the New Zealand Transport Agency.

Underlying the assessment is a view on the future growth of international trade. The study takes a long term view (out to 2046) utilising forecast volumes for exports and imports generated by the NFDS. These forecasts give a projected increase in the container freight task of 50% by 2046 **-** see Figure 3.

Figure 3 Forecast volumes by commodity out to 2046



Note: These forecasts have been derived from the NFDS data

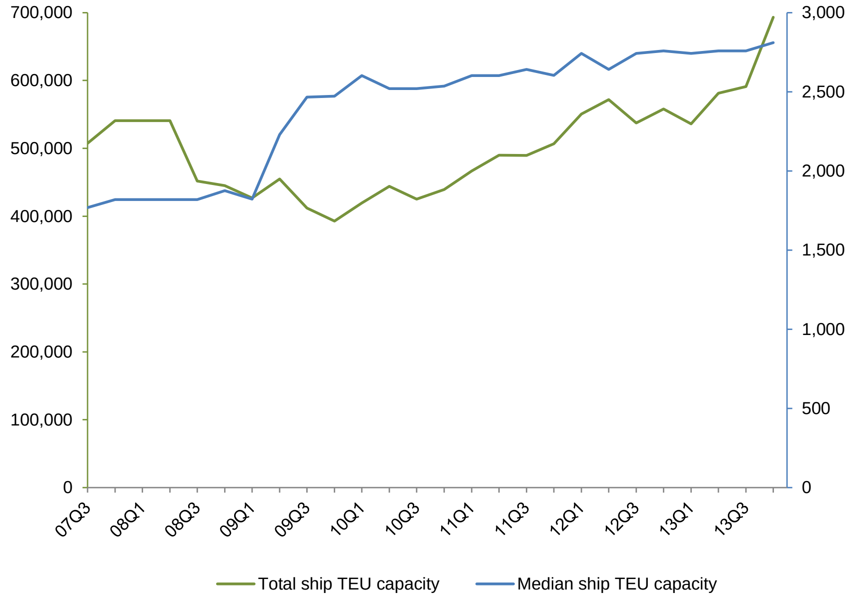
Key findings

Larger vessels will probably be introduced to the New Zealand trades

The general market consensus is that the trend to larger container ships will continue into the future and larger vessels will probably be introduced to the New Zealand trades.

This trend is already evident in New Zealand, Figure 4 shows that the median size vessel to visit New Zealand has increased from 1,700 TEU (in quarter 3 2007) to just under 3,000 TEU (in quarter 3 2013). As the shipping lines continue to introduce larger vessels on key trades, this trend to larger ships visiting New Zealand is likely to continue.

Figure 4 Total and median quarterly TEU capacity



Source: Maritime New Zealand, Ministry of Transport

Furthermore, services are likely to concentrate on fewer ports, which will require upgrades to existing port and related infrastructure.

This is occurring in the market at present, as international shipping services concentrate on the five main ports (Auckland, Tauranga, Napier, Lyttelton and Otago). This trend will be further accentuated by the recently announced agreement between Port of Tauranga, PrimePort and Kotahi to channel more freight through Port of Tauranga (and PrimePort). As such it seems unlikely that the Status Quo will continue as an option.

Whether operating savings generated from larger vessels would be passed through to the customers of the shipping lines, for example New Zealand exporters, is debatable. Given the current poor financial performance of the shipping lines, any savings generated from larger vessels are likely to be retained by the lines. However, the extent to which the lines can retain cost savings will be influenced by the competitive forces operating in each trade.

Ports will need to invest to cater for larger vessels

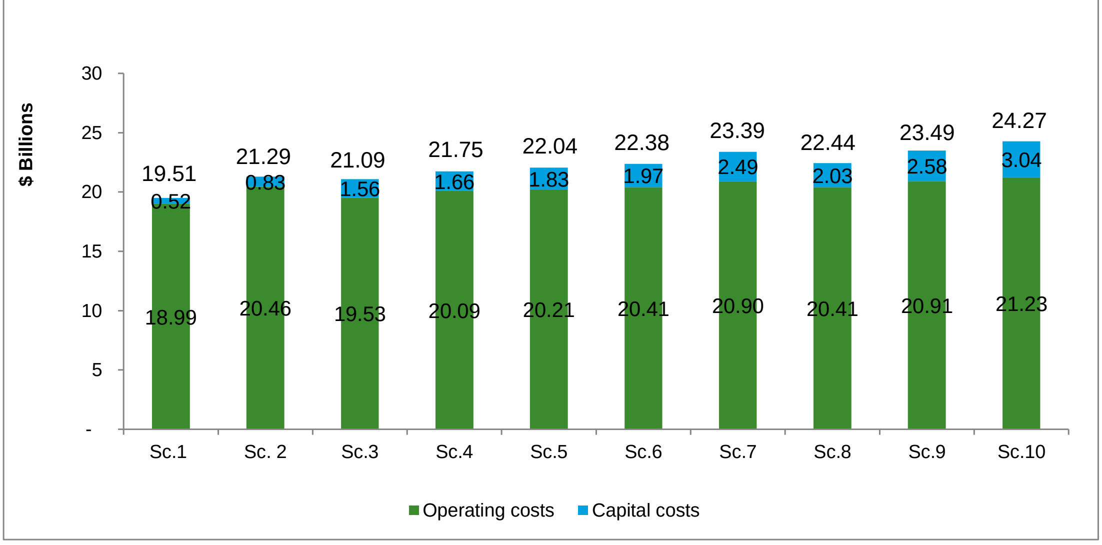
In order to accommodate larger vessels, New Zealand's ports will need to invest in new infrastructure, such as deeper channels, longer berths and larger quay cranes. The current ability of ports to cater for larger vessels varies considerably between ports. Based on our analysis, all of the hub ports would require investment in order to have sufficient channel and berth depth and width, and equipment capable of accommodating larger (7,000 and 8,000 TEU) vessels considered in this study. Of the major ports Lyttelton is the most constrained to take larger vessels. The analysis has not considered the operational feasibility or potential environmental impacts associated with these investments.

The impact of these changes on the freight system and New Zealand as a whole

Overall, we found that the potential benefits that New Zealand gains from the use of larger international container ships are outweighed by the increased port costs, domestic freight transport costs, and capital costs on the road, rail and coastal shipping networks.

The difference in total costs (capital and total operating costs) to supply chains over all of the scenarios was 24% between the highest (Scenario 10 – Single Hub Port) and lowest cost (Scenario 1 – Status Quo). The results are outlined in Figure 5.

Figure 5 Total Costs by Scenario ($billion PV from 2017 to 2046)*



Source: FMM - Note numbers in this Figure have been rounded

*Refer to scope and limitation of this study and the FMM when interpreting these results

The Status Quo Scenario (Sc. 1 - 10 container ports and restrained vessel sizes) generated the lowest overall cost impact for New Zealand supply chains.

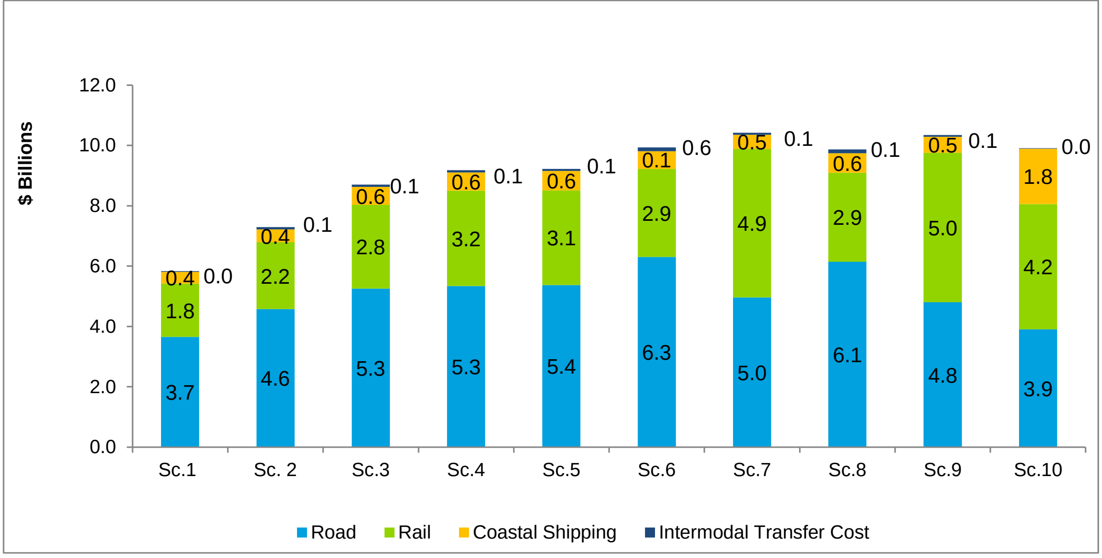
Of the scenarios that incorporated port hubbing and the introduction of larger vessels, Scenario 3 (two hub ports in each island) generated the best outcome on a PV cost basis.

In all of the scenarios, operating costs represented a much higher proportion of total costs (between 88% and 97% of total costs) than capital costs. Generally, capital costs increased as the number of hub ports decreased. This is due to the concentration of cargo through fewer ports placing pressure on the road, rail and port infrastructure capacity and triggering the requirement for capital investment in upgrades.

Domestic transport operating costs also increased as the number of hub ports decreased. Fewer international ports require a significant proportion of the cargo to be transported over longer distances (either via land or coastal shipping) within New Zealand.

There was some variation between hub scenarios, for example, those scenarios which included Ports of Auckland (Scenarios 2, 3, 5, 6 and 8) tended to have lower domestic transport costs due to the high proportion of imports destined for the Auckland region (see Figure 6).

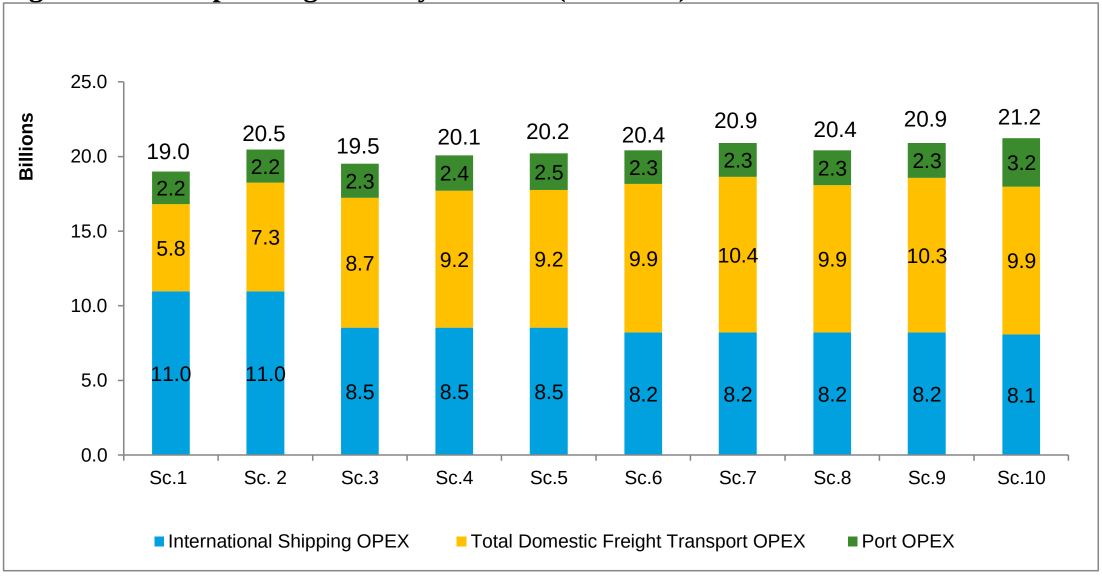
Figure 6 Total domestic transport operating costs ($billions PV from 2017 to 2046)



Source: FMM - Note numbers in this Figure have been rounded

In the scenarios that included larger vessels (up to 7,000 TEU vessels for Sc.3, 4 and 5 and 8,000 TEU vessels for Sc. 6, 7, 8, 9 and 10), the increase in domestic transport costs was offset to some extent by the realisation of benefits from the larger vessels (assuming that 100% of the benefits are passed on to cargo owners). However there is no scenario where the gain from international shipping offsets the increase in domestic transport costs. Furthermore, these benefits are sensitive to the magnitude of the savings realised and passed on to New Zealand cargo owners. Sensitivity analysis suggests that if only 50% of the benefits are are passed on to cargo owners, this will result in an increase in international shipping costs of approximately 8% to 10%, which in turns leads to a 3% to 4% increase in total operating costs (compared to where 100% of the cost savings are passed on to the cargo owners). Figure 7 shows total operating costs including international shipping for each scenario.

Figure 7 Total Operating Costs by Scenario ($ billions) PV from 2017 to 2046



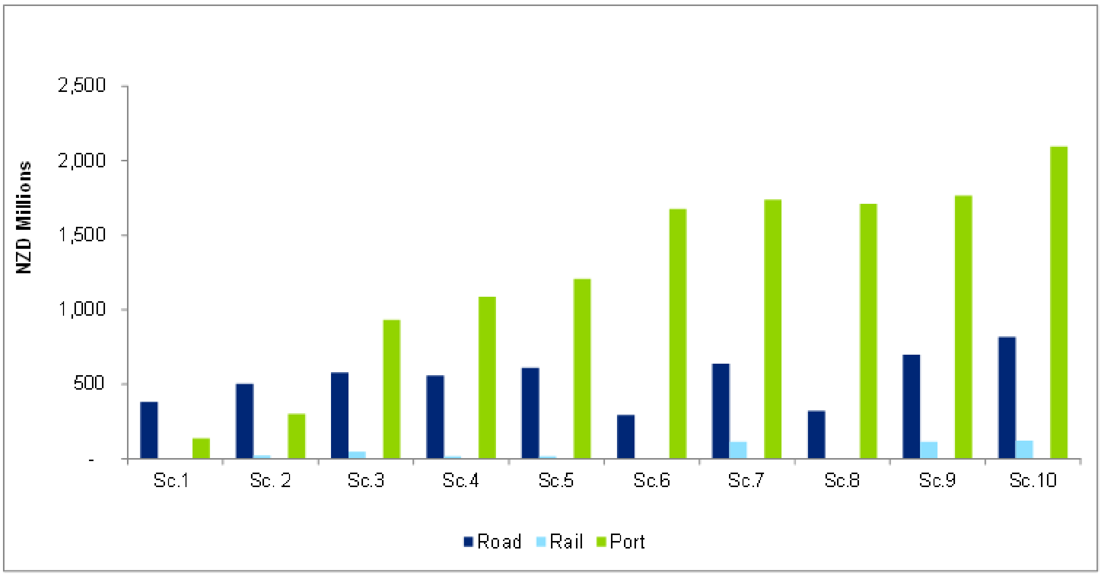
Source: FMM - Note numbers in this Figure have been rounded

Note: International shipping operating costs include 100% of the savings of larger vessels

Our capacity analysis showed that there is sufficient capacity on most parts of the transport network to meet forecast demand under the Status Quo Scenario (Sc. 1). However, as cargo becomes more concentrated on fewer ports and vessel size increases there is a growing requirement for new capital expenditure particularly at the hub ports. Generally there is sufficient capacity on the rail and road networks, with the exception of key access routes to Ports of Auckland (road and rail), Tauranga (road and rail) and Port Otago (road). Additional road upgrades will be required on the Auckland to Hamilton route under some scenarios.

Under the one hub port scenario (Sc.10), capital expenditure is five times higher than under the Status Quo Scenario (Sc. 1). For all hub scenarios capital requirements at the ports are higher than that required for the other parts of the network. This is illustrated in Figure 8.

Figure 8 : Capital costs ($ billions PV from 2017 to 2046)



Source: FMM - Note numbers in this Figure have been rounded

The impact of hubbing does not affect all supply chains equally. Generally, the further from a hub port that a producer is the bigger the impact on their supply chain costs. For example, cargo owners in Wellington and Taranaki are likely to be significantly worse off under the port hubbing scenarios considered in this study. Cargo owners in Auckland, Waikato and Bay of Plenty are all better off under the scenarios where hub ports are located in or adjacent to these regions.

There is a little relation between the type of commodity and supply chain cost impacts, with the exception of those commodities that are concentrated in certain regions – but it is location that matters. For example, "bulk containerised" commodities tend to be better off than other commodities in scenarios where Auckland is a hub port. This is because these commodities tend to be inputs to manufacturing and construction related activities which are focussed in the Auckland region.

Dairy also tends to be better off compared to other commodities when Port of Tauranga is the hub port, this is due to the concentration of dairy production in the Waikato and Bay of Plenty regions.

Analysis of selected supply chains shows that producers in Southland will have both higher costs to get product to market and will incur slower transit times than producers in the Waikato region, particularly under hub scenarios which exclude Port Otago.

Economic Assessment

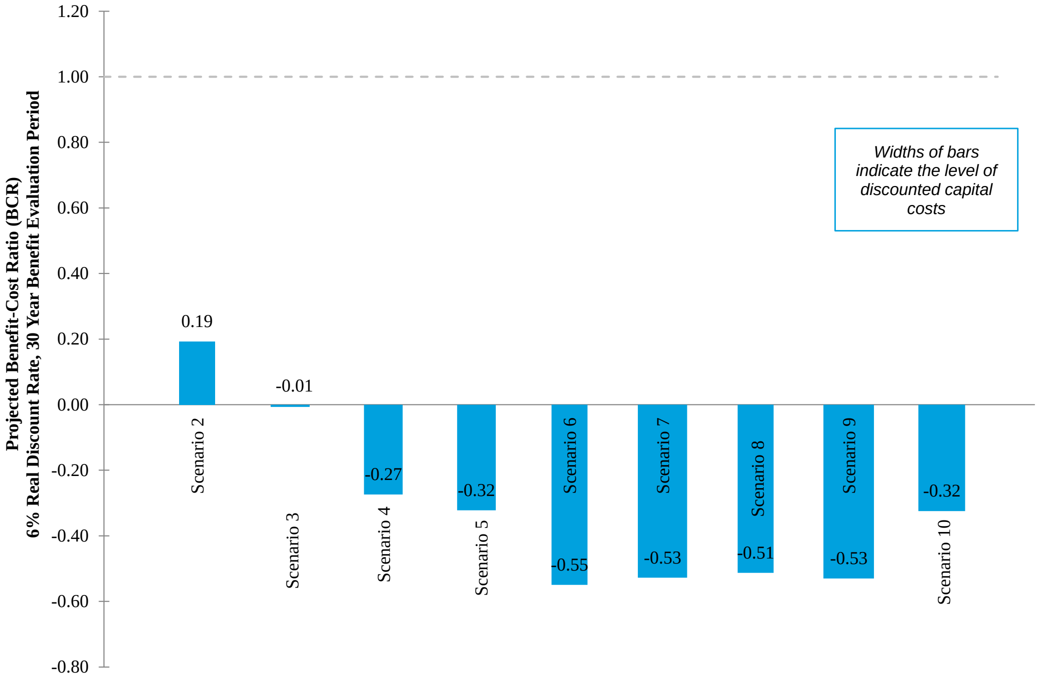
The economic cost benefit analysis indicates that the projected benefit cost ratio (BCR) for all scenarios is less than 1 with almost all projected BCR being less than zero.

Where the BCR is less than 1, this suggests that there may be some economic benefits but these benefits are insufficient to offset the additional capital costs associated with port consolidation.

However, the projected BCRs for all but one scenario is less than zero. This reflects that the projected economic benefits of these scenarios are negative (i.e. the scenarios generate disbenefits) compounded further by additional capital costs associated with developing hub ports.

Relative to the status quo, road, rail and coastal shipping costs increase with port consolidation. These increases more than outweigh the general reduction in international shipping costs, thus increasing total transport costs across the supply chain.

Figure 9 : Projected Cost Benefit Ratio (incremental to Scenario 1)



In general, while the CGE modelling suggests an initial boost in economic activity due to an initial increase in construction activity, this boost is offset in the longer term by lower levels of activity relative to the base case. This reflects the higher aggregate transport costs incurred under the do-something scenarios considered, which in turn adversely impacts on the productivity of the broader economy.

A detailed summary of the results for each scenario is provided in Section 8.

In summary:

- The difference in total costs (capital and total operating costs) to supply chains over all of the scenarios was 24% between the highest (Scenario 10 – Single Hub Port) and lowest cost (Scenario 1 – Status Quo).
- The Status Quo Scenario (Scenario. 1 - 10 container ports and restrained vessel sizes) generated the lowest overall cost impact for New Zealand supply chains.
- Of the scenarios that incorporated port hubbing and the introduction of larger vessels, Scenario 3 (two hub ports in each island) generated the best outcome on a present value cost basis.
- In all of the scenarios, operating costs represented a much higher proportion of total costs (between 88% and 97% of total costs) than capital costs.
- Generally, capital costs and domestic transport operating costs increased as the number of hub ports decreased.
- Those scenarios which included Ports of Auckland as a hub tended to have lower domestic transport costs due to the high proportion of imports destined for the Auckland region.
- The lower operating costs associated with larger vessels do not offset the higher land transport costs associated with port hubbing.
- The impact of hubbing does not affect all supply chains equally – proximity of production to a hub port has a significant bearing on whether or not there are cost and transit time benefits for the respective export or import industry.
- The economic cost benefit analysis indicates that the projected BCR for all scenarios is less than 1 and eight of the scenarios have a projected BCR less than zero. This means that the increases in broader economic costs associated with port hubbing, as well as operating costs and capital investments, outweigh the economic benefits (incremental to the Status Quo – Scenario 1) under the port hubbing.

2 Introduction

2.1 Purpose of this Study

In 2013 the Ministry of Transport commissioned Deloitte to undertake a study to examine the impact that larger container ships could have on the freight system. The study examines the likely impacts on freight costs and the wider economy from the range of choices that shipping lines, ports and/or exporters could make in the face of changes in international shipping and a growing freight task.

The study concerns the identification of possible future configurations of port and port related infrastructure, and modelling to assess the impacts of those configurations on freight flows within, to and from, New Zealand. It identifies where future freight flow bottlenecks may emerge, and as a result where asset owners may need to direct future investment or to make other changes in order to maintain the required level of service.

The New Zealand Productivity Commission in its report, International Freight Transport Services Inquiry (April 2012), noted a number of key coordination challenges that affect those who make investment decisions in the freight sector. These include: the number, type and location of ports; how to get the best out of larger container ships; how best to coordinate road and rail investments; and local and central government interactions in freight transport[3].

The purpose of the Future Freight Scenario Study is to improve the understanding of the strategic choices New Zealand has, and the impacts these choices could have on the wider freight system and the international competitiveness of New Zealand's firms.

2.2 Project Context

A key goal in the Government's Business Growth Agenda is to increase the ratio of exports to GDP from 30% to 40% by 2025[4].

Transport is an important enabler of the export industry. The standard and frequency of the international shipping services that call at New Zealand ports, and the quality and reliability of our ports and their road, rail and coastal shipping connections all impact on New Zealand's competitiveness and trade performance.

The Growth Agenda goal is set within an environment of increasing freight volumes. The National Freight Demand Study 2014 (NFDS) forecasts that the overall internal freight task is expected to increase from 236 million tonnes in 2012 to 373 million tonnes by 2042, an increase of 58%[5] over the next 30 years. Table 3 summarises these forecast volumes by broad commodity group.

[3] New Zealand Productivity Commission, 2012. *International Freight Transport Services Inquiry April 2012* pg. 273.
[4] The Business Growth Agenda, Building Export Markets, August 2012
[5] National Freight Demand Study. Jan 2014

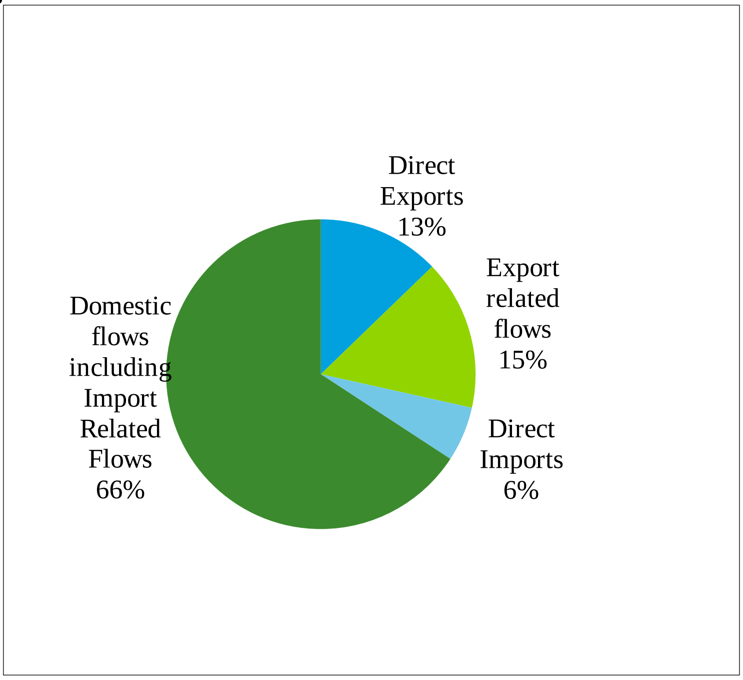
Table 3 Freight Forecasts by Broad Commodity Group (million tonnes)

Commodity Group	2012	2017	2022	2027	2032	2037	2042
Milk and Dairy	26.44	30.22	35.28	36.97	38.72	40.53	42.41
Logs and Timber Products	37.26	41.01	52.85	55.09	56.04	47.80	47.70
Livestock Meat and Wool	9.85	10.47	11.44	11.85	12.27	12.70	13.14
Other agriculture and fish	10.21	10.69	12.56	14.10	15.11	15.81	16.51
Petroleum and Coal	13.19	13.92	14.37	14.80	15.39	16.18	16.95
Building materials fertiliser and other minerals	45.43	51.96	60.69	68.99	76.71	84.37	91.91
Steel and aluminium	38.47	41.56	45.10	48.68	52.29	55.74	59.08
Other manufactured and retail goods	3.40	3.54	3.71	3.87	4.02	4.15	4.26
Waste	7.37	8.32	9.22	10.09	10.94	11.76	12.55
General Freight	44.41	48.41	52.70	56.81	60.79	64.65	68.39
Total tonnes p.a. (m)	**236.02**	**260.10**	**297.91**	**321.25**	**342.27**	**353.68**	**372.93**

Source: National Freight Demand Study, 2014

The NFDS estimated that approximately 19% of the freight task was either direct exports or imports (of which an estimated 15.5 million tonnes was international containerised trade). However, if export related movements (e.g. upstream activities) are included the total trade related freight task is in excess of 30% of the total freight task.

Figure 10 Freight movement and international flows



Source: NFDS 2014

Servicing New Zealand's goods trade is complicated by the imbalance between where imports are consumed (predominately the Auckland region) and where exports are generated, predominately rural regions further south. This means transport systems need to accommodate the relocation of equipment (in particular containers) from Auckland to other parts of the country.

At the same time, there are opportunities and risks emerging as a result of the trends in international shipping. The types of vessels servicing the New Zealand trade are driven by the global deployment of vessels by the shipping lines. New Zealand as a relatively small market and even when combined with Australia has little influence on decisions about shipping services which are made within the broader requirements of international markets and route profitability. The shipping lines are introducing larger vessels into their key East – West trades (between Europe and Asia) and "cascading" vessels from this route to their lower volume North – South trades (such as between New Zealand, Australia and Asia). Already, the median size of vessel servicing New Zealand has increased from 1,900 TEU to 2,800TEU since 2008[6]. Shipping lines are investing in larger ships to reduce costs (through harnessing the economies of scale that the larger vessels offer).

As well, in an era of over capacity further cost reductions are achieved through implementing "slow steaming" operating regimes, which reduce fuel consumption and costs.

Due to these trends it is likely that there will be a need for investment in freight infrastructure (in particular at ports) to accommodate larger vessels and the growing freight task. This brings with it choices for individual ports about their role in the network.

The interconnectedness between ports and the landside road and rail linkages means new investment in any part of the system presents a co-ordination challenge on a national scale. Tension can arise between overall efficiency and commercial drivers for individual players. This is increasingly complex when infrastructure owners are trying to maximise commercial returns for their individual investments rather than seeking to determine the most efficient supply chain for exports.

[6] Maritime New Zealand and Ministry of Transport FIGs data

For example, a transport operator is motivated to increase utilisation of its assets (by gaining freight volume and revenue) which may not necessarily be the same as optimising the most efficient supply chain for an exporter. Furthermore, while increased activity in the transport sector contributes to higher GDP this does not necessarily result in optimum export competitiveness and supply chain returns.

The investment challenge could continue to be met as it has in the past, whereby decisions have been made on the best information available to the individual market participants. However, as recommended by the Productivity Commission, richer information shared between market participants involved in "facilitated discussions" will assist participants in investment decision making and help to optimise supply chain costs for exporters.

It is within this context that the Ministry of Transport has commissioned this study.

2.3 What the study contributes

By examining the impact of a variety of possible changes in the freight system this study:

- Helps to inform debate about possible future infrastructure requirements
- Helps all levels of government and the companies they own plan for, and prioritise infrastructure investment
- Identifies the implications for exporters of alternative infrastructure futures
- Identifies the implications for the New Zealand economy of alternative infrastructure futures.

2.4 What this study doesn't do

How New Zealand's port sector responds to changes in international shipping, and how this impacts on the land transport sector, and coastal shipping will depend on the cumulative decisions made across the private and public sectors.

This study contributes to the information base that can be used to inform decisions but it does not make recommendations about:

- A preferred port network or a government policy stance on ports
- Future land transport infrastructure investment
- The future role, level of investment required or operation of coastal shipping
- Possible or recommended funding options or sources
- Where the private sector should invest in the freight market.

The Study addresses the impact on containerised freight. It notes the likely impact on non-containerised cargo at a high level but:

- Does not consider the future requirements for bulk trades through the ports
- Does not consider what benefits may accrue to container traffic/port capacity as a side effect of investment in increased capacity for bulk cargoes e.g. channel deepening, ancillary services etc.

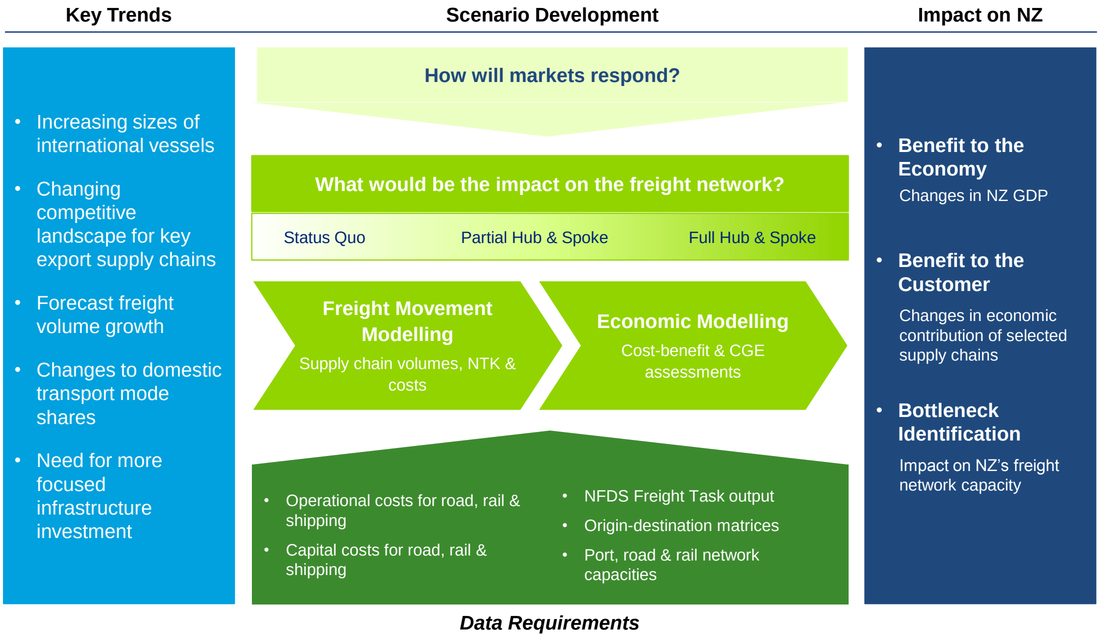
3 Approach to analysis

3.1 Part of a system

This analysis seeks to demonstrate the impact of a number of potential infrastructure configurations on New Zealand containerised export supply chains, and more generally the New Zealand economy. In order to make a comparison of the potential impacts, we have developed a number of scenarios based on alternative "international gateway" port configurations. Under these scenarios specific ports are designated as international gateways (or hubs) serviced by the international shipping fleets, the remaining ports operate in conjunction with road and rail links as "feeders" to these hubs.

Each configuration (scenario) is compared to the status quo (the current configuration) to identify where capacity constraints are likely to occur, what the economic cost or benefit of each scenario is likely to be and what the impact on selected meat and dairy export supply chains may be.

The following diagram provides a graphic representation of the inputs to the analysis. As is demonstrated the scenario based analysis is critical to the approach taken to the analysis. More detail on the scenarios assessed is provided in Section 5



3.2 Development of an evidence base

A credible base of underlying data has informed our analysis. Due to the commercial sensitivity of the information, the large number of participants in the sector (for example cargo owners and transport operators) and the variety of units used to measure freight volumes, reliable freight data is notoriously difficult to obtain.

However, we have been able to leverage the information gathered for the NFDS, including the forecasting methodology. We have also accessed published data such as the Freight Information Gathering System (FIGS), Port Annual Reports, New Zealand Transport Authority (NZTA) traffic and other information and broader industry sources (particularly in the shipping sector). All data sources are referenced.

We also sought the advice of industry experts to underpin the analysis. Port companies, road and rail owners and shipping lines were consulted, all of whom provided invaluable data, information and insights to the study.

In addition, we have drawn heavily on Deloitte’s own data bases and transport models, which provide insights into road, rail, shipping and port costs.

This process has enabled us to build evidence based data sets of current export and import container numbers, origins and destinations and what assets are deployed in moving containers through the ports and on the road and rail networks. These data sets have informed our modelling of the various scenarios under examination.

3.3 Freight Movement Model

The Freight Movement Model (FMM) was developed specifically for this project. It is an excel based model capable of testing and comparing a range of port and landside infrastructure scenarios under different freight growth assumptions. It generates estimates of volume, capacity and operational costs associated with handling New Zealand’s international container freight task (including port, road, rail, coastal shipping and international shipping costs). These outputs are used to identify infrastructure bottlenecks and estimate capital investments required to provide additional capacity. The outputs of the FMM provide inputs for economic impact assessments and an assessment of impacts to cargo owners under each scenario. In this way, the FMM provides a basis to test the relative impacts of the port “hubbing” and international shipping scenarios considered as part of the FFSS.

The FMM seeks to replicate the movement of freight around New Zealand and to international ports under the different scenarios. Key metrics for each scenario generated from the FMM include:

- Volume of freight (tonnes and TEU) through the transport and freight network
- Total national operational costs by mode
- Cost for selected supply chains (commodity and region)
- Identification of bottlenecks in the infrastructure and transport networks
- Indicative capital expenditure (and timing) for network upgrades
- Net present value of costs.

The outputs are then used to:

- Undertake an economic assessment of different scenarios
- Identify infrastructure bottlenecks on the transport networks and at the ports
- Assess the potential impacts on supply chain costs for a small number of indicative export supply chains.

It is not practical to accurately model every individual supply chain or the potential changes to freight movements in response to future changes in port, trade and infrastructure. Nor is it necessary in order to meet the objectives and requirements of this study. To this end, the FMM has been designed to strike the right balance between accuracy and precision, flexibility and robustness, size and usability and accommodating the details of the minutia versus providing the high level macro outputs necessary to inform the study.

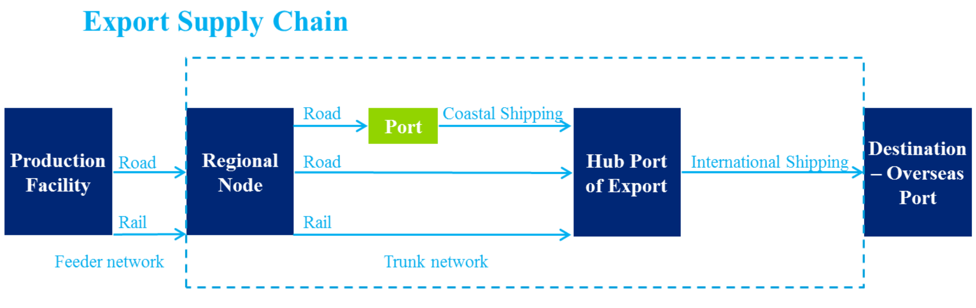
A detailed description of the FMM, inputs and assumptions is provided in Appendix A. Some important aspects of the model are:

- The FMM is not a transport model, and mode choice and route selection are inputs and assumptions built into the model rather than outputs produced by the model. Nor does the model consider complete, end-to-end supply chains such as warehouse locations, container staging moves or the first/last distances undertaken from the main nodes on the transport network. It only approximates the most common routes and modes used to move containerised freight from key nodes to international gateway ports under each scenario.
- Capital cost estimates are based on high level, desktop analysis only. Due to the whole of system nature of the work (and the scope of the study) it has not been possible to undertake detailed analysis of each individual port or piece of the road and rail networks. The modelling assumes that the capacity upgrades to road, rail and port infrastructure used in the model are all "do-able". To this end high level "reference" operational and capital upgrade costs have been used across the entire network. No assessment has been made of the ability for these capacity upgrades to be made at the appropriate time.
- Given the primary objective of the study is to assess the "whole of system" and understand the impact on the overall system it has not been possible to undertaken detailed analysis of individual supply chains. The FMM models does not consider the following supply chain costs:
    - Warehousing/depot and packaging costs in New Zealand
    - Travel costs associated with any container moves from the producer/consumer on the feeder network beyond the main trunk transport infrastructure
    - Taxes and customs charges
    - International port charges
    - Transport costs at the international origin/destination.

The following diagram represents the generic supply chain for exports from production facility to destination port. The specific steps identified as the "trunk network" represent the processes that have been modelled.

Other technical notes relating to the methodology and assumptions with material impacts on the FFSS are presented in Appendices A, B and C.

Figure 11 Map of export supply chain – dotted line indicates scope of FMM



3.4 Impact assessment

The impact of each scenario is compared relative to Scenario 1 – Status Quo. This comparative analysis considers the following impacts:

- Total operational and capital costs over a 30 year evaluation period (2017 to 2046) expressed as a PV (note the costs excluded from this analysis are identified in Section 3.3). Capital costs consider only where bottlenecks are caused by freight, and the likely cost to be attributed to container freight users
- Average impacts to cargo owners (by commodity and region)
- Impact to specific export supply chains

A two-step process was undertaken to assess the impact on the New Zealand economy of the various freight futures examined:

- Cost benefit analysis – valuation of key cost and benefit streams
- Computable general equilibrium (CGE) – to assess broader economic impacts.

Economic appraisals aim to encompass the costs and benefits incurred or accrued not only by project proponents and potential users but also the costs incurred and benefits accrued by many different stakeholders, including government and the community in general. A brief description of the cost benefit analysis and CGE is provided in the following Sections 3.4.1 and 3.4.2.

3.4.1 Cost benefit analysis

A cost-benefit analysis framework was adopted to quantify key costs and benefits. Key requirements of this framework include the monetisation of key benefits and costs using nationally accepted guidelines with parameters drawn from the latest New Zealand Transport Agency's *Economic Evaluation Manual*[7] released in October 2013.

Under conventional transport cost benefit analysis, the assessment of costs and benefits are undertaken against a pre-defined base case which for this study is Scenario 1 – Status Quo.

The cost benefit analysis reflects the changes in economic costs and benefits of changes in the transport task, as modelled by the FMM. The cost benefit analysis considered the cost and benefit streams listed in Table 4.

Table 4 Key Costs and Benefits Considered

Costs Considered	Benefits Considered
• Do-something scenario port and land transport capital costs • Do-something scenario port and land transport operating and maintenance costs	• Avoided (base case) port and land transport capital costs • Avoided (base case) port and land transport operating and maintenance costs • Value of time savings (including freight time) • Changes in vehicle operating costs • Changes in rail operating costs • Changes in sea transport costs • Changes in greenhouse gas emissions • Change in crash costs • Residual asset value

[7] NZTA (2013), *Economic Evaluation Manual*

Source: Deloitte

Typically, the do-something infrastructure costs would be netted off against the base case infrastructure costs to estimate the BCR. However, during the course of the economic analysis, it was found that estimated disbenefits[8] were distorting the level of economic losses that were being incurred across all do-something scenarios. The following example illustrates this issue:

The BCR formula where disbenefits are present

The conventional approach to estimating the benefit cost ratio is to take the ratio of discounted benefits and the discounted costs. This approach works well where a project generates positive benefits and the level of costs is reasonably large.

Under situations where a project may generate disbenefits, the BCR formula has the potential to distort how projects should be prioritised. Consider three scenarios A, B and C where A is the do-minimum case and B and C are two potential do-something projects. The three scenarios have the following transport and capital costs:

Cost Item	A (Do-minimum)	B	C
Transport costs	$20	$25	$25
Capital costs	$50	$60	$70

A conventional economic cost benefit analysis would assess the merits of the two potential do-something scenarios Scenario B and C against the do-minimum Scenario A. The following table outlines the resultant NPVs and BCRs.

Item	B	C
Transport cost savings	-$5	-$5
Incremental capital costs	$10	$20
NPV	**-$15**	**-$25**
BCR	**-0.5**	**-0.25**

Amongst the do-something options, Scenario B would be favoured over Scenario C as the losses under Scenario B are lower.

However, the BCR would suggest that Scenario C would be favoured as the BCR is higher when compared to Scenario B (at -0.25 compared to -0.50). This erroneous prioritisation can occur when disbenefits are present.

[8] With intervention, a range of recurrent cost streams considered in the economic assessment (such as transport costs) would typically fall in value relative to the status quo. Should this reduction occur, these reductions would be coined as ‘benefits’. However, when this reduction does not occur i.e. costs increase with an intervention, the increases in cost are denoted as ‘disbenefits’.

To avoid this distortion, the BCR formula used has been adjusted by:

- Assuming that the cost base comprises of the upfront and ongoing cost of a given scenario and does not net off the cost of the base case scenario (Scenario 1)
- Assuming that the cost of the base case scenario is an avoided cost (and adopting it as a benefit).

The following formula outlines the formulation used for this study:

$$BCR = \frac{\Delta\, transport\ costs + \Delta\, externalities + \Delta\, asset\ residual\ value + base\ case\ infrastructure\ capital\ and\ operating\ costs}{do - something\ infrastructure\ capital\ and\ operating\ costs}$$

3.4.2 Computable general equilibrium modelling

Changes in demand patterns, transport costs and infrastructure investment will have flow-on effects across the New Zealand economy – including factors such as overall levels of economic activity and standards of living for New Zealand residents.

Capturing and valuing these flow-on benefits requires additional detailed economic modelling beyond what is conducted as part of the cost benefit analysis. As part of the economic assessment, Computable General Equilibrium (CGE) modelling has been undertaken to track how the initial consequences of infrastructure investment eventually result in changed economic outcomes.

Utilising cost and benefits streams valued as part of the cost-benefit analysis, a CGE model developed for the New Zealand economy allows an assessment of changes in one area on common economic yardsticks such as economic growth and employment impacts.

4 Industry overview

This section of the report provides an overview of each of the industry sectors that enable the containerised import and export (IMEX) supply chains. For each sector we examine the current market environment and capabilities and the likely future trends.

4.1 International Shipping

4.1.1 Current environment

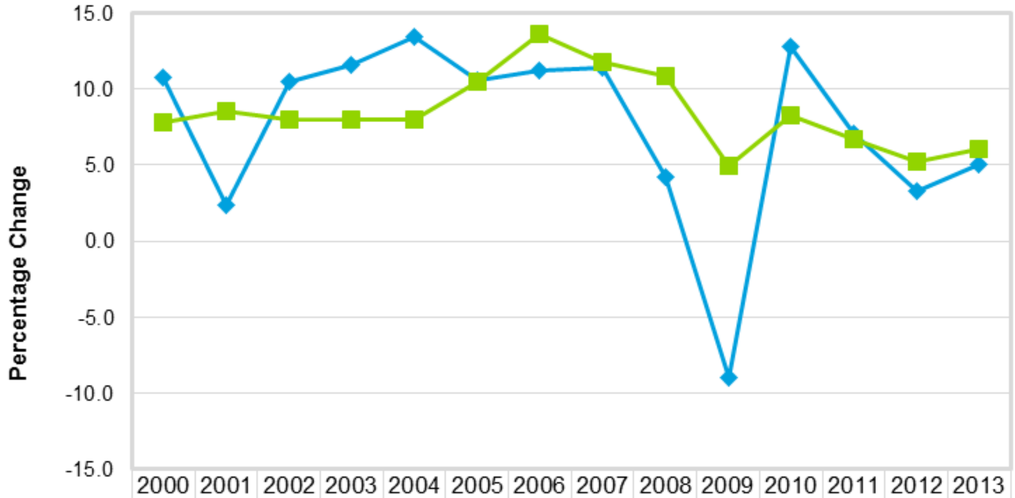
The shipping industry servicing New Zealand is influenced by a number of factors, including the overall level and direction of international trade movements, the introduction of larger vessels and the balance between capacity (the number and size of vessels available to carry cargo) and the level of demand (the volume or cargo to be moved).

Three significant recent trends in the international shipping market are impacting on New Zealand's supply chains.

- Excess capacity in the international container shipping fleet, a legacy of the Global Financial Crisis (GFC) of 2008/09 and committed forward orders for new vessels
- The trend to larger container ships particularly on the East – West trade routes (between Europe, Asia and North America), and the subsequent "cascading" of relatively larger vessels to the North – South routes (including Asia to New Zealand)
- Consolidation of the international shipping market into global operational consortia.

Shipping capacity has consistently outstripped demand in recent years. Figure 12 illustrates that annual growth rates in supply (total container- carrying fleet capacity as measured in TEU slots available) has been greater than demand (as represented by TEU) since 2005 (with the exception of 2010, which represents the rebound from the impact of the Global Financial Crisis in 2008/09).

Figure 12 Container Shipping Supply & Demand 2000 – 2013 (annual growth rates)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Demand	10.7	2.4	10.5	11.6	13.4	10.6	11.2	11.4	4.2	-9.0	12.8	7.1	3.3	5.0
Supply	7.8	8.5	8.0	8.0	8.0	10.5	13.6	11.8	10.8	4.9	8.3	6.7	5.2	6.0

Source: Compiled by the UNCTAD secretariat on the basis of data from Clarkson Container Intelligence Monthly, various issues http://unctad.org/en/publicationslibrary/rmt2013_en.pdf p68
Note: Supply data refer to total container-carrying fleet capacity, including multi-purpose and other vessels with some container-carrying capacity. Demand growth is based on the million TEU lifts. The data for 2013 are projected figures.

This overcapacity is in part the result of the drive to deploy ever larger ships in order to gain the related benefits of economies of scale to rectify the poor financial performance of most of the major container carriers particularly since the GFC. Table 5 provides a summary of the financial performance of a selection of major shipping lines since 2009. All lines suffered major losses in 2009, with much better performance in 2010, reflecting a spike in business in 2010. However, financial performance since 2010 has been poor.

Table 5 Financial performance of major container carriers 2009- 2012 (profit/loss US$000)

Container carrier	2009	2010	2011	2012
Maersk Line*	-2,195	2,616	-553	126
NOL	-741	461	-478	-321
Zim Line	-429	54	-397	-194
Hapag-Lloyd	NA	573	-37	-122
Yang Ming	-495	405	-310	-85
Hanjin	-739	361	-721	-358
HMM	-685	517	-409	-515
OOIL 2	-375	834	86	NA
CMA CGM	-1.447	1,627	-30	284
CSAV	-656	171	-1,250	-290

Source: Drewry Consultants
*2009 is for Maersk Container Division, Maersk Line 2010 -2012, 2 Container and Logistics only

The potential cost benefit gained from operating larger more modern ships is derived from:

- Improved technology, particularly through better fuel performance (which is the largest single cost item for the operator at around 30% of the total) derived from hull form and engine efficiency
- Improved loading and discharging efficiencies in port
- Economies of scale in respect of overheads and other fixed costs.

This trend to larger vessels is reflected in the composition of the global containership fleet. The Post-Panamax (greater than 8,000 TEU capacity vessels) and super-post-Panamax (greater than 12,500 TEU) ship sizes have increased as a proportion of total fleet capacity. Put another way, since 1996, the Post-Panamax containership fleet has grown at an average annual rate of 27% in terms of total TEU container capacity, and by 23% in terms of the number of ships9.

The impact of the growth of ship sizes is resulting in 5,000 -12,000 TEU vessels being replaced by new 12,000 -18,000 TEU vessels, with the smaller vessels "cascading" from the East-West trade onto lower volume trade routes. This trend is likely to continue as the forward order-books for new vessel builds reflect this trend – of the 220 new container vessels scheduled for delivery in 2013, 40% were for vessels over 7,500 TEU capacity which accounts for 68% of the new capacity (on a TEU basis)10.

In order to counter this over capacity (and subsequent decline in rates) the shipping lines have implemented a number of strategies. These included laying vessels up, the introduction of "slow steaming" and forming global operating alliances.

Due to the reduction in demand caused by the GFC, the near doubling of bunker (ship's fuel) prices between 2009 and 2012 and lower cargo growth rates, many international container trades have absorbed additional vessel capacity and cut fuel costs by adding vessels to existing services and

[9] http://clarksonsresearch.wordpress.com/

[10] Thompson Clarke Shipping and Alphaliner

slowing the operating speed of all ships in the service (the practice known as slow steaming). In effect the lines have increased the number of vessels, increased transit times but maintained service frequency and capacity on offer and reduced unit fuel consumption. It is estimated that by the end of 2012, slow steaming had taken capacity equivalent to 1.6 million TEU[11] out of the market. Put another way an additional 1.6 million TEU capacity is being used to undertake the same task. This makes sense for the lines as the savings in fuel consumption outweighs the additional costs incurred from utilising the additional vessels (which would otherwise be laid up).

Furthermore, global operating alliances are seeking to improve operational performance, vessel utilisation and service offerings through the sharing of vessels across various trades (primarily on the main East – West trades).

Three global "super" operational consortia are emerging:

- Maersk, MSC and CMA CGM (the world's top three container operators in market share) had proposed the P3 Alliance. However, even though the arrangement gained approval from European and USA regulatory authorities, it has been rejected by the Chinese regulator authority. As a result Maersk and MSC have now formed a new Vessel Sharing Agreement, called 2M.
- The G6 Alliance (formed in 2011) is comprised of Hapag-Lloyd, NYK Lines, Orient Overseas Container Lines, Hyundai Merchant Marine, APL and Mitsui OSK Lines
- CKHY – comprising COSCO, Kawasaki Kisen Kaisha Ltd or ("K" Line), Yang Ming Marine Transport Corp and Hanjin Shipping Co Ltd.

Into the future it is likely that the lines will continue to seek cost savings through slow steaming, the use of larger vessels and through operating alliances.

4.1.2 Cost benefit of larger vessels

Our analysis of the operating costs of vessels of varying sizes, confirms that benefits can be achieved through the introduction of larger vessels. However, those vessels have to consistently operate at planned capacity. The benefits of larger vessels are highly sensitive to the volume of cargo carried per trip.

Table 6 summarises the estimated unit slot cost for four sizes of container vessels in the 4,000 TEU to 11,000 TEU range. The first set of data is from the New Zealand Shippers Council's 2010 "The Question of Bigger Ships" study based on the New Zealand — South East Asian trade and has adopted the higher level of bunker costs indicated ($600 per tonne). The second set of data is from a Hong Kong Shanghai Bank 2013 study for vessels on the transpacific trade to North America. Importantly, the typical voyage time of both trades analysed is around 6 weeks or 42 days.

[11] http://clarksonsresearch.wordpress.com/

Table 6 Cost Economies of Big Ships (US $ Per Vessel Container Slot)

NZSC Big Ship Study 2010				
Vessel Size TEU	4,300	6,500	8,500	11,000
US$ cost per slot (estimate)	608	536	470	420
$ saving v. next smaller vessel	n/a	72	66	50
% saving v. next smaller vessel	n/a	11.8%	12.3%	10.6%
HSBC Transpacific Study 2013				
Vessel Size	4,000	6,000	8,000	10,000
US$ cost per slot (estimate)	579	579	514	452
$ saving v. next smaller vessel	n/a	nil	65	62
% saving v. next smaller vessel	n/a	nil	11.2%	12.1%

Sources: NZSC "The Question of Bigger Ships" 2010; Hong Kong Shanghai Bank/ Clarksons/ Containerisation International 2013, Thompson Clarke Shipping Analysis

While the ship sizes and trades are not exactly comparable the results are reasonably similar suggesting just over a 10% saving in slot cost for each step up in ship size. These findings are not dissimilar to the analysis undertaken by others. Det Norske Veritas (DNV), for example found that at 100% utilisation the slot cost for a 18,000 TEU vessel is 91% (a 9% saving) of the slot cost for a 14,000 TEU vessel. However, these findings were highly sensitive to vessel utilisation, for example reducing the utilisation of a 14,000 TEU vessel from 100% to 75% increases the slot cost by 31%[12].

In summary, large vessels need to be fully utilised to realise the benefits of economies of scale compared to fully loaded smaller vessels. In order to achieve this, significant volumes of cargo need to be available on a regular basis. Conversely, smaller vessels are more appropriate where total cargo volumes are smaller and/or less regular.

Whether such savings will be shared with cargo owners on an ongoing basis is questionable. Rates tend to be based on the balance between supply and demand, rather than benefit sharing with customers. Given the financial performance of major carriers in recent years, it is unlikely that they will share cost saving benefits with cargo owners unless they are forced to do so through competition. The New Zealand trades are serviced by carriers virtually all operating in consortia with excess capacity (displaced from the dominant East West trades). In this environment the key driver of freight rates is the ongoing issue of too much capacity chasing too little cargo, as opposed to any sharing of unit cost savings arising from larger ships with cargo owners.

4.1.3 Current shipping trends affecting New Zealand

New Zealand's international container trade (excluding the Pacific Islands which is relatively small in trade volumes and is serviced by geared ships) is arranged into five regions (trades) with a total of 13 dedicated services. Each service within each trade operates a regular schedule of ports calls (or strings) between various New Zealand and overseas ports. Table 7 summarises the shipping services operating in New Zealand as at June 2014.

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[12] DNV, Container Ship Update, No 01 2013

Table 7 Summary of Shipping New Zealand Services

Trade	Number of services	Name of service	Shipping lines	New Zealand Ports called (in order of call)
North East Asia	2	Asia Star/NZ3	ANL, CMA, Maersk, OOCL	Auckland, Otago, Lyttelton, Napier, Tauranga
		NZJ/CNZ NE Asia	Cosco, Hamburg Sud, Hapag, MOL, NYK	Auckland, Lyttelton, Napier, Tauranga
South East Asia	5	Southern Star/NZ1	Hapag, Maersk	Auckland, Lyttelton, Otago
		Northern Star	Hapag, Maersk	Nelson, CentrePort, Tauranga
		NZS/NZX SE Asia	Hapag, MOl	Auckland, Lyttelton, CentrePort, Napier, Tauranga
		MSC Capricorn	MSC	South Port, Otago, PrimePort Timaru, Lyttelton, Napier, Tauranga, Auckland
		Kiwi International Express	ANL, APL, Hanjin	Auckland, Tauranga
North America West Coast	4	OCL1/USEC	Hamburg Sud, Hapag, Maersk, MSC	Auckland, Otago, Napier, Tauranga, Auckland
		VSA PSW USWC	ANL, Hamburg Sud, Hapag, MSC	Auckland (south bound), Tauranga (north bound)
		VSA PNW USWC	ANL, Hamburg Sud, Hapag	Auckland (north bound), Tauranga (south bound)
		PIL CTP Transpacific	PIL	Tauranga
North America East Coast and Europe	1	CMA PDL USEC/EU	ANL, CMA, Hapag, Marfet	Tauranga, Napier, Lyttelton
Trans-Tasman	1	Trans-Tasman	ANL, Maersk, MSC	Nelson, Taranaki, Auckland, Tauranga, CentrePort, Lyttelton

Source: Thompson Clarke Shipping Pty Ltd on behalf of MOT

Three of the trades operate exclusively to specific regions (North East Asia, South East Asia and Trans-Tasman). In addition there are two services which operate in multiple regions, one covering the US East Coast and Northern Europe via Panama and one providing a triangular service between the US West Coast, South West Pacific and North East Asia. All but two of these services (Asia Star/NZ3 and North America East Coast and Europe) also call in one or more of Australia's East Coast container ports, primarily Brisbane (South East Asian services) and Sydney and Melbourne (North American services).

All the New Zealand services (with the exception of MSC Capricorn to South East Asia and PIL China Transpacific) are provided by consortia as opposed to individual shipping lines. Where consortia are operated key members provide vessels to the service, other lines commit to paying for a number of container slots per voyage at a contract wholesale price instead of providing a vessel in their own right. All participants market their own services on independent terms and conditions, and while the lines providing ships will normally market services between all ports served, slot purchasers may only market selective services between specific port pairs.

All services are provided weekly with the exception of the VSA PNW USWC service which is operated fortnightly. See Table 8 for more details.

The services operating through New Zealand reflect the flow of commodities to and from New Zealand's major trading partners. However, there is a trend away from direct services to traditional markets in Europe as the shipping lines increasingly take advantage of the larger East West services and "hub" New Zealand cargo through the major transhipment ports (e.g. Tanjan Palapas and Singapore) in South East Asia.

The size of vessel serving each trade varies within and between trades, depending on the cargo volumes, the ports serviced (and the associated operational constraints) and the fleet deployment requirements of individual shipping lines. Table 8 provides a summary of each trade, the overseas ports served the total number of vessels and the specifications of the largest vessels deployed in each trade.

Table 8 New Zealand International Container Service and Ship Profiles as at Q4 2013

Service	Overseas Ports	Voyage Days	Ships	Largest Service Vessel Specification								
				Name	TEUs	RF	GT	LOA	Beam	Draft	Speed	Built
Asia Star/NZ3 (1)	NZ/Noumea/HK/Chiwan/Ningbo/ Shanghai/Busan/Suva	49	7	*Calidris*	2,758	540	35,878	213	32	12.5	22	2011
NZJ/CNZ NE Asia (2)	TYO/Kobe/Busan/Shanghai/ Yantian/ HK/BNE/NZ	42	6	JPO Tucana	4,178	879	42,609	269	32	12.5	24.5	2010
Southern Star (2)	NZ/Tj Pelepas/Singapore/Brisbane	35	5	Lexa Maersk	4,045	800	50,721	266	37	14	24	2001
Northern Star (1)	NZ/Tanjung Pelepas/Singapore	35	5	Oluf Maersk	3,028	600	41,028	237	32.5	12	24	2003
NZS/NZX SE Asia (2,5)	Port Klang/Singapore/BNE/NZ	35	5	Kota Lumba	4,250	400	39,906	260	32	12.6	24.5	2010
MSC Capricorn	Freo/ADL/MEUSYD/NZ/BNE/SIN/ JKT	49	7	Mare Phoenicium	4,038	438	40,306	261	32	12.5	22.5	1999
Kiwi Intl Express^	Singapore/Pt. Klang/BNE/ SYD/ NZ /BNE	42	6	Hanjin Mexico	3,560	500						2013
VSA PSW USWC	MEUSYD/NZ/Papeete/Oakland /LA/NZ	49	7	*Hugo Schulte*	3,635	550	38,364	240	32	12.5	22	2010
VSA PNVV USWC(3)	SYD/MEUADL/NZ/Suva/HNL/ Oakland/ Tacoma/Vanc'vr/LA/NZ	56	4	*Cap Pasado*	2,741	400	28,372	222	30	11.4	22	2006
PIL CTP Transpac	MEUSYD/NZ/BNE/MNUKeelung/ Ningbo/Shanghai/Long Beach	70	10	Kota Juta	1,728	394	18,502	193	28	9.6	20	2000
0C1 USEC	SYD/MEUNZ/Panama/Cartagena/ Phila/Ch'Iston/Savannah/C'gena/ Balboa/NZ	70	10	Bahia	3,650	844	41,483	254	32	12.4	21	2007
CMA PDL USEC-(4)	SYD/MEUNZ/Manzanillo/Kingstonn/ Savannah/Philadelphia/Tilbury/ Rotterdam/Dunkirk/LeHavre/New York/SavannahllKingston/Cartagena/ Papeete/Lautoka/Noumea	91	13	*CMA CGM L'Etoile*	2,556	600	26,836	210	30	11.5	21.5	2005
Trans Tasman	SYD/MEUNZ	21	3	Larentia	2,702	500	27,915	215	30	11.6	21.5	2005

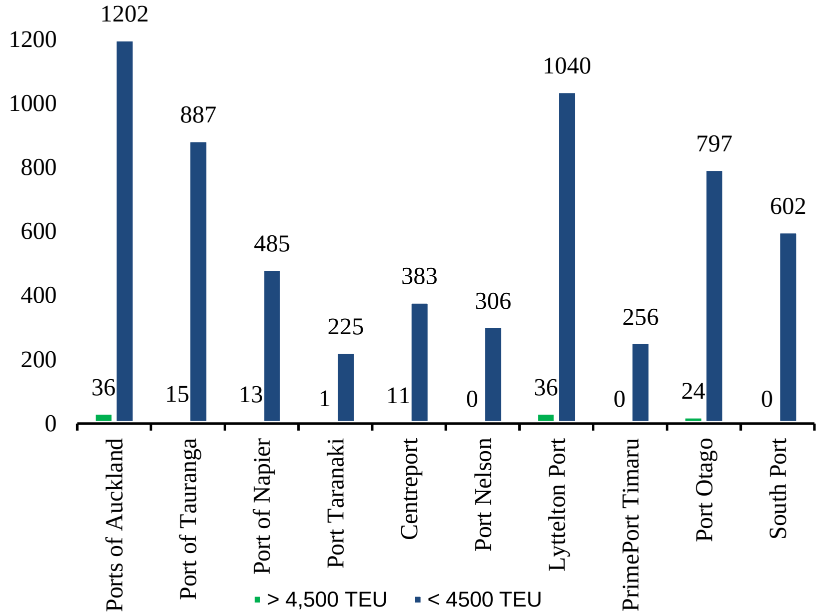
(1): Only serve New Zealand
(2): Call Brisbane SB, and in the case of KIX Sydney as well plus Brisbane fortnightly
(3): Service fortnightly
(4): Service upgraded from fortnightly (6 ships) to weekly (13 ships, additional vessels yet to be nominated)
(5): New service expected to commence Sept 2013
Note 1: Vessels in *italics* are geared in common with all operating in the relevant service
Note 2: Data on container ship TEU capacity varies depending on whether it derives from the shipbuilder, the operator or the flag registry. It can be a function of a) the ship's physical slot numbers or b) the ship's available DWT (net of crew, water, fuel and stores – operators usually make a 10% allowance to cover these items) divided by the assumed deadweight tons per container slot. For this analysis a normal working average of 14 tonnes per TEU has been assumed.
Source: Thompson Clarke Shipping Pty Ltd on behalf of MOT

Under the current shipping arrangements a total of 88 vessels service the New Zealand market. However, it should be noted that the international shipping market is dynamic and whilst the services described in this section where correct as at June 2014 they are subject to change.

4.1.4 Future shipping trends

Consistent with international trends the average size of vessel serving the New Zealand market has been increasing over time. As previously noted, vessels are being "cascaded" out of the East West Trade into the North South trades including routes servicing New Zealand (and Australia). As a result higher capacity and larger vessels are servicing New Zealand ports. For example, during 2013, 26% of TEU exchanges through New Zealand ports were on vessels 4,500 TEU or greater. This was up from 3% in 2012. Furthermore, during 2013, vessels of this size visited most of the container ports (the exceptions were Port Nelson, PrimePort Timaru and South Port) see Figure 13 and Table 10.

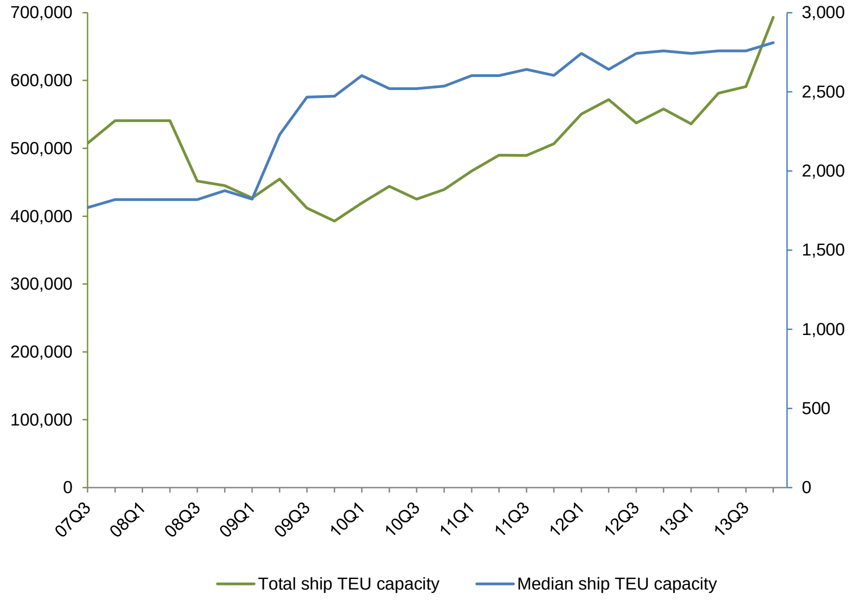
Figure 13 Ship visits by port (2013)



Source; FIGS Data YE December 2013

This trend is also demonstrated in the increase in the median size vessel visiting New Zealand between 2007 and 2013.

Figure 14 Total and median quarterly TEU capacity



Source: Maritime New Zealand, Ministry of Transport

The general market consensus is that this trend to larger vessels will continue into the future. The size of vessels and the likely timing of their deployment to the New Zealand trade are difficult to forecast. For example, the New Zealand Shippers Council study in 2010[13] argued that the likely maximum size vessel to serve New Zealand over the medium term would be 7,000 TEU. This forecast was based on discussions at that time with shipping lines and port companies. However, as acknowledged in the report[14] there is no single view within industry as to when or what size of vessel will service the New Zealand market in the future.

Discussions undertaken with industry for this study bear this out. The general consensus among the carriers interviewed was that for the foreseeable future the maximum container ship size that may operate to New Zealand would be Panamax Max or vessels up to 4,500 TEU. Underpinning this view is the opening of the widened Panama Canal in 2015, when the new Panamax class will be 12,000 TEU and large numbers of current Panamax (4,000 - 4,500 TEU) will be released on to the market. However, a minority view was expressed that 8,000 TEU vessels would arrive in the North South trades in general and the South West Pacific in particular sooner rather than the common view of around 10 years' time. The rationale provided to support this view is:

- Two of the region's leading carriers, Maersk and OOCL, have over 30% of their current fleet in the 7,500 to 10,000 TEU category compared with an average of 21% for the top 20 operators

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13 NZSC " The Question of Bigger Ships – Securing New Zealand's International Supply Chain"
14 Ibid, p17

- It is these ship sizes that are going to be displaced on the Asia - Europe trade by a flood of new vessels in excess of 12,000 TEUs which cannot transit Panama and are too big for the US West Coast ports.

Timing of such redeployment is almost impossible to predict trade by trade, but in the case of New Zealand the following issues need to be considered:

- The scale of New Zealand's container trade is such that deployment of 8000 TEU vessels is likely on its Asian trades, and then in only very small numbers after major consolidation of current services
- The economics of larger ships is only realised if these ships operate at or near full capacity - given the current scale of New Zealand's trade this is going to be very difficult to achieve with vessels of this size
- Larger vessels may change port visit patterns in New Zealand and elect to visit fewer ports. This practice may be required to maintain a high percentage of container transfers at each port stop and reduce travel distances and overall time spent in port to improve vessel utilisation and reduce costs for the shipping operators
- Redeployment of 8000 TEU vessels will be supply driven not demand driven - this makes redeployment particularly difficult to forecast as it will be a function of the fleet profile, global service commitments and operating economics of the shipping lines involved.. The "cascade" or "trickle down" effect of surplus vessels will hit Australia first, given its larger trade volumes, and the fact that the ports of Sydney and Brisbane with 3 terminal operators and significant recent investment in upgraded terminal equipment could handle such ships today. The current constraint is Melbourne, which will not have bigger ship capability until the end of 2016 with the opening of the new Webb Dock terminal. The timing of this development following within 12 months of the widening of the Panama Canal is critical and related container service changes will need to be monitored closely.

4.2 Ports

The focus of this study is on the containerised trades to and from New Zealand, as such this section of the report provides an overview of ports servicing this trade, and more specifically the infrastructure each port has deployed to handle the container movements.

4.2.1 Role of ports in containerised international trade

New Zealand has 15 ports nationally of which10 are involved in international container trade. During 2013 these ports involved in the international container ports handled a throughput of 2,503,733 TEU (total throughput of full and empty TEU) moved through the 10 container ports. The volume of containers passing through each port is summarised in the Table 9. The Ports of Auckland and Tauranga combined accounted for over 60% of all container movements, each handling over double the volume of Lyttelton, the third largest container port. The Port of Taranaki, handled the lowest number of containers.

Table 9 Total number containers (TEU) handled by port (calendar 2013)

Port	Total*	%
Ports of Auckland	780,710	31
Port of Tauranga	741,341	30
Port of Napier	205,941	8
Port of Taranaki	14,274	1
CentrePort	88,335	4
Port Nelson	83,362	3
Lyttelton Port	359,640	14
PrimePort Timaru	17,484	1
Port Otago	180,849	7
South Port	31,797	1
Total	**2,503,733**	**100**

Source: FIGS report Jan 2013_Dec 2013 v3

Notes:

1. Total is the sum of "Imports, Exports, Re-exports, Import Transhipments, Export Transhipments, Domestic and Coastal Unknown" –as defined by FIGS. FIGS excludes restows

2. FIGS container handling data differs to that represented in the port annual reports. The container numbers shown in the annual reports reflect all container moves which generates revenue for the ports, some of which are not captured by the FIGS data. The FIGS data has been adopted for use in this report as it is a sole source for data on all ports.

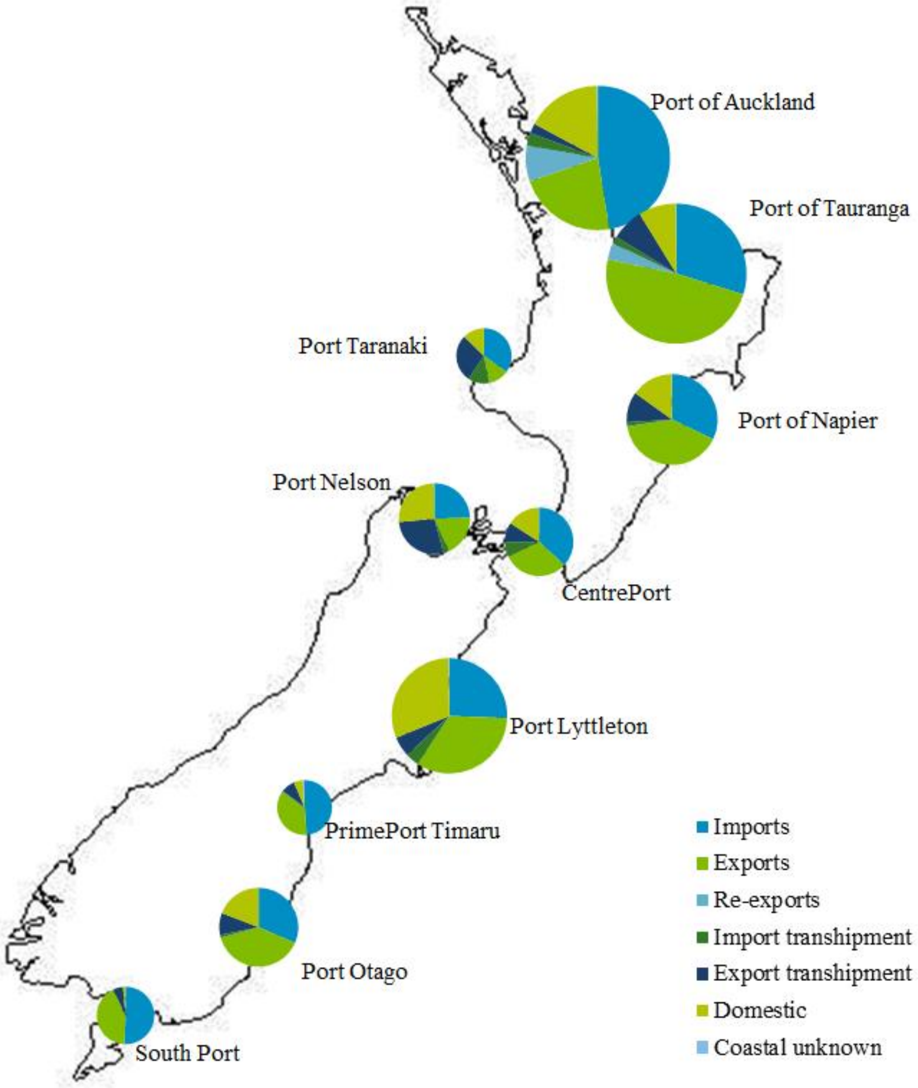
3. The modelling that has been undertaken for this analysis used the 2012 throughput data – during this period Ports of Auckland was experiencing industrial action, As a result some container volumes were diverted to Port of Tauranga, which distorted the throughput figures for Ports of Auckland and Port of Tauranga during that time.

New Zealand's port system has evolved from the original hinterland ports used to service regional economies. Even though road and rail has become more efficient over time, the regional nature of the port network has persisted. This is due to a combination of factors including geography (the long narrow nature of the country), two main islands, challenging terrain, relatively low density population and inter-port competition.

By world standards New Zealand's ports are small. For example in 2013 the Port of Melbourne handled 2.5 million TEU (the equivalent of the total through put of every port in New Zealand combined). However, even though larger ports can generate benefits from economies of scale, the port network must be considered in the broader context of the whole supply chain and the cost associated with the operation of the links along that chain.

Due to the geographic nature of the port network the proportion of import and export trade through each port varies. The Ports of Auckland is situated in New Zealand's major urban centre and therefore attracts a higher proportion of imports compared to all other ports (see Figure 15). Even though Port of Tauranga attracts considerable import volumes destined for the Auckland market the majority of its trade is export oriented. The other ports tend to reflect the predominately export orientated economic activities in their hinterlands. Due to this imbalance in trade, the import containers to southern ports (PrimePort Timaru, Otago and South Port), are predominantly empty containers being relocated to those ports for loading. For example 94% of Ports of Auckland's import containers are full, while only 21% of Port Otago's import containers are full.

Figure 15: Import, export and transhipment movements (TEU) by port



Source: FIGS report Jan 2013_Dec 2013 v3

4.2.2 Capability

Each port has unique operating constraints such as channel depth, tidal and current constraints, berth length, crane capacity and yard space. Each port organises its operations to accommodate its unique operating situation. For the purposes of this study we have collected information on each port's container operations. Table 10 provides a summary of key operating parameters by port. Of note is the number of visits by vessels with capacity greater than 4,500TEU. These visits have concentrated on the Ports of Auckland, Tauranga, Lyttelton and Otago.

Table 10 Summary of Operating Attributes by Port

	Ports of Auckland	Port of Tauranga	Port of Napier	Port Taranaki	CentrePort	Port Nelson	Lyttelton Port	PrimePort Timaru	Port Otago	South Port
Container throughput 2012/2013[1]	780,710 TEU	741,341 TEU	205,941 TEU	14,274 TEU	88,335 TEU	83,362 TEU	359,640 TEU	17,484 TEU	180,849 TEU	31,797 TEU
Quay length for container services (m)[2]	870	770	390	300	550	375	363	240	300	300
Storage yard container terminal (ha)[2]	40	49	18	3	24	8	12	n/a	15	3
Total Port land holdings (ha)[3]	116	188	47	51	67	58	164	n/a	28.7	49
High Water maximum Draft (m)[3]	13.9	13	12.4	12.5	11.2	10.3	12.4	n/a	13.5	9.9
Number of ship visits 2013[1]	517	679	340	32	162	126	306	64	201	49
Number of vessels > 4,500 TEU 2013[1]	36	15	13	1	11	0	36	0	24	0
Ave cont. exchanges per vessel (< 4500 TEU) 2013[1]	1202	887	485	225	383	306	1040	256	797	602
Ave cont. exchanges per vessel (> 4500 TEU) 2013[1]	3498	2187	694	286	675	n/a	1321	n/a	1171	n/a

Source 1: FIGS report Jan 2013_Dec 2013 v3 – includes all empty and loaded imports, exports, transhipments, re-exports, domestic and coastal as defined by FIGS

Source 2: Provided by ports

Source 3: AmZLtd for MoT, and Drewry

As well as providing traditional port services such as, cargo assembly, ship loading, marine services (towage and pilotage), many ports provide upstream transport services.

For example the Ports of Auckland and Tauranga both operate "inland port" services (MetroPort and Wiri Freight Hub) both of which offer off dock port gate services (customs and biosecurity clearance), with rail services from the terminals to the port. (See Section 4.6 for more detail). Port of Tauranga has recently purchased PrimePort's container terminal and announced its intention to buy land at Rolleston to establish an intermodal terminal to service the Canterbury region. Lyttelton has also recently announced similar plans for an inland port at Rolleston. Port Otago has established a rail service from Timaru (in conjunction with KiwiRail) to attract cargo from southern Canterbury.

4.2.3 Capacity

There are two aspects of port capacity that have been examined in this analysis. The first is the ability of the ports to increase throughput, the second is the ability of ports to service larger vessels.

Throughput

Based on international industry benchmarks we have calculated the current capacity for each port over its current berths. This analysis suggests that all the ports have the capacity to increase throughput. For example, based on current quay length, Ports of Auckland and Tauranga could increase throughput by approximately 78% and 66% respectively. Lyttelton Port has the lowest latent capacity of all ports reviewed. The ability of ports to match the throughput benchmarks is contingent on:

- Total volume of containers moving through the port
- Productivity of quay cranes, stacking equipment, cargo marshalling, yard configuration
- Number of vessels serving the port
- The volume of other cargoes (e.g. bulk, break bulk) moving through the port.

Table 11 Port capacity assessment

Port	Container throughput 2012/2013	Quay length	Current throughput /m/year	Potential throughput/m [1]	Max. throughput	Capacity used %
Ports of Auckland	780,710	870	897.37	1,600	1,392,000	56%
Port of Tauranga	741,341	770	962.78	1,600	1,232,000	60%
Port of Napier	205,941	390	528.05	1,300	507,000	41%
Port Taranaki	14,274	300	47.58	1,300	390,000	4%
CentrePort	88,335	550	160.61	1,600	880,000	10%
Port Nelson	83,362	375	222.30	1,300	487,500	17%
Lyttelton	359,640	363	990.74	1,300	471,900	76%
PrimePort Timaru	17,484	240	72.85	1,300	312,000	6%
Port Otago	180,849	300	602.83	1,300	390,000	46%
South Port	31,797	300	105.99	1,300	390,000	8%

Source: AmZLtd for MoT, and Drewry

[1] Based on industry benchmarks of 1,300 TEU for berths between 250 – 500m and 1,600 TEU for berths between 500- 1000m

Larger vessel capability

The ability of ports to handle the larger vessels expected in the New Zealand trades, depends on a number of factors, including:

- Channel and berth pocket dimensions (depth, width, length)
- Size of quay cranes - larger cranes are required to reach wider beamed vessels
- Number of quay cranes – larger vessels will mean higher exchanges of containers per visit, with the requirement to turn vessel around within specified times more cranes will be deployed to load/unload each vessel
- Number of container handlers required to support each quay crane
- Larger capacity container yards – to ensure more containers can be marshalled for each vessel visit.

The following analysis assesses the current capacity of each port to accommodate larger vessels from the perspective of length and draft. For the purposes of this analysis “reference vessels” from Maersk’s fleet have been used. It should be noted that not all vessels of a certain capacity have the same dimensions. For example the Gudrun Maersk has a capacity of 9,500 TEU and is 367m long, 42.8m wide and a15.0m draft. This can be compared with the Compact Wide class which has the same capacity but is shorter, wider and has a shallower draft (298m long, 49m wide (19 rows) with 9,500 TEU and a max draft of 14.5 metres).

Based on our analysis, Port of Tauranga is the only port with sufficient channel and berth depth and width capable of taking the 8,200 TEU reference vessels (the Sovereign Maersk). Ports of Auckland and Otago have the capacity to take the 7,403 TEU reference vessels. Of the major ports Lyttelton is the most constrained to take larger vessels.

Ports of Tauranga and Auckland have recently invested in post-panamax cranes which are suitable for unloading vessels of up to 18 TEU wide.

Port and Ship Class			Ports of Auckland	Port of Tauranga	Port of Napier	Port Taranaki	Centerport	Port Nelson	Lyttelton	PrimePort Timaru	Port Otago	South Port
Emma Maersk												
	TEU:	LOA(1)										
	15,200	Depth										
Gudrun Maersk												
	TEU:	LOA		✓								
	9,500	Depth										
Sovereign Maersk												
	TEU:	LOA	✓	✓								
	8,200	Depth										
Regina Maersk												
	TEU:	LOA	✓	✓							✓	
	7,403	Depth	✓						✓		✓	
NYK Altair												
	TEU:	LOA	✓	✓	✓						✓	
	4,953	Depth	✓	✓					✓		✓	
President Truman												
	TEU:	LOA	✓	✓	✓	✓			✓		✓	
	4,538	Depth	✓	✓		✓	✓		✓		✓	

Assumes fully loaded draft at high water

(1) LOA Length Over All – total length of the vessel

Our assessment suggests that all the ports have latent capacity that can be utilised to increase throughput. We understand that a number of ports (e.g. Auckland, Tauranga, Napier, CentrePort, Lyttelton and Otago) have plans to invest in new infrastructure such as channel deepening, reclamation and or new post panamax quay cranes. These upgrades, whilst increasing throughput will also accommodate larger vessels.

For the purposes of this study we have made estimates of upgrades required to accommodate the increased throughput that is likely to arise in a number of the Scenarios modelled.

4.3 Rail

Rail plays a major role for the delivery of items in international trade, particularly exports (both bulk and containerised), to and from most ports. Rail has dedicated equipment and systems to carry out export and import tasks. It has the capacity to expand should future configurations of ports place additional loads on the system.

4.3.1 Network description

KiwiRail operates on nearly 3,500 km of the National Rail System in both islands. It serves nearly every significant port in the country. The exceptions are Northport, Gisborne, and Nelson.

The system consists of a spine from Auckland to Invercargill (connected by rail ferries across Cook Strait) with important spurs to the Bay of Plenty, Taranaki, Hawkes Bay and the South Island West Coast. The line from Auckland to Hamilton, the metro lines in Auckland and Wellington, and lines around Christchurch are mostly double track, totalling 263 km. All the rest of the network is single track with passing loops for opposing trains. Where the single track has heavy traffic, signalling is centrally controlled from Wellington. On more lightly used lines a system of movement orders (Track Warrants) are used.

4.3.2 Current role of rail in the supporting international trade

Rail has a significant role hauling containerised exports to ports (as well as bulk products like logs). It has significant market share in the major commodities of meat and dairy, which are largely containerised. NFDS 2014 shows rail's market share for manufactured dairy to be 49% (tonnes) and 75% (tonne km), and for meat 36% and 51%. For example, of all dairy exported through Port of Tauranga in 2012 (including that arriving by coastal ship and tranships), 58% arrived at the port by rail.

Most of this product moves from the producing plants inland from the ports, mostly but not exclusively within the ports nearby hinterland. The 2012 average haul for rail for dairy was 180 km and for meat 259km. In addition to these movements from the port's hinterland, rail frequently moves containers from outside the port's hinterland to meet changes in shipping line port calls or to reach ships that make only a limited number of calls.

4.3.3 Capacity

This study is concerned about the capacity of infrastructure only. Clearly aggregating traffic on fewer ports will increase the need for investment in operational equipment like trucks, ships, and rail vehicles, but these investments can be made in step with demand from the market. For rail, this study is about the capacity of the track.

The double track sections of the route have substantial latent capacity, as they can handle following trains at short headways without concerns about opposing trains. The actual headway depends on the signalling system, but can be as low as 2 minutes between trains. On these sections of track capacity could be increased by upgrading the signalling system.

However, there are local potential constraints, such as short single track sections, which limit the absolute capacity, and competition for train paths with other traffic, notably commuter train traffic. This is likely to be an important constraint in peak hours between Wiri and Otahuhu in Auckland, a section that is designed to have a large number of passenger trains per hour. This section is 8 km long, and a third track can be laid to increase the capacity. Such a track is already planned (though not committed) to handle future traffic levels.

Two routes are available between Westfield and Ports of Auckland, either via Newmarket or via Orakei. The line via Orakei is relatively flat enabling heavier trains with fewer locomotives (compared to Newmarket which has steeper grades). The route via Orakei is and will remain the primary route for port freight. It is forecast to have half the number of commuter trains than the line south of Westfield, and so commuter traffic should not create a problem for additional freight traffic. However it is also possible to create a third track over most of this route should it be needed.

Most single track sections currently have excess capacity. The capacity of a single track route depends on the number and distance between crossing points. There is space in the existing corridor to accommodate additional passing loops, and they typically cost in the order of $3.5m (assuming only moderate earthworks). Given the topography, crossing loops are not often evenly spaced, so an immediate increase in capacity can be achieved by adding a crossing loop at the midpoint of the longest section.

Where lower density train control methods are currently used, capacity can also be increased by adding advanced signalling like CTC (centralised traffic control).

For the purposes of this study, single track capacity is only an issue on the line between Hamilton and Tauranga. All other routes have adequate capacity for the scenarios under consideration. The Tauranga line has recently been upgraded by adding new crossing loops and extending a number of existing ones. Its nominal capacity in terms of trains per hour was effectively doubled at a cost of approximately $12m. Similar work could be carried out to further increase its capacity until the maximum capacity of the Kaimai Tunnel (the ultimate bottle neck on this route) is reached. The capacity of this section could be enhanced, but only with significant capital expenditure on additional sections of tunnel. However, the need for that is unlikely as the current Waharoa-Tauranga (Kaimai Tunnel) capacity of 92 trains per day is more than is required under this study.

Table 12 shows the current maximum capacity of the major routes affected by this study.

Table 12 Rail Route Capacity (trains/day)

Route	Current use	Maximum capacity
Westfield – Auckland Port12	119	720
Westfield – Wiri12	268	720
Papakura – Paerata2	26	960
Paerata – Hamilton3	31	160
Hamilton - Waharoa	33	100
Waharoa - Tauranga	25	92
Hamilton – Marton	24	60
Marton – Palmerston Nth	43	133
Palmerston North – Oringi	18	48
Oringi –Hastings	8	27
Hastings – Napier	8	85
Palmerston Nth – Waikanae	15	120
Waikanae – Wellington3	88	200
Picton – Christchurch	11	42
Christchurch –Lyttelton3	26	200
Christchurch – Greymouth	16	37
Christchurch – Rolleston3	35	133
Rolleston – Temuka	15	57
Oamaru – Dunedin	9	40
Dunedin – Balclutha	31	75
Balclutha – Invercargill	11	30

Source: KiwiRail, and Consultant analysis

1. Includes proposed electric passenger timetable.

2. Double track routes. Westfield –Auckland Port may eventually need grade separation of the Westfield Junction to achieve high capacity. Note that Britomart Station, beyond Ports of Auckland, is currently a constraint on the number of passenger trains on this line

3. Largely double tracked. The capacities are constrained by short single track sections.

Significant increases in train numbers may require investment in terminal facilities, especially at the ports (which are covered elsewhere in the report). It may also require investment in KiwiRail's hub points. However, the extra traffic is likely to be carried in direct point to point trains, avoiding most of these facilities.

In keeping with the overall position for this study, analysis of rail has focused on the technical ability of the system to cope with increased demand, not any environmental pressures that may be brought to bear on increased activity. However, in Auckland (and elsewhere) issues regarding local amenity have been raised by owners of adjacent land, themselves wishing to intensify its use (e.g. for new residential developments).

Rail has rights under the designation provisions of the Resource Management Act 1992 to carry out train traffic. Once a designation has been granted, no further resource consent is required from District Councils for activities on the corridor. There are corresponding provisions for roads and a number of other "network" industries. Nevertheless some parties have complained about impacts outside the corridor. A case at Orakei, on the waterfront rail route into Ports of Auckland, went as far as the

Environment Court in 2013. The Court approved a Plan Change incorporating measures to protect rail operations, including developers taking mitigating measures against noise and vibration in design, location, and construction. As well, an encumbrance is placed on land titles to ensure mitigation measures are taken, and to prevent the owners and lessees from complaining about adverse effects from rail operations.15

While this case is specific to the site, it has implications at other sites. Hence, KiwiRail is seeking that the Auckland Unitary Plan, and district plans throughout the country, have similar rules relating to the impact of rail activity.

4.3.4 Capability

The capability and capacity of the rail network is determined by a number of factors such as:

- Allowable axle loads – primarily dictated by the standard of the track and bridges
- Type of track – double track versus single track
- Length of train – a function of gradient and locomotive effort, or crossing loop length
- Track clearances – for example height restrictions due to tunnels, overhead lines, bridges etc.
- Train control and signalling systems
- Line speed and curvature.

The carrying capacity of wagons and trains is dependent on the allowable axle load on the track and on the wagon. Most of the network (apart from some minor lines, and some wagon restrictions) is able to carry wagons and locomotives with 18 tonne axle weight. For a typical four axle container wagon, that translates into 72t gross load. Such wagons are relatively light in terms of tare, so the net load (including the weight of the container) is about 56 tonne. Some wagons have a higher capacity of 80 tonne gross, 64 tonne net (20 tonne axle loads), but current track conditions do not allow operation of these loads. KiwiRail is gradually rebuilding bridges and upgrading track on key routes, which will eventually permit these higher axle loads.

The number of containers (measured as TEU) per wagon is dependent on the length of the wagon and the weight of the load. The wagon deck length is typically 15-16m, equivalent to 2.5 TEU. There are some 2-TEU and 3-TEU wagons as well. The standard modern wagon can carry 2 full TEU (6m) containers of up to 28t each. (It can carry a 40ft (12m) container of any load within a standard container's rated capacity.). Allowing 2.5 tonne for the tare weight of each TEU container, then the freight carrying capacity of two containers on a wagon is over 25 tonne per container. There are few commodities in New Zealand's trade that are that dense. Typical weights for export commodities are summarised in Table 13.

[15] Ports of Auckland, New Zealand Railways Corporation (trading as KiwiRail) and Orakei Point Trust v Auckland Council (2013) NZEnvC 188

Table 13 Weight of export freight per 20ft container

Commodity	Average weight (t)
Dairy products	16.87
Meat	16.04
Paper	10.79
Hides	18.56
Wool	18.63
Frozen Fish	18.46
Total all commodities to ports (exc. empty)	14.56

Note: based on KiwiRail 2012 data, third party 20ft containers, port destination.

If a container is over 28 tonne gross load, then in general it can still be carried with a lighter container on the other end of the wagon.

Imports generally have a lower weight per container than exports. Most of rail's role in direct imports is on the Tauranga – Auckland MetroPort route, where TEU containers average just over 13t of freight each. KiwiRail's fleet of 3-TEU wagons is concentrated on this route. Clearly with 3 TEU and the same net weight available, the average maximum load per container is less, at about 16 tonne. Individual containers on these wagons can however weigh up to the normal maximum, as long as the other two are lighter.

Most routes can accommodate 9'6" (2.9m) high boxes, including the routes to all main ports. Only the relatively low-trafficked Northland and West Coast lines have clearances restricting the container height to 8'6" (2.6m). On some routes 10ft (3.05m) high and over width containers are used for internal movement of dairy products.

The maximum speed of freight trains is 80km/h, and the whole fleet is capable of this speed. However the topography of the country results in steeply graded and sharply curved sections, reducing the overall average allowable speed. Most imports and exports travel relatively short distances, so that movement to and from ports is relatively quick.

Trains are timetabled and connect with other trains at major nodes to enable movement from a point on one line to another line. For example, containers are moved from the Fonterra dairy plant near Hawera to Palmerston North and then on to Port of Napier, Port of Tauranga or other ports. Transit time (including transfer between lines) from Hawera to Napier (359 km) is approximately 15 hours, and from Hawera to Port of Tauranga (675 km) varies upwards from about 19.5 hours

4.4 Road

The road network plays a vital role in linking the ports to inland markets and production facilities. Containerised import and export freight is carried over the majority of New Zealand's state highway network and many local roads.

The state highway network has almost 11,000 kilometres of road, with 5,981.3 kilometres in the North Island and 4,924.4 kilometres in the South Island. It links almost 83,000 kilometres of local roads - 17,298.3 kilometres urban and 65,600.7 kilometres rural[16]. The state highway network is the responsibility of NZTA. Local roads are operated and maintained by local and regional authorities.

[16] http://www.nzta.govt.nz/network/operating/faqs.html#statehighways

The capacity and operating attributes of the road segments vary considerably depending on:

- Number of lanes
- Gradients and curves
- Overall speed limits and the number of speed restrictions (urban areas)
- Number of intersections (traffic lights, roundabouts)
- The underlying road usage both passenger and freight (which can also vary depending on the time of day)
- Vehicle mass limits.

NZTA estimates that on the main roads as much as 15% of road capacity can be consumed by heavy vehicles and freight movements[17]. This is highly dependent on where the road is located (e.g. industrial areas have a higher proportion of freight), the time of day (morning and afternoon peak traffic in urban areas have a higher proportion of passenger traffic) and the curvature and gradient (on very steep roads slow moving trucks consume a higher proportion of capacity).

NZTA is currently overseeing the Roads of National Significance programme (RoNS), which involves seven major upgrade projects, including:

- Puhoi to Wellsford – SH 1 (under investigation)
- Western Ring Route, Auckland – SH16,SH18, and SH20 (under construction)
- Victoria Park Tunnel, Auckland- SH1 (complete)
- Waikato Expressway – SH1 (under construction)
- Tauranga Easter Corridor – SH 2 (under construction)
- Wellington Northern Corridor – SH 1 (in planning phase)
- Christchurch Motorways (in planning phase).

These projects are all based around New Zealand's largest population areas and are focussed on facilitating the efficient and safe movement of people and freight. All of the RoNS projects are of strategic importance for the movement of freight between regions and to ports.

NZTA is currently in the process of developing its 30 year plan for the long term development of road infrastructure; this planning is being informed by detailed transport modelling. Planning is also undertaken at the local level with local governments and stakeholders, for example the Upper North Island Freight Plan.

NZTA also administers the heavy vehicle regulation on New Zealand's roads. The standard maximum size of truck allowed to operate on New Zealand's road network has a gross vehicle mass of 44 tonnes. The 50Max HMPV has recently been introduced. This allows trucks slightly longer and with an additional axle (9 in total) than the standard 44 tonne vehicles, to operate on State Highways nationwide and most local roads at upto 50 tonnes[18]. In addition, vehicles can operate at higher mass (up to 62t) on certain routes if a high productivity motor vehicle permit (HPMV) has been issued.

It is beyond the remit of this study to assess and model the entire road network. As such we have examined key sections of the network, which we have classified into two groups:

- State highways linking the major regional centres and the ports
- The key access roads to each port.

[17] Anecdotal in discussion with NZTA

[18] http://www.nzta.govt.nz/vehicle/your/50max/docs/50max-faqs.pdf

4.5 Coastal Shipping

Container coastal shipping services are provided by both New Zealand based ship operators and the international shipping lines. The New Zealand operators tend to concentrate on the movement of domestics cargoes, whereas the international lines move large numbers of IMEX containers between the container ports.

Two of the New Zealand operators, Interisland Line and Bluebridge Shipping operate freight and passenger ferry services on the Cook Strait.

Pacifica Shipping operates a dedicated coastal container service utilising two vessels, which have a combined capacity to move 1,600 TEU per week on scheduled services between Auckland, Tauranga, Lyttelton, Nelson and New Plymouth. Pacifica Shipping has recently been acquired by the China Navigation Company (CNCo), the deep sea shipping arm of the Swire Group. Swire Group operates a number of international multipurpose services to New Zealand. These include; container, bulk and break bulk operations to the Pacific Island (on route to Asia and North America). Whether this change in ownership will mean a change in the market focus for Pacifica has yet to be seen.

International shipping lines undertake a large number of coastal container movements primarily for the purposes of repositioning empty containers to where the cargo is located or transhipping loaded export containers to utilise international services. There is also some transport of loaded import containers being distributed domestically using international line services up and down the New Zealand coast.

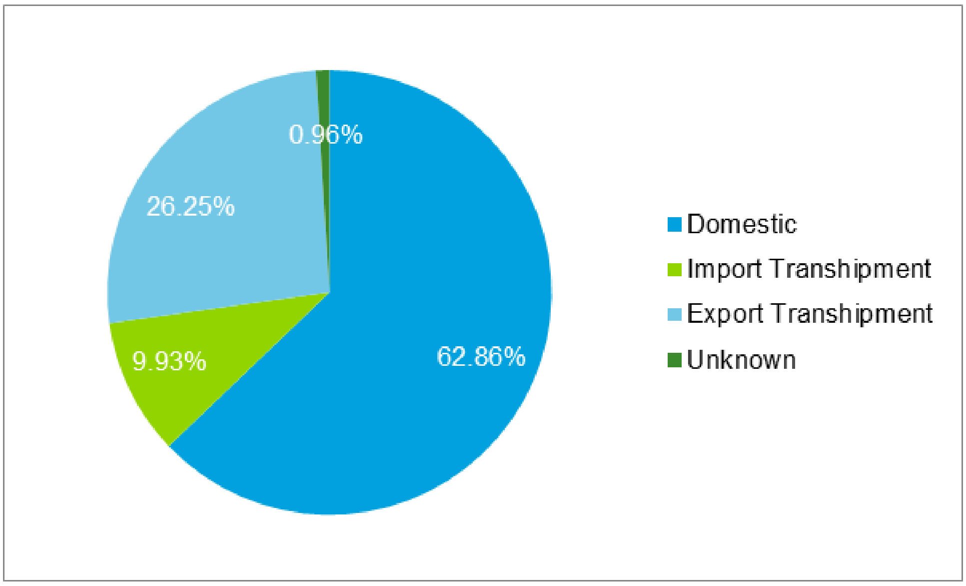
The FIGs data defines Coastal Container movements as: "A container that is loaded in one New Zealand port and moved to another New Zealand port where the container is discharged." This can be one of three movements:

- Export transhipment – where a container is loaded at a New Zealand port, is shipped to a second port, discharged and then loaded for export without leaving the second port, and without the cargo changing
- Import Transhipment **-** the cargo arrives from overseas at a New Zealand port, is discharged and then loaded onto another ship without leaving the port or the cargo changing, and is then shipped to a second New Zealand port, is discharged and gated-out
- Domestic shipment **-** Movements of containers from one New Zealand port to another New Zealand port, which are not import or export transhipments[19].

During 2013, 323,219 coastal container movements were recorded.

[19] http://www.transport.govt.nz/assets/Uploads/Sea/Documents/FIGS-October-2012-September-2013-report.pdf ,p 5

Figure 16 Total coastal TEU movements by type



Of a total of 323,219 coastal movements, 203,169 were classified as domestic freight of which 68% were empty containers. This reflects the imbalance of trade between ports. Import transhipments are dominated by the movement of both full and empty containers from Ports of Auckland and Port of Tauranga to ports further south, either for repositioning empty containers to where the cargo is or transhipment of full containers destined for domestic markets. Conversely export containers are moved predominantly from the southern ports to Ports of Auckland and Port of Tauranga for transhipment onto other international shipping services.

For the purposes of this study we have assumed a dedicated fleet of vessels providing coastal services. See Appendix B for details.

4.6 Intermodal terminals

There are two intermodal terminals currently operating specifically to service international ports. These are Port of Tauranga's MetroPort located in Onehunga and Ports of Auckland's Wiri Freight Hub.

MetroPort works in conjunction with KiwiRail to provide access via the Port of Tauranga to the Auckland market (for both imports and exports). As MetroPort is a Customs bonded and Ministry of Primary Industries (MPI) approved site, it is in effect the port gate to Port of Tauranga located in Auckland.

Ports of Auckland operate the Wiri Freight Hub in South Auckland. Like MetroPort this is a Customs and MPI approved facility. The facility has a rail service connecting the Wiri terminal with the Ports of Auckland container terminal.

In addition, there are a number of proposed intermodal terminals:

- Tainui Group Holdings is proposing a new intermodal terminal development at Ruakura north of Hamilton. This facility will also act as an inland port (similar to MetroPort and Wiri). This project is currently in the approvals phase of development

- Port of Tauranga's recent acquisition of PrimePort's container terminal may also offer "intermodal" services such as utilising coastal shipping services (or international shipping services) to transport containers for transfer to other services through Tauranga. In conjunction with the PrimePort acquisition, Port of Tauranga has recently announced its intention to develop an intermodal terminal at Rolleston in order to attract cargoes from Canterbury to PrimePort
- Port Otago offers rail services from Timaru, utilising KiwiRail's rail terminal
- Lyttelton Port has also recently announced plans for an inland port at Rolleston.

These terminals serve a number of purposes:

- They can facilitate inter-port competition by leveraging lower cost rail services to move containers over longer land distances. The advent of MetroPort meant that Port of Tauranga could compete with Ports of Auckland, and has been instrumental in the growth of container freight through the Port of Tauranga over the past 15 years. Similarly the Rolleston terminal could provide the same outcome for PrimePort.
- Intermodal terminals can lead to increased volumes of freight on rail, which means fewer trucks on congested road. This is particular the case with the Wiri Freight Hub, which enables lower truck activity at the port and the adjacent roads. However to be effective, it must be cost effective to transfer the containers from road to rail. The Wiri Freight Hub is located 25km south of the port, which is considered a short (high cost) haul for rail. Whether there are benefits of transferring from road to rail will depend on the length of the overall journey; as such this service may be attractive to shippers located in Waikato
- Intermodal terminals can provide cargo assembly services, which generate scale that can effectively utilise lower cost rail services. For example the Ruakura terminal could provide an assembly point for cargoes which may otherwise travel by road to either Tauranga or Auckland for export.
- When collocated with freight precincts, intermodal terminals, are also generators of freight, as warehousing and distribution providers and manufacturers locate adjacent to terminals.

For the purposes of this report we have not included any new intermodal terminals in the system. However, if a port hubbing scenario were to eventuate it is highly likely that inland intermodal terminals would play a much larger role in the network. Intermodal terminals would facilitate the assembly of cargoes remote from the port (often on relatively lower cost land), and enable the increased use of rail and as a result a faster delivery of containers to the port and increased throughput of behind dock container stacks.

MetroPort and Wiri Freight Hub have been included in the modelling as a specific site.

5 Scenarios

Our methodology in undertaking this study relies on the comparison of a number of possible port scenarios. Under these scenarios some ports are designated as hub ports and the resulting impact on capacity at ports, and the road and rail links are assessed. The "total cost" of each scenario is then compared. The selection of the scenarios is critical to this assessment.

The scenarios were selected to capture the range of possible choices that the port sector could make in response to the trend to larger ships. This was to give effect to the objective of the project, namely:

> *To understand the current freight system (including road, rail, coastal shipping and ports) and assess the impact on the system of possible changes to freight volumes and international shipping services particularly in respect to increasing ship size*.

Specifically a spectrum of infrastructure scenarios (combinations of international shipping, ports, road, rail and coastal shipping services) were selected in order to:

- Consider consolidation (hubbing) of container traffic (they do not consider consolidation of non-containerised cargoes)
- Create sufficient differentiation between each scenario to "test" the outcomes,

Based on this process, 5 broad scenarios were identified as can be seen in **Table 14**.

Table 14 Overview of Scenarios

Scenario	Description
Status Quo	A continuation of the status quo with all current container ports providing international services
Emerging Trends	Some trade consolidation of major ports in both islands with ports such as Nelson, Taranaki, PrimePort Timaru and South Port being feeder ports to the major ports – this represents the emerging trend currently being evidenced in the market
Partial Hub and Spoke	A maximum of two international ports in each Island with all other ports being feeder ports to these international ports
Hub and Spoke	One international port in each island with all other ports being feeder ports to these international ports
Single Hub and Spoke	One international port for the whole country with all other ports being feeder ports to this international port

Table 15 summarises the port combinations assessed in each scenario.

Table 15 Port selected by Scenario

Port	Scenario									
	Status Quo	Emerging Trend	Partial Hub & Spoke				Hub & Spoke			Single Hub & Spoke
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ports of Auckland	√	√	√	√	√	√		√		
Port of Tauranga	√	√	√	√	√		√		√	
Port of Napier	√	√								
Port Taranaki	√									
CentrePort	√									
Port Nelson	√									
Lyttelton	√	√	√	√		√	√			
PrimePort Timaru	√									
Port Otago	√	√	√		√			√	√	
South Port	√									
Single hub Port										√

Key: √ represents ports included in scenario as an international hub port

In selecting these scenarios consideration was given to:

- Current container volumes through each port (including emerging trends in transshipping)
- The long term impact of increasing ship sizes
- The spectrum of most likely outcomes (port selections), i.e. they must be reasonable and consider market trends and drivers. This includes an assessment of likely roll out of larger vessels by trade
- The time period under consideration, that is the likely possibilities through the planning period to 2046
- At a theoretical level the ability of ports to expand capability both from the marine (channel depth, width and ship handling) and landside (quay length, terminal footprint, landside road and rail links)
- Container traffic only
- Markets served by each port (catchment area for each port)

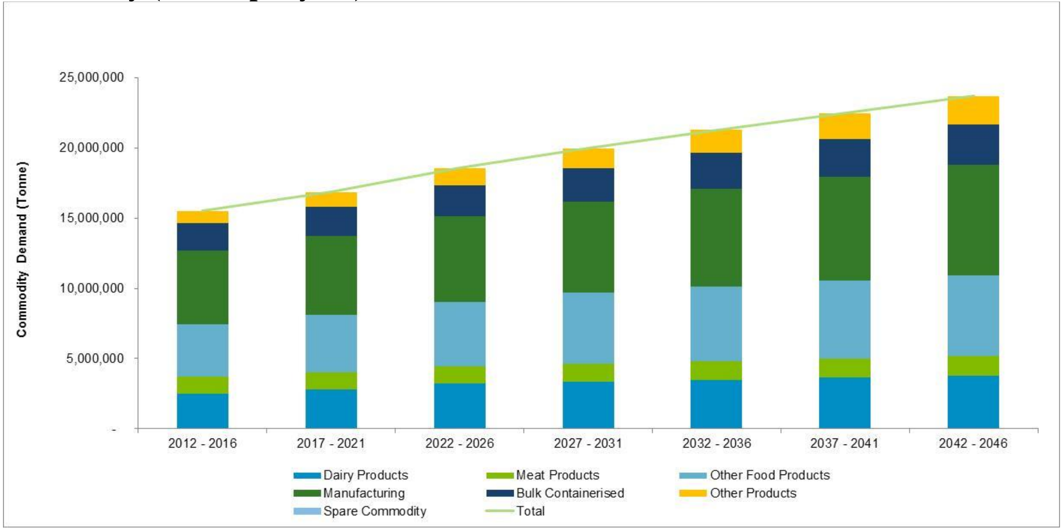
- The end market for exports (product type)
- The current shipping cycles and international regions served.

6 The Container Freight Task

The FFSS focuses on international container freight and has been informed by demand forecasts undertaken as part of the National Freight Demand Study (NFDS) – which provides long range forecast for freight demand in New Zealand. The international containerised freight task is defined as the total number of tonnes imported and exported by New Zealand in shipping containers.

Demand for international containerised freight in New Zealand is projected to increase by 50% in the next 30 years from 15 million tonnes in 2012 to 24 million tonnes by 2046 (or approximately 2.6 million full TEU) – See **Figure 17**. Such an increase is likely to put pressure on port capacity and infrastructure in the future. Hub and spoke scenarios will place increased pressure on hub ports and landside infrastructure feeding into these ports in the future.

Figure 17 Annual import and export container traffic demand forecasts – by commodity (tonnes per year)



Note: These forecasts have been derived from the NFDS 2014 data

7 Overview of Results

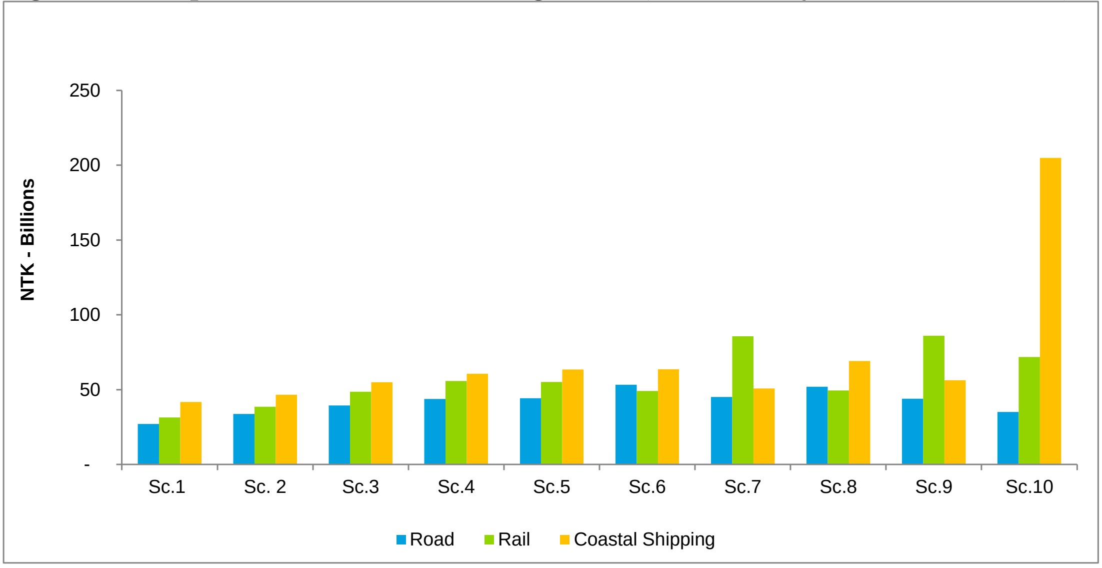
7.1 The domestic transport task

For the purposes of this study, the demand for freight doesn't change between scenarios. What does change is the size of the domestic freight task (the road, rail and coastal shipping required to move the containers between the ports and the domestic origin or destination) and the national port capacity required to handle the task. This can be measured in the net tonne kilometres (NTK) which is a function of distance travelled and tonnes carried between domestic origin/destination and the gateway or hub port.

Figure 18 provides a summary of the total domestic transport task, by mode of transport, from 2017 to 2046 under each of the scenarios considered in the FFSS. The results clearly illustrate that port hubbing and 'hub and spoke' scenarios increase the distance freight must travel in order to move between its domestic origin/destination and the gateway or hub port.

Increased domestic travel has an impact on supply chain costs and capacity on transport infrastructure.

Figure 18 Comparison of the domestic freight task (total NTK by mode, 2017 to 2046)



Source: FMM - excludes distances travelled associated with container freight movement beyond the key regional 'nodes' and beyond the main trunk infrastructure on the transport network).

Some of the important results included in the figure above are summarised as:

- Port hubbing and 'hub and spoke' scenarios (Scenarios 3 to 10) increase the distance freight must travel in order to move between its domestic origin/destination and the gateway or hub port
- Freight movements undertaken by coastal shipping and rail are likely to increase under port hubbing and 'hub and spoke' scenarios (Scenarios 3 to 10). This will be driven by economies of scale these modes can offer, compared with road, over longer distances. In particular:
    - The transport task, particularly rail, increases significantly in any scenario where Ports of Auckland is not an international container port. The majority of all container imports are unpacked and/or consumed in Auckland. Under the scenarios

where Ports of Auckland is not an international container port (Scenarios 7, 9 and 10) these imports would need to be transported into Auckland. It has been assumed that a significant portion of these movements would be undertaken by rail – especially between Port of Tauranga and MetroPort

  - Coastal shipping would be significantly higher under a Scenario where New Zealand is served by a single hub port (Scenario 10)

In additional to the domestic freight transport task, the FMM also demonstrates the increase in the port freight task under port hubbing scenarios. Depending on the port configuration and transhipment practices, this could equate to total port freight task of between 3.8 million TEU (Sc. 1) and 5.0 million TEU (Sc. 10) by 2046 including empty containers, transhipments through ports and restows.

7.2 Operating and Capital Costs

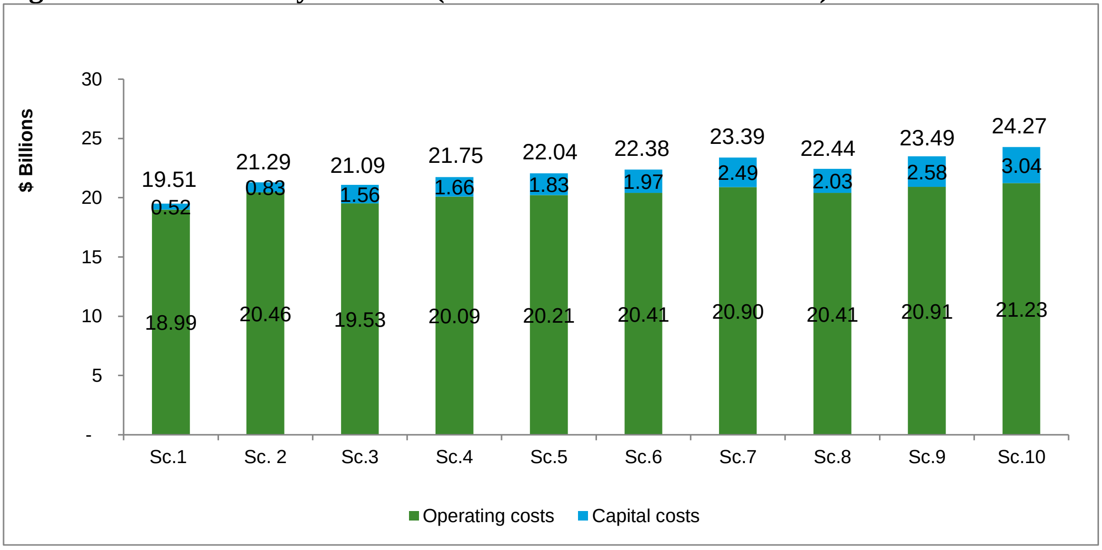
Overall, total operating costs are significantly higher than the incremental capital costs for all the scenarios considered as part of this study (see **Figure 19**).

The study estimates that incremental capital costs would be higher under the scenarios that include larger vessels and port hubbing due to the new capital investment required to accommodate bigger vessels and alleviate bottlenecks in the transport system. However, even under these scenarios, capital costs still only represent between 3% and 13% of total costs (PV).

Overall, total costs are higher under the port hubbing scenarios. The results indicate that operating costs are likely to be of a similar order of magnitude under all scenarios. However, the Status Quo ($19.5 billion PV) represents the lowest operating cost with Scenario 10 having the highest operating costs ($24.3 billion PV).

The drivers behind differences in costs are explored in following sections. Detailed descriptions for each scenario are provided in the Scenario Snapshots see Section 8.

Figure 19 Total Costs by Scenario ($billion PV from 2017 to 2046)*



Source: FMM - Note numbers in this Figure have been rounded

*Refer to scope and limitation of this study and the FMM when interpreting these results

7.2.1 Operating Costs

It is important to understand how operating costs change under each scenario since these make up the majority of total costs under each scenario. The FMM provides a basis to understand how operating costs might change and what drives these changes under the scenarios.

The domestic transport task (road, rail, coastal shipping) and the port task (total port throughput) all increase overall under the port hubbing scenarios (See Section 7.1). It is intuitive that, while some efficiency may be achieved, the increased domestic transport and port tasks will lead to higher operational costs.

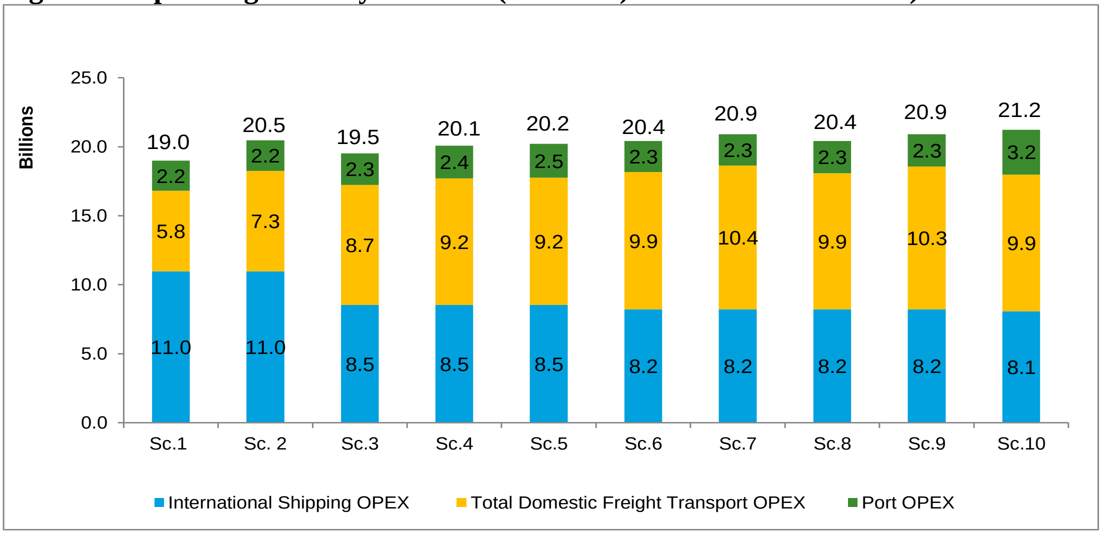
On the other hand, the larger vessels for international shipping services scenarios (7000 TEU +) are assumed to be more efficient than smaller vessels and therefore lead to a reduction in international shipping costs under the port hubbing scenarios.

These propositions are supported by the results shown in Figure 20 below which indicate that:

- Total international shipping costs reduce by between 22% and 26% under the port hubbing scenarios (with greatest savings achieved under Scenarios 6 to 10 with 8,000 TEU vessels assumed to operate on the Asian trade routes from 2017)
- Total port operating costs increase by between 1% (Scenario 1) and 49% (Scenario 10) due to the higher port task under the port hubbing scenarios
- Total domestic transport costs (road, rail and coastal shipping) increase under all scenarios compared with the Status Quo (Scenario 1). These increases are projected to be as high as 70% to 79% under Scenarios 6 to Scenarios 10.

Overall, the results show that potential savings in international shipping costs from larger vessels do not offset increases in domestic transport costs for the hub and spoke scenarios. Scenario 3 (partial hub and spoke, with 2 ports in the North Island and two ports in the South Island and 7,000 TEU vessels on the Asian trade routes) achieves the smallest increase in total operating costs – 3% higher than the Status Quo.

Figure 20 Operating Costs by Scenario ($ billions) PV from 2017 to 2046)

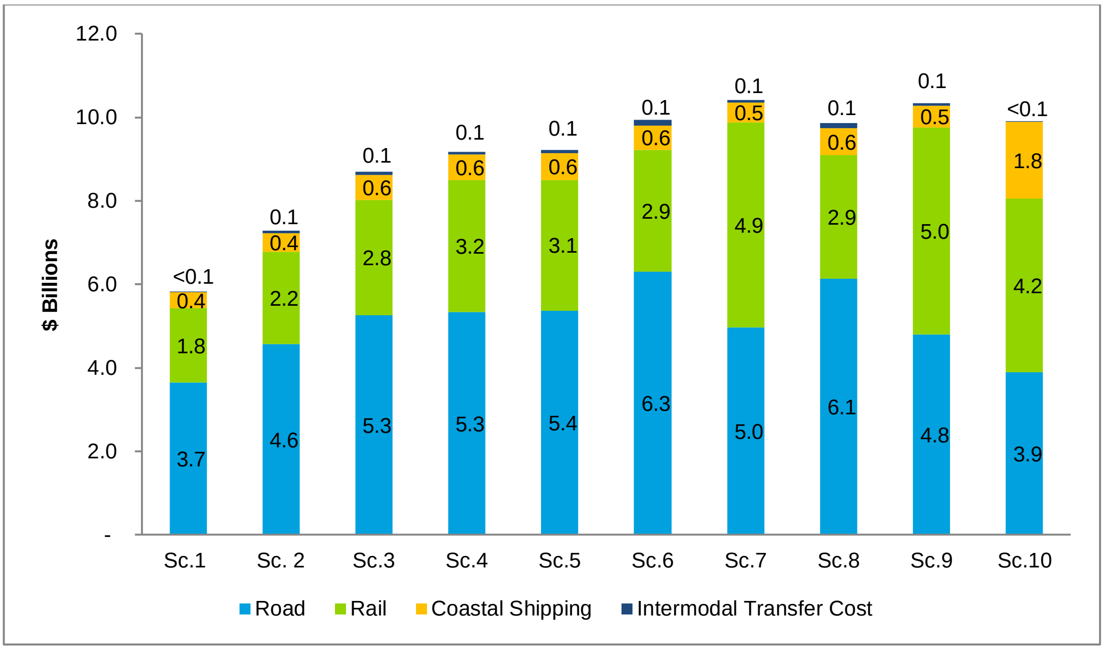


Source: FMM - Note numbers in this Figure have been rounded

Figure 21 provides a breakdown of total domestic transport costs for each of the scenarios. This breakdown shows that the increase in domestic freight transport costs are driven by increased road, rail and coastal shipping costs associated with the larger freight transport task under port hubbing scenarios.

As described in Section7.1 rail mode share will increase significantly in any scenario where Ports of Auckland is not an international container port. The majority of all container imports are unpacked and/or consumed in Auckland. Under the scenarios where and Ports of Auckland is not an international container port (Scenarios 7, 9 and 10) these imports would need to be transported to Auckland and therefore lead to increased total transport costs.

Figure 21 Total domestic transport operating costs ($billions PV from 2017 to 2046)



Source: FMM - Note numbers in this Figure have been rounded

7.2.2 Capital Costs

Capacity analysis finds that that there is sufficient capacity on most parts of the transport network and ports to meet forecast demand under the Status Quo Scenario. As such, capital costs under Scenario 1 are approximately $0.5b (PV) and comprise minimal upgrades to Port of Tauranga and on the road network around Auckland, Tauranga, Hastings and the Port of Napier.

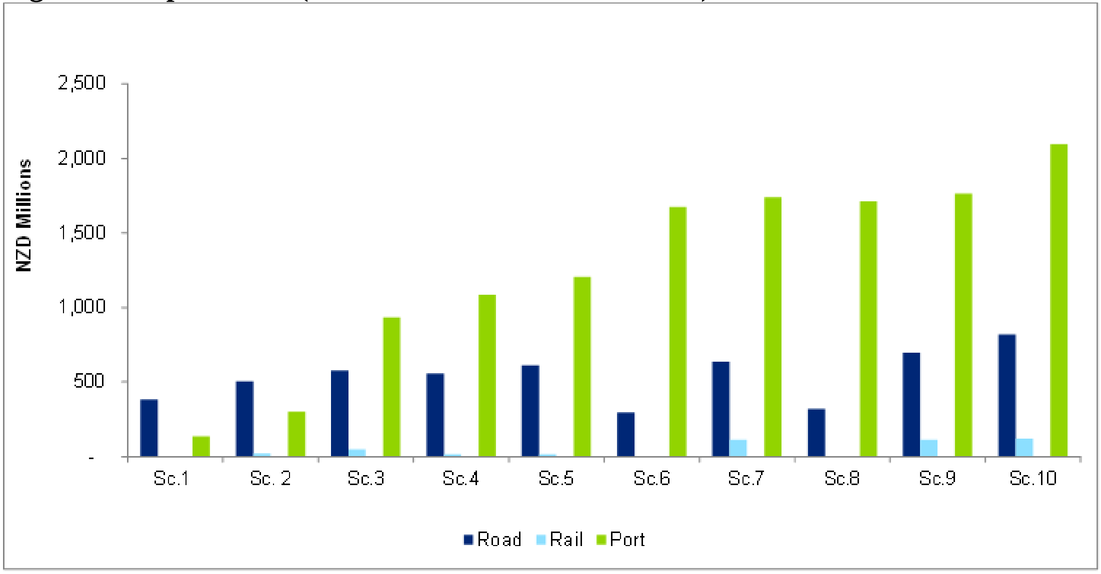
Any consolidation of ports or increase in vessel sizes will require increased investment at hub ports in order to accommodate these vessels and higher volumes. Port capital expenditure is $0.9 billion (PV) under Scenario 3 (for upgrades to Ports of Auckland, Port of Tauranga, Lyttelton Port and Port Otago). Scenarios where there is one hub port in each of the North and South Island (Scenarios 6, 7, 8, and 9) require further port capital investment ($1.7 billion to $1.8 billion PV) to accommodate the increased port task and 8,000 TEU vessels. These figures are 17 to 18 times higher than the port expansions assumed under the Status Quo.

Hub port scenarios also lead to a higher number of bottlenecks and capacity constraints on the transport network feeding the hub ports. The amount of additional capital investment required to alleviate bottlenecks caused by increased container freight on the road and rail network close to double under the hub and spoke scenarios compared with the Status Quo. Additional upgrades required on the following parts of the transport network under some scenarios:

- Key access routes to major hub ports (road and rail)
- Road routes connecting Auckland to Hamilton, Hamilton to Tauranga
- Road and rail routes within Auckland itself.

Details of capital costs for each scenario are provided in the Scenario Snapshot and in Appendix C.

Figure 22 Capital costs ($ billions PV from 2017 to 2046)



Source: FMM - Note numbers in this Figure have been rounded

7.3 Economic Analysis

7.3.1 Cost Benefit Analysis

Approach and Assumptions

Economic cost benefit analysis requires an assessment of a 'do-something' scenario against a base case. The base case does not necessarily represent a 'do-nothing' scenario but may represent a 'do-minimum' scenario. For this cost benefit analysis, the Scenario 1, Status Quo, forms the base case. The following parameters were used to prepare the analysis:

- A real discount rate of 6% per annum
- An evaluation period of 30 years commencing from 2017
- A base and price year of 2017.

The approach and methodology used to prepare the economic cost benefit analysis is described in Section 3.4.1. This methodology outlines the range of benefits considered within the economic assessment.

Of particular note, the method used to assess the BCR has been customised for this analysis. The following table summarises the approach adopted to estimate the BCR, which effectively sees the costs of Scenario 1 shift from the denominator, where it would reduce the cost base, to the numerator, where it increases the benefit base.

Table 16 BCR Formulation

BCR Element	Conventional Approach	This Analysis
Benefits (Numerator)	Transport cost savings + Avoided externalities	Transport cost savings + Avoided externalities + **(Avoided) costs of Scenario 1**
Costs (Denominator)	Costs of Scenario X – **Costs of Scenario 1**	Costs of Scenario X

The rationale for this approach is described in Section 3.4.1.

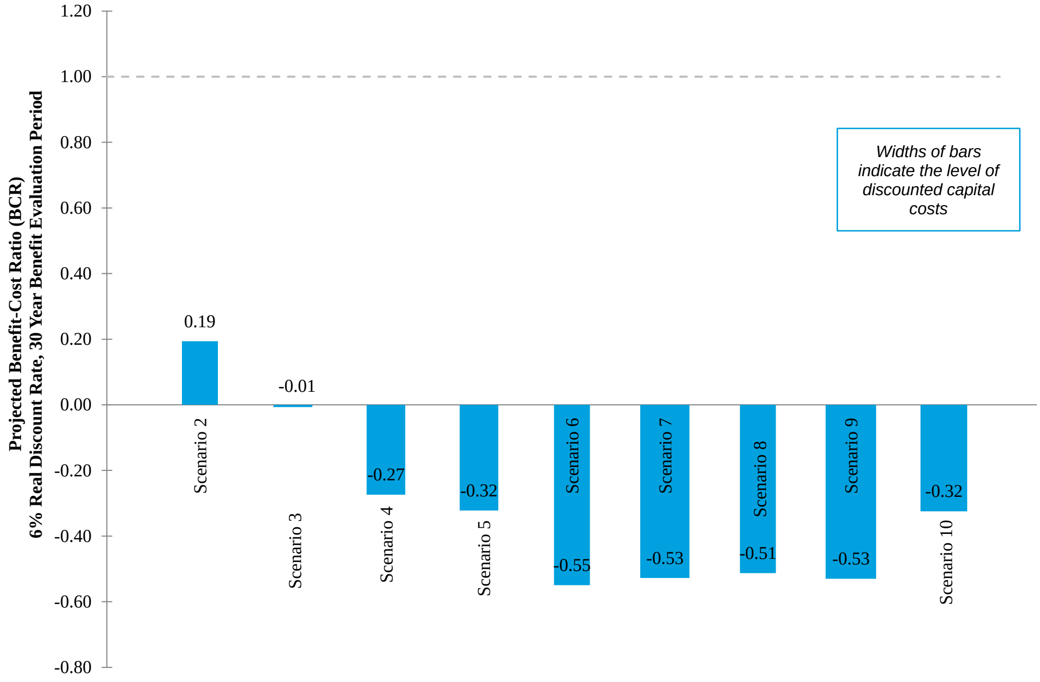
Headline Results

The results of the economic cost benefit analysis are shown in Table 17, with Figure 23 illustrating the BCRs for each scenario, incremental to the base case (Scenario 1). Scenario 2 (emerging trends) achieves the highest benefit cost ratio (BCR) of 0.19. The BCRs for the remaining scenarios (the full hub and spoke scenarios) are below zero with Scenario 6 returning the lowest BCR. It should be noted that the NPV for Scenario 6 is not the lowest – Scenario 10 has the lowest NPV.

Table 17 Projected Economic Costs, Benefits and Indicators ($ billion)

Scenario	Discounted Economic Costs	Discounted Economic Benefits	NPV	BCR
Scenario 2	3.0	0.6	**-2.4**	**0.19**
Scenario 3	3.9	0.0	**-3.9**	**-0.01**
Scenario 4	4.3	-1.2	**-5.5**	**-0.27**
Scenario 5	4.3	-1.4	**-5.7**	**-0.32**
Scenario 6	4.2	-2.3	**-6.5**	**-0.55**
Scenario 7	4.8	-2.5	**-7.3**	**-0.53**
Scenario 8	4.4	-2.2	**-6.6**	**-0.51**
Scenario 9	4.9	-2.6	**-7.5**	**-0.53**
Scenario 10	6.3	-2.0	**-8.3**	**-0.32**

Figure 23 Projected Benefit Cost Ratio



The economic cost benefit analysis indicates that the projected benefit cost ratio (BCR) for all scenarios is less than 1 and most are less than zero.

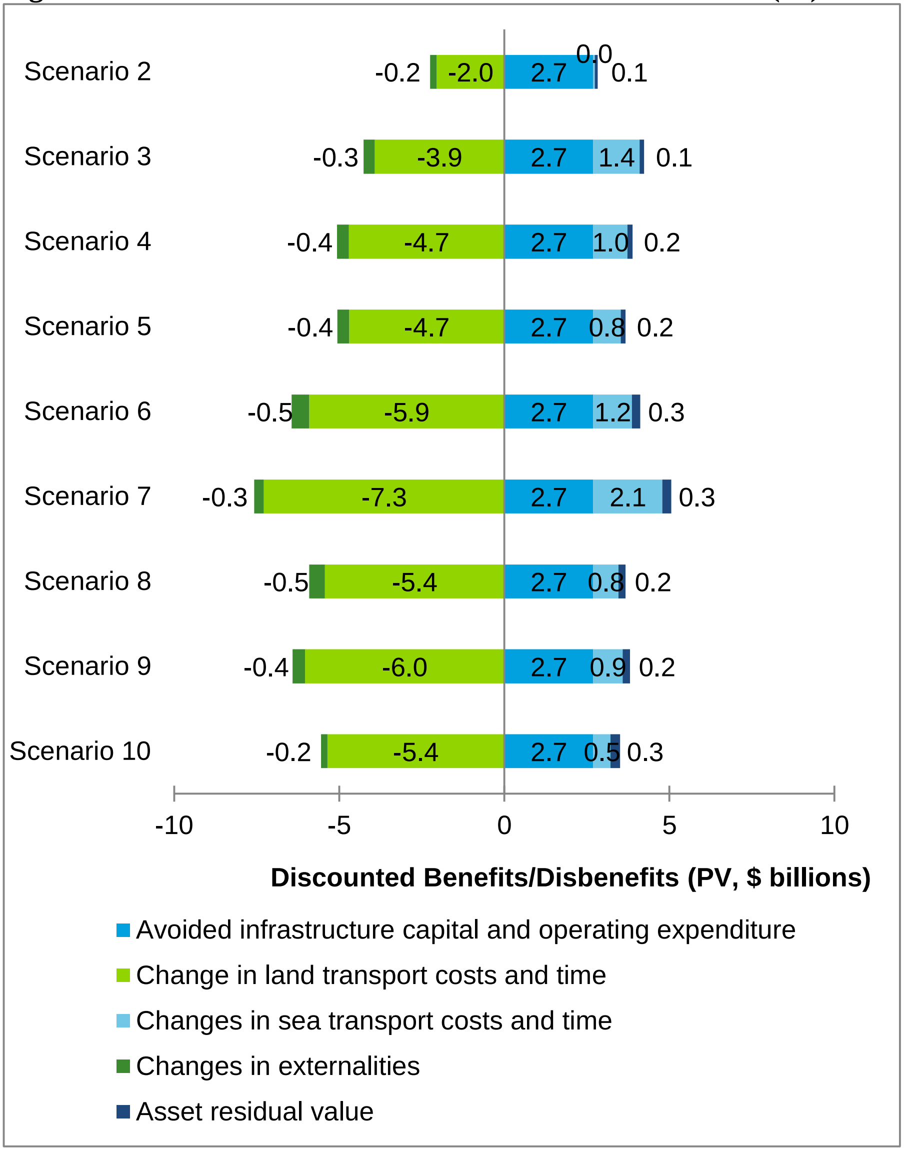
Where the BCR is less than 1, the do-something scenario may generate benefits, but these benefits are not sufficient to cover the costs of the scenario. Accordingly, these scenarios would have limited merit from an economic perspective.

However, almost all estimated BCRs are under zero, an unusual phenomenon. This indicates that the a do-something scenario would generate ongoing disbenefits, generally in the form of higher transport costs and associated externalities, on top of the additional quayside and landside infrastructure capital costs that would be incurred with port consolidation. What international shipping transport costs may be saved is outweighed by the additional land transport (and associated externalities), coastal shipping costs, port costs and travel time.

This is illustrated in Figure 24, where the benefits of lower international shipping costs (shown in light blue) are far outweighed by an increase in land transport costs (shown in light green).

As an aside, the avoided capital and ongoing costs of Scenario 1, which are considered a benefit in this analysis, are shown in blue.

Figure 24 Breakdown of Discounted Benefits and Disbenefits ($b)



The increase in road and rail transport travel time (which includes crew/occupant time and the value of time for freight) and supply chain operating costs for both road and rail, as well as increased investment in infrastructure compared to Scenario 1, are the main causes of the low BCRs for the other scenarios.

7.3.2 Computable General Equilibrium Modelling

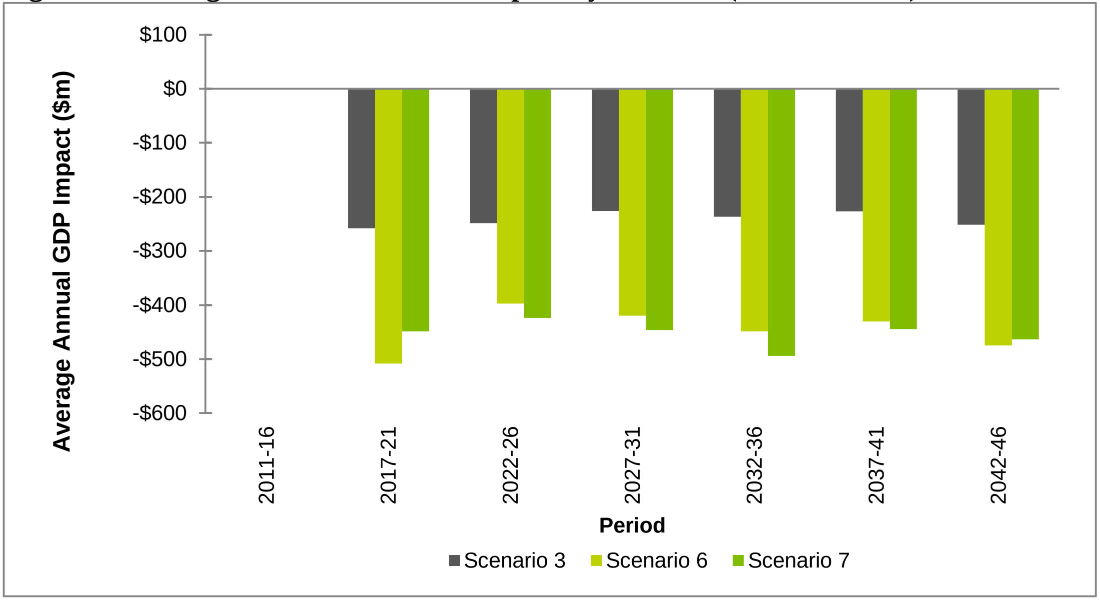
Computerised General Equilibrium modelling was undertaken by Deloitte Access Economics for three scenarios

- *Scenario 3*: 2 Hub Ports per Island,
- *Scenario 6*: 2 Hub Ports Auckland and Lyttelton
- *Scenario 7*: 2 Hub Ports Tauranga and Lyttelton

These represent a sample of the port hub scenarios with a wide range of factors contributing to operating costs, transport modes and benefit streams from an economic cost-benefit perspective. Scenario 6 was also selected to provide a relative perspective against Scenario 7, to test the impact of Auckland versus Tauranga as a hub port for the North Island.

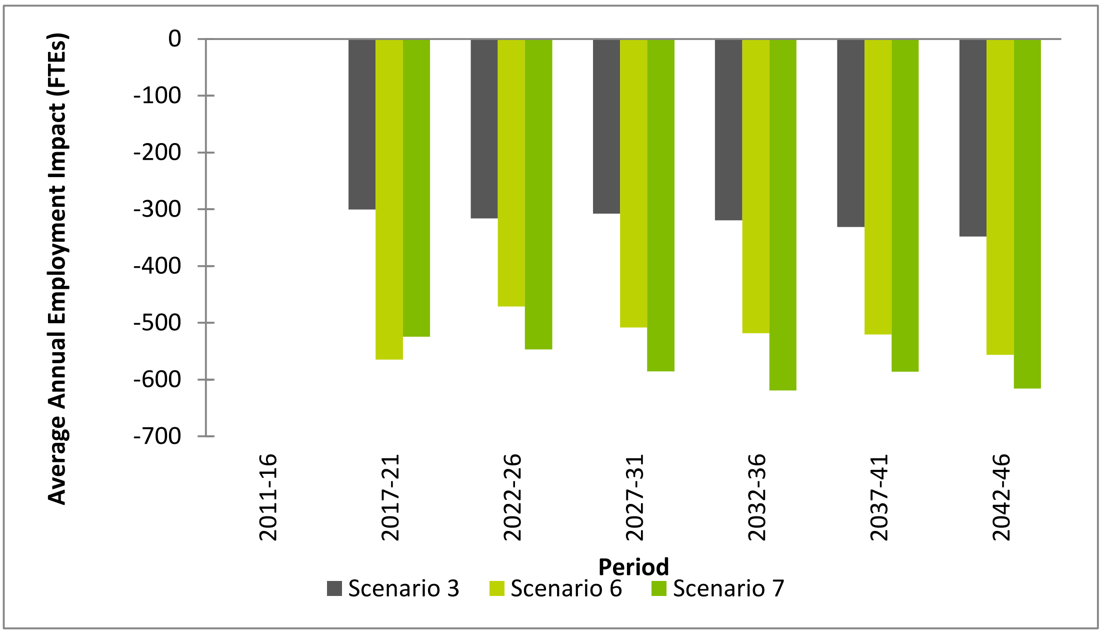
Figure 25 and Figure 26 illustrate the estimated annual average impact on GDP and employment by scenario respectively against the base case by 5 year periods.

Figure 25 Average Annual Real GDP Impact by Scenario (Undiscounted)



Source: Deloitte Access Economics estimates. Estimates are relative to the base case (Scenario 1)

Figure 26 Average Annual Employment Impact by Scenario



Source: Deloitte Access Economics estimates. Estimates are relative to the base case (Scenario 1)

The CGE modelling suggests no boost in economic activity due to construction activities and in the longer term, higher transport costs result in lower levels of economic activity relative to the base case. This reflects the impact of higher aggregate transport costs on the productivity of the broader economy.

7.4 Sensitivity Analysis

7.4.1 What if cargo owners don't receive the benefits of bigger ships?

Analysis and findings presented in earlier sections of this report are underpinned by the following assumptions:

- That operational costs are indicative of prices charged to cargo owners
- That larger vessels are able to realise efficiencies that lead to lower unit operational costs
- That efficiencies realised by larger vessels will be passed on to cargo owners in full.

The results presented in Sections 7.1 and 7.3 indicate that efficiency and cost saving in international shipping from larger vessels may be generated, but will also result in higher transport costs under port consolidation and port hubbing scenarios.

Analysis has been undertaken to test how sensitive the results are to increases in operating costs for larger vessels. This could test a number of circumstances including the following:

- Shipping lines operating larger vessels are not able to realise the potential economics of scale and efficiencies for the New Zealand trade
- Shipping lines operating larger vessels do not pass on the full extent of any efficiencies and costs savings to cargo owners.

The table below presents the changes in assumptions for international shipping costs underpinning two sensitivity tests:

- Sensitivity Test 1 - 75% of potential cost savings realised or passed on for vessels >4,500 TEU compared with 4,500 TEU vessels (assuming average vessel load of 60% of nominal container capacity).
- Sensitivity Test 2 - 50% of potential cost savings realised or passed on for vessels >4,500 TEU compared with 4,500 TEU vessels compared with 4,500 TEU vessels (assuming average vessel load of 60% of nominal container capacity).

Since these changes only apply to vessels with capacity greater than 4,500 TEU, Scenarios 1 and 2 are not impacted.

Table 18 Change in international shipping operating cost under sensitivity tests

FFSS Sensitivity Tests		Operating Costs ($/TEU/Nautical Mile)	
Percent of cost savings realised	Base Case 100%	Sensitivity Test 1 75%	Sensitivity Test 2 50%
Vessel 5 (4,500 TEU, 13m)	0.082	0.082	0.082
Vessel 6 (6,000 TEU, 13m)	0.069	0.072	0.076
Vessel 7 (7,000 TEU, 14m)	0.063	0.068	0.072
Vessel 8 (8,000 TEU, 15m)	0.058	0.064	0.070
Vessel 11 (Vessel 8 with higher utilisation)	0.055	0.062	0.069

Notes:

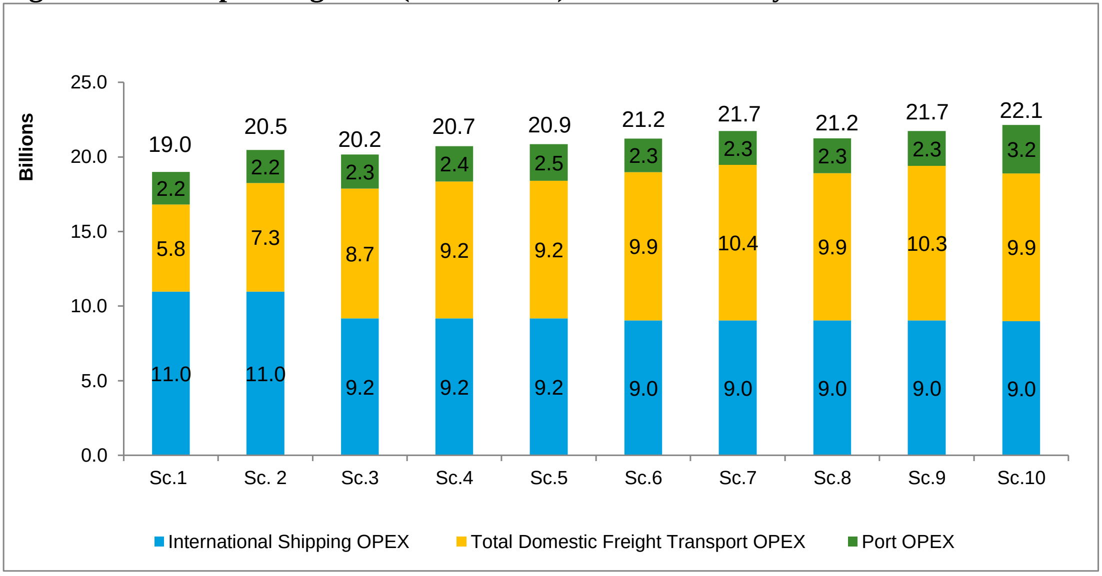
- All international shipping operating costs are indicative estimates only based on average $/TEU/Nautical Mile, as calculated using Deloitte's shipping model for international vessels
- International shipping operating costs represents indicative unit costs to vessel operators rather than prices charged to customers. Operating costs are assumed to be indicative of prices charged to customers in a competitive environment1
- For Scenario 10, there is one international port for the whole country with all other ports being feeder ports to this international port, this will reduce overall international travel time and distances to New Zealand from international locations, hence providing international shipping cost benefits

The impact of these changes is presented in the tables and charts below. These results show the importance of realising potential efficiencies for larger vessels for cargo owners in order to mitigate the impact of higher overall domestic transport costs under the port hub scenarios. Specifically, these results show that:

- Sensitivity Test 1 (75% of potential cost savings realised or passed on) results in an increase in international shipping costs (compared to where 100% of the cost savings are passed on to the cargo owners) of 5% for scenarios with larger vessels (Scenario 3 to 10). This 5% increase in international shipping costs leads to a 1% to 2% increase in total operating costs and a further reduction in benefit cost ratios
- Sensitivity Test 2 (50% of potential cost savings realised or passed on) results in an increase in international shipping costs (compared to where 100% of the cost savings are passed on to the cargo owners) of approximately 8% to 10% for scenarios with larger vessels (Scenario 3 to 10). This 8% to 10% increase in international shipping costs leads to a 3% to 4% increase in total operating costs and a further reduction in benefit cost ratios.

In all cases, vessel utilisation is assumed at 60% of nominal container capacity.

Figure 27 Total operating costs ($ billion PV) under Sensitivity Test 2



Source: FMM - Note numbers in this Figure have been rounded

Table 19 International shipping costs under sensitivity tests ($ billion PV from 2017 – 2046)

Scenario	1	2	3	4	5	6	7	8	9	10
Base Case - 100% savings passed on	11.0	11.0	8.5	8.5	8.5	8.2	8.2	8.2	8.2	8.1
Test 1 – 75% of savings passed on	11.0	11.0	8.9	8.9	8.9	8.6	8.6	8.6	8.6	8.6
Test 2 – 50% of savings passed on	11.0	11.0	9.2	9.2	9.2	9.0	9.0	9.0	9.0	9.0

Table 20 Total operating costs under sensitivity tests ($ billion PV from 2017 – 2046)

Scenario	1	2	3	4	5	6	7	8	9	10
Base Case - 100% savings passed on	19.0	20.5	19.5	20.1	20.2	20.4	20.9	20.4	20.9	21.2
Test 1 – 75% of savings passed on	19.0	20.5	19.9	20.4	20.5	20.8	21.3	20.8	21.3	21.7
Test 2 – 50% of savings passed on	19.0	20.5	20.2	20.7	20.9	21.2	21.7	21.2	21.7	22.1

Table 21 Change in total operating costs under sensitivity tests (% increase on base case)

Scenario	1	2	3	4	5	6	7	8	9	10
Test 1 – 75% of savings passed on	0%	0%	2%	2%	2%	2%	2%	2%	2%	2%
Test 2 – 50% of savings passed on	0%	0%	3%	3%	3%	4%	4%	4%	4%	4%

Table 22 Benefit cost ratios under sensitivity tests ($ billion NPV from 2017 – 2046)

Scenario	1	2	3	4	5	6	7	8	9	10
Base Case - 100% savings passed on	-	0.19	-0.01	-0.27	-0.32	-0.55	-0.53	-0.51	-0.53	-0.32
Test 1 – 75% of savings passed on	-	0.19	-0.09	-0.35	-0.40	-0.65	-0.61	-0.61	-0.61	-0.40

Test 2 – 50% of savings passed on	-	0.19	-0.17	-0.42	-0.47	-0.75	-0.70	-0.70	-0.70	-0.47

7.4.2 A single hub port in Auckland versus Tauranga

Scenario 10 is defined with Port of Tauranga as the single hub port for New Zealand. As discussed in previous sections of this report, significant expansion and capital investment would be required in order to develop a single port capable of handling the entire international container trade. The feasibility and environmental impacts of this have not been considered as part of this analysis.

For the purposes of comparison, a sensitivity analysis has been undertaken to assess how the results for Scenario 10 might change if Ports of Auckland were to be the single hub port in Scenario 10 rather than Tauranga.

The modelling suggests that while the capital upgrade costs associated with Ports of Auckland as a single hub port are lower than the Port of Tauranga single hub port, the total operating costs are 28% higher. This results in overall higher costs (capital plus operating) and a much poorer BCR for the Ports of Auckland scenario.

Domestic transport operating costs are higher for Ports of Auckland due to a higher domestic transport task (28% higher than for the Port of Tauranga hub) and the higher road task assumed under this scenario. All freight from the South Island would travel to the North Island Hub port via coastal shipping and Tauranga is closer for all South Island supply chains compared with Auckland. The Port of Tauranga scenario assumes extensive use of rail, particularly to the Auckland region. All supply chains travelling via road in Auckland are likely to experience congestion and reliability issues in Auckland due to high volumes of passenger traffic. As a result, under this sensitivity test with Auckland as the sole hub port for New Zealand, all North Island freight travelling to Auckland via road will experience higher operating costs and travelling time. This will also lead to increase economic costs and therefore reduced economic benefits compared with the base case.

International shipping and port operating cost are also higher (11%) for the Ports of Auckland single hub port variation.

Table 23 Summary of costs and BCR for single hub port in Auckland vs. Tauranga

Single hub port	PV Total Operating costs	PV Capital costs	PV Total costs	BCR
Port of Tauranga	$21.2b	$3.0b	**$24.3b**	-0.32
Ports of Auckland	$27.1b	$2.8b	**$29.9b**	-1.23

8 Detailed Results by Scenario

The following section presents a summary of assumptions, results and findings for each scenario.

Scenario 1: Status Quo

Scenario 1: Status Quo – 10 Ports		
Description		This Scenario reflects a continuation of current international trade operations in which all 10 ports provide international trade services and the size of vessels serving the New Zealand market remains at current levels.
Key Assumptions	Ports	Ports of Auckland, Tauranga, Napier, Taranaki, CentrePort, Nelson, Lyttelton, Otago, PrimePort and SouthPort.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 4,500 TEU vessel South East Asia Trade – 4,500 TEU vessel North America Trade – 2,700 TEU vessel Europe – 2,700 TEU vessel Trans-Tasman – 2,500 TEU vessel Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	Domestic freight flows will continue to reflect current practise. For the most part international freight will tend to flow through the nearest port.
	Coastal shipping	Under current practise the coastal shipping task is undertaken predominately by the international shipping fleet. Some containers are moved by a dedicated coastal shipping service.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 30% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Port expansion activities are required to accommodate the forecast throughput at Port of Tauranga (additional quay length, container cranes and yard upgrades) – see port capacity and capital expenditure assumptions on the opposite page. Upgrades for road connections to Ports of Auckland, MetroPort, Port of Tauranga and Port of Napier have been identified. No upgrades were identified for the rail network under this Scenario.
Findings and implications		Most ports (with the exception of Tauranga and Lyttelton) have sufficient capacity to meet forecast volumes and ship sizes. As such this Scenario results in a comparatively lower requirement for capital investment at the ports and on the road and rail networks. It has the lowest volume of domestic transport of all the scenarios as trade will mostly flow to the nearest port. Operating cost represent 97% of the total cost of $19.5 billion (PV) in the Status Quo. However, due to the lack of concentration of trade at a few major ports, it is assumed that larger vessels would not be deployed on the New Zealand trades. This is reflected in the relatively higher cost of international shipping in this Scenario, 58% of total operating costs. Domestic transport and port cost account for 31% and12% of total operating costs, respectively. The domestic freight task (in NTK) is split between road (27%), rail (31%) and coastal shipping (42%). Taking these factors into consideration, this Scenario represents the lowest overall cost of all 10 Scenarios with a total cost (including operating and capital) of $19.5 billion (PV). However, with the likely introduction of larger vessels on some of the New Zealand trades, some ports will be required to invest in new infrastructure and more cargoes will be aggregated at fewer ports. If this is the case it seems unlikely that this Scenario will be sustainable over the longer term.

10 Ports

Port capacity and capital assumptions

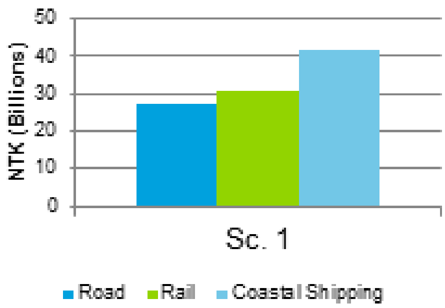
Port	Estimated capacity (TEU million p.a.) 3		Throughput (TEU million p.a.)1			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Auckland	1.40	1.40	0.64	0.79	1.10	
Port of Tauranga	1.24	1.82	0.83	0.91	1.28	$398
Port of Napier	0.51	0.51	0.20	0.23	0.32	
Port Taranaki	0.39	0.39	0.02	0.02	0.03	
CentrePort (Wellington)	0.88	0.88	0.10	0.12	0.19	
Port Nelson	0.49	0.49	0.08	0.09	0.12	
Port of Lyttelton	0.47	0.47	0.31*	0.22	0.32	
PrimePort (Timaru)	0.31	0.31	0.03	0.04	0.06	
Port of Otago	0.39	0.39	0.17*	0.16	0.23	
SouthPort	0.39	0.39	0.03	0.03	0.04	

Economic assessment

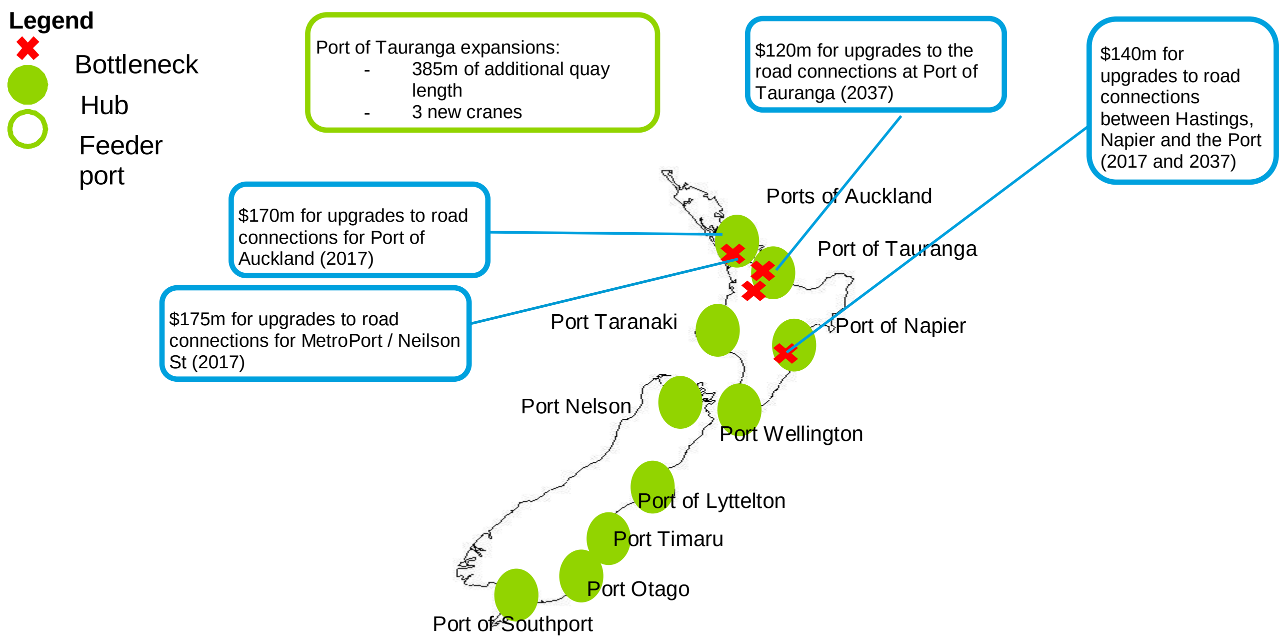
Benefit cost ratio
n/a[2]

Total cost (Present Value $ billions 2017-2046)

Total cost (Present Value $ billions)



Capacity constraints and upgrade assumptions



Notes: 1. 2012 Actual volumes are derived from the FIGS data. The 2012 base year data was affected by industrial action at Ports of Auckland – which understates the volumes that would usually pass through Auckland. Forecast volumes are generated through the model leading to some minor anomalies between actual and forecast volumes.

2. Status Quo is the 'base case' against which the benefits and costs are compared. As such it does not have a benefit cost ratio

3 Port capacity estimates for 2012 are based on quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 2: Emerging Trends

Scenario 2: Emerging Trends – 5 Hub Ports		
Description	This Scenario represents the emerging trends currently seen in the market. There is some trade consolidation through major ports in both islands (Auckland, Tauranga, Napier, Lyttelton and Port Chalmers) with the remainder becoming feeder ports ie they no longer serve international services from 2017.	
Key Assumptions	Ports	Ports of Auckland, Tauranga, Napier, Lyttelton and Otago are hub ports. CentrePort, Nelson, PrimePort, Taranaki and SouthPort would no longer serve international services beyond 2017. The volumes passing through the hub ports increase due to traffic being diverted from the smaller ports.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 4,500 TEU vessel South East Asia Trade – 4,500 TEU vessel North America Trade – 2,700 TEU vessel Europe – 2,700 TEU vessel Trans Tasman – 2,500 TEU vessel Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there are at least two hub ports in each Islands, freight moves to the nearest hub port predominantly by rail and road. Little additional coastal shipping is utilised in this Scenario.
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 30% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment	As with the Status Quo, port expansion activities (extension of quay length and new cranes) are required to accommodate the forecast throughput at Ports of Tauranga (which will also require rail yard upgrades under this Scenario) and Lyttelton. The other hub ports have sufficient capacity to meet forecast volumes. All the hub ports are able to accommodate the international vessel fleet assumed under this Scenario. Upgrades for road connections to Ports of Auckland, MetroPort, Port of Tauranga and Port of Napier have been identified. In addition, upgrades to the road connections between Hamilton and Tauranga will be required toward the end of forecast period. Upgrades to the port rail link at Port of Tauranga were also identified for this Scenario.	
Findings and implications	As international shipping services call at fewer ports cargo is moved over longer distances within New Zealand, resulting in an increase of 8% for total operating costs compared with the Status Quo ($20.5 billion compared with $19.0 billion PV under Scenario 1). The task for rail and road increase by 23% and 24% respectively and coastal shipping increases by 12%. Total cost (including operating and capital) increased from $19.5 billion in the Status Quo to $21.3 billion PV in this Scenario. As the international fleet assumptions are the same as for the Status Quo, there is no change in international shipping costs. Under this Scenario, producers who are located further away from hub ports will have higher domestic land transport costs. This will have the most impact on producers located in Taranaki, Wellington, Tasman, Nelson and Marlborough. It seems likely that this trend would be compounded if larger vessels are introduced on the various trades. This effect is analysed in subsequent Scenarios. The benefit cost ratio under this scenario is 0.19 – based on this economic analysis the Status Quo has greater merit than this scenario.	

5 Hub Ports

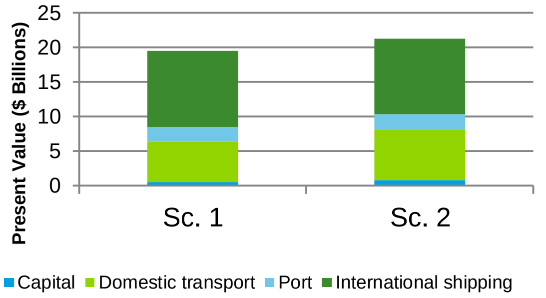
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.) 1		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Auckland	1.40	1.40	0.64	0.80	1.13	
Port of Tauranga	1.24	1.82	0.83	0.97	1.37	$408
Port of Napier	0.51	0.51	0.20	0.30	0.41	
Port of Lyttelton	0.47	0.82	0.31	0.31	0.45	$255
Port Otago	0.39	0.39	0.17	0.20	0.29	

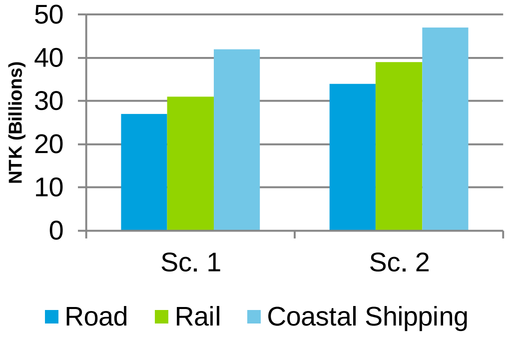
Economic assessment

Benefit cost ratio
0.19

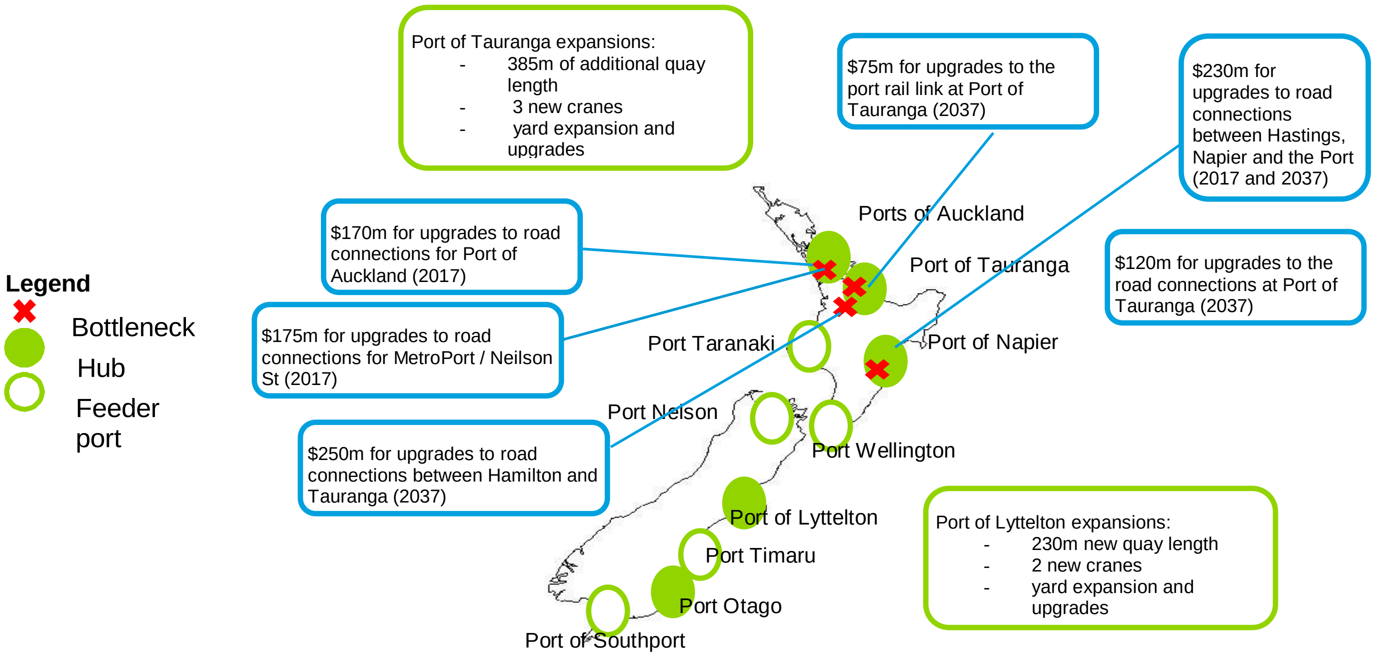
Total cost (Present Value $ billions 2017-2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1 Port capacity estimates for 2012 are based on quay length and industry benchmarks. Port capacity estimates for 2042 reflect port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 3: Partial Hub and Spoke

Scenario 3: Partial Hub and Spoke - 2 Hub Ports Per Island		
Description		This Scenario assumes two international ports in each Island serving larger vessels. The remaining ports do not serve international services beyond 2017.
Key Assumptions	Ports	Ports of Auckland, Tauranga, Lyttelton and Otago are hub ports. Ports of Napier, Taranaki, CentrePort, Nelson, PrimePort and SouthPort become feeder ports beyond 2017. The volumes passing through the hub ports increase as international trade concentrates at the hubs.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 7,000 TEU vessel in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 7,000 TEU vessel in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there are two hub ports in each island, freight moves to the nearest hub port predominantly by rail and road. As longer distances to hub ports are assumed, the level of coastal shipping utilised has increased for this scenario.
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 30% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Due to the concentration on a smaller number of ports and the introduction of larger vessels, a number of bottlenecks have been identified in the ports and on the road and rail networks. Port expansion activities are required at Ports of Auckland, Tauranga, Otago and Lyttelton to accommodate higher volumes and larger vessels (additional quay length, new quay cranes and channel and berth deepening) – see port capacity and capital expenditure assumptions on the opposite page. Road upgrades around Ports of Auckland, Port of Tauranga and between Hamilton and Tauranga will be required. Rail upgrades will be required to Port of Tauranga.
Findings and implications		As with the other Scenarios, operating expenditure is far more significant than capital expenditure (the present value of operating expenditure is $19.5 billion compared with a present value of capital expenditure of $1.6billion). Total operating costs increase by 3% under this Scenario compared with the Status quo. This increase is a significantly smaller increase than between Scenarios 1 and 2. Overall domestic transport operating costs (road, rail and coastal shipping) increase by 50%. The task for all modes increases, reflecting the increased distance travelled by some cargo. The percentage increases are 44%, 56% and 31% respectively. The increase in domestic transport costs are partially offset by a reduction in international shipping costs resulting from the realisation of the operating cost benefits of larger vessels. This result is contingent on the benefits of larger ships being realised by or passed back to cargo owners. If only 50% of the benefits of larger vessels are passed on to cargo owners operating costs will increase from $19.5 billion to $ 20.2 billion – which represents a 6% increase in total operating costs compared with the Status Quo. The total cost (including operating and capital) increases from $19.5 billion in the Status Quo to $21.7 billion PV in this Scenario. The benefit cost ratio (BCR) under this scenario is -0.01, based on this economic analysis the Status Quo has greater merit than this scenario.

2 Hub Ports Per Island

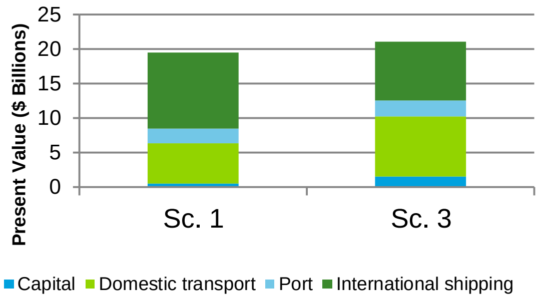
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.) [1]		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Auckland	1.40	1.59	0.64	0.80	1.13	$200
Port of Tauranga	1.24	2.67	0.83	1.51	2.15	$850
Port of Lyttelton	0.47	0.64	0.31	0.29	0.42	$355
Port Otago	0.39	0.45	0.17	0.20	0.29	$100

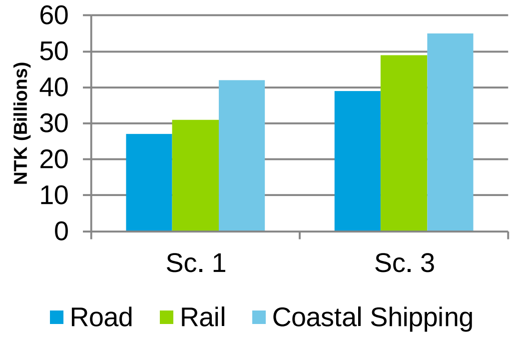
Economic assessment

Benefit cost ratio
-.01

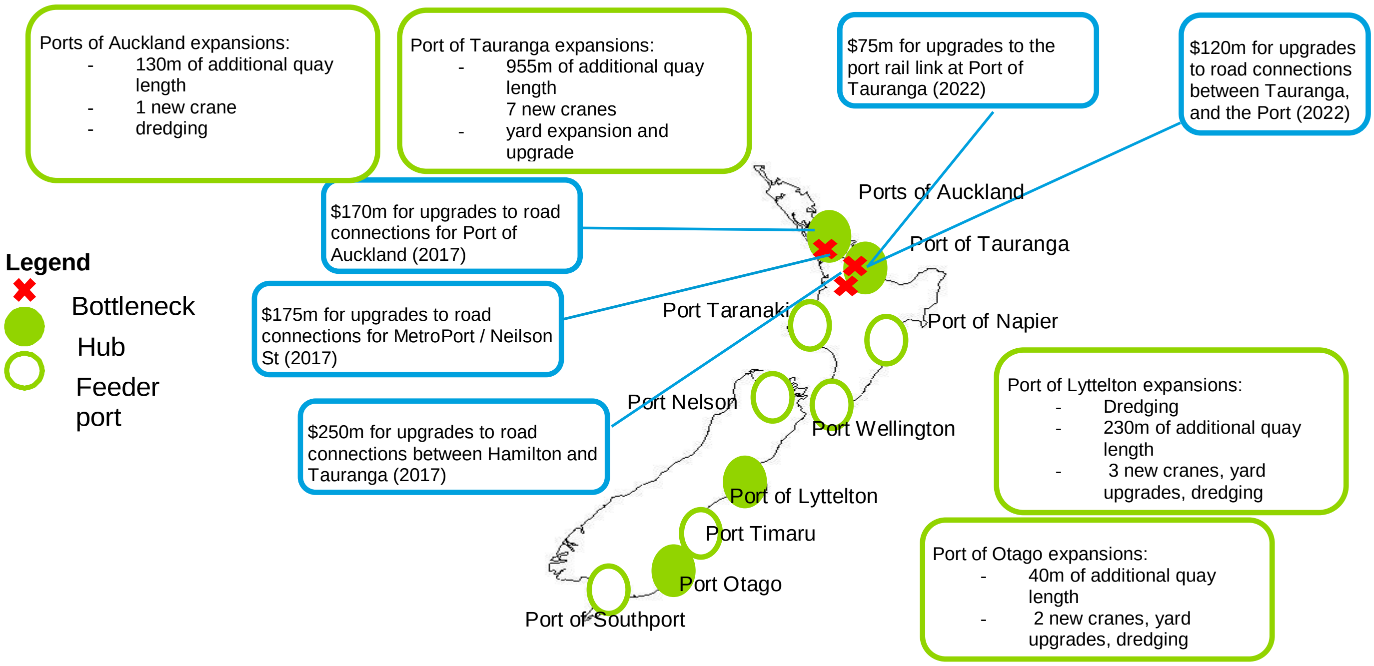
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1 Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 4: Partial Hub and Spoke

Scenario 4: Partial Hub and Spoke - 3 Hub Ports (including Lyttelton)		
Description		This Scenario assumes three international ports serving larger vessels. The remaining ports do not serve international services beyond 2017.
Key Assumptions	Ports	Ports of Auckland, Tauranga and Lyttelton are hub ports serving international services. Ports of Napier, Taranaki, CentrePort, Nelson, PrimePort, Otago and SouthPort become feeder ports beyond 2017. The volumes passing through the hub ports increase as trade concentrates on the three hub ports.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 7,000 TEU vessel in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 7,000 TEU vessel in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there are two hub ports in the North Island and one hub port in the South Island, freight will move over longer distances to reach export ports. As longer distances to hub ports are assumed, increased volumes on all domestic modes in particular rail and coastal shipping are also assumed
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 20% is assumed to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Capacity constraints arise at the international ports due to both the increased volumes through fewer ports and the introduction of larger vessels. All international ports require additional quay lengths, quay cranes, yard upgrades and dredging. This is particularly the case for Lyttelton, which will be the only international port in the South Island. Road upgrades to port connections at Auckland and Tauranga will be required as well as at MetroPort and on the road corridor between Hamilton and Tauranga. Rail upgrades will be required to the port link at Tauranga.
Findings and implications		As there is only one international port in the South Island, a significant uplift in volumes will be channelled through this port. Total operating costs (including international shipping costs) are $20.1 billion representing an increase of 6% compared with the Status Quo with overall domestic transport operating costs increasing by 57%. The rail task would increase by 78% reflecting the fewer number of ports on each Island (in particular the South Island). The use of coastal shipping increases by 45% and the use of road by 61%. As with Scenario 3, the increase in domestic transport cost is partially offset by the savings achieved through the use of larger international vessels. However, if only 50% of the benefits of larger vessels are realised by or passed onto cargo owners, total operating costs will increase from $20.1 billion to $20.7 billion – 9% higher than under Status Quo. The total cost (including operating and capital) increases from $19.5 billion in the Status Quo to $21.7 billion PV in this Scenario. The benefit cost ratio under this scenario is -0.27 based on this economic analysis the Status Quo has greater merit than this scenario.

3 Hub Ports (including Lyttelton)

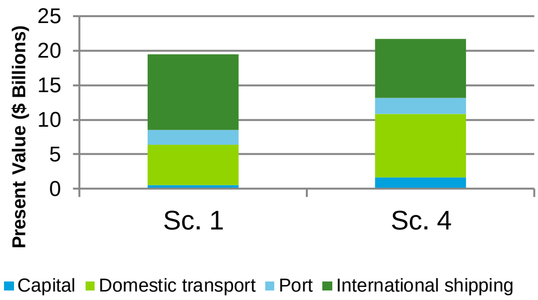
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.)[1]		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Auckland	1.40	1.59	0.64	0.79	1.11	$200
Port of Tauranga	1.24	2.67	0.83	1.48	2.10	$850
Port of Lyttelton	0.47	1.01	0.31	0.52	0.74	$465

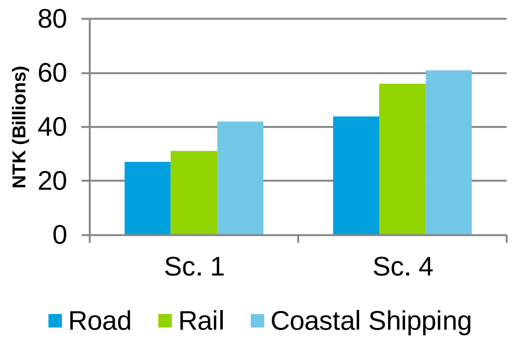
Economic assessment

Benefit cost ratio
-.27

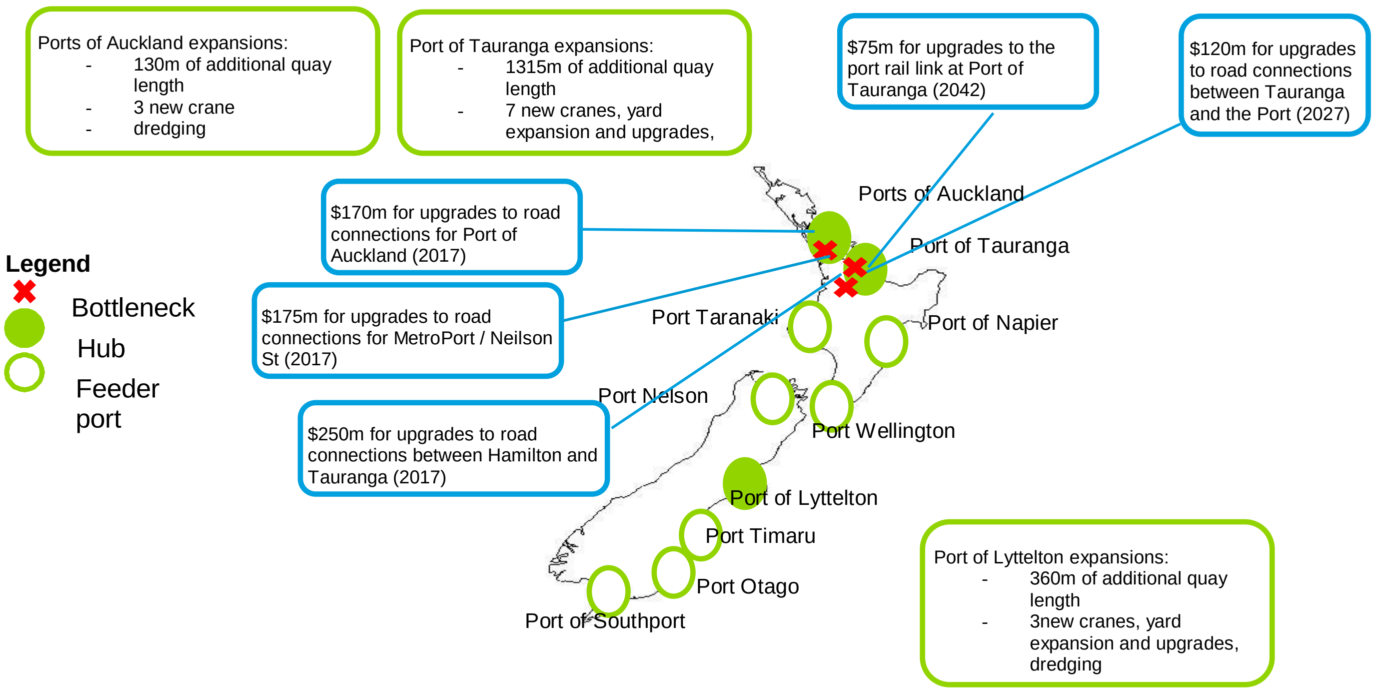
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1 Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 5: Partial Hub and Spoke

Scenario 5: Partial Hub and Spoke - 3 Hub Ports (including Otago)		
Description		This Scenario assumes three international ports serving larger vessels. The remaining ports do not serve international services beyond 2017.
Key Assumptions	Ports	Ports of Auckland, Tauranga and Otago are hub ports serving international shipping services. Ports of Napier, Taranaki, CentrePort, Nelson, PrimePort, Lyttelton and SouthPort become feeder ports beyond 2017.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 7,000 TEU vessel in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 7,000 TEU vessel in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there are two hub ports in the North Island and one hub port in the South Island freight will move over longer distances to reach export ports. We have assumed that this will result in increased volumes on all domestic modes in particular on rail and coastal shipping.
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 20% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Capacity constraints arise at the international ports due to both the increased volumes through fewer ports and the introduction of larger vessels. All international ports require additional quay lengths, quay cranes, yard upgrades and dredging. Otago, as the only international port in the South Island, will require significant capital upgrades (in excess of those required at Lyttelton). Road upgrades to port connections at Auckland and Tauranga will be required as well as at MetroPort and on the road corridor between Hamilton and Tauranga. Road upgrades will also be required between Dunedin and Port Chalmers. Rail upgrades will be required to the port link at Port of Tauranga.
Findings and implications		This Scenario generates very similar total operating cost (both domestic and international shipping costs) to Scenario 4. As Otago is the only international port in the South Island, a significant uplift in volumes will be channelled through this port. Total operating costs are $20.2 billion – an increase of 6% under this Scenario compared with the Status Quo. Total overall domestic transport cost increases by over 58% compared to the Status Quo. The rail task would increase by nearly 76% reflecting the fewer number of ports in each Island. The use of coastal shipping increases by 52% under this Scenario and road by 64% compared to Status Quo. The domestic transport costs for Scenario 4 and 5 are within 0.5% of each other. However the capital cost allowance for upgrades at Port of Otago is higher than that for Port Lyttelton under Scenario 4. There are also additional road upgrades required in this Scenario compared to Scenario 4. As with the previous two scenarios, the increase in domestic transport cost is partially offset by the savings achieved through the use of larger international vessels. If only 50% of the benefits of larger vessels are realised or passed on to cargo owners, operating costs will increase from $20.2 billion to $20.9 billion – which is 10% higher than under Status Quo. The total cost (including operating and capital) increases from $19.5 billion in the Status Quo to $22.0 billion PV in this Scenario. While there are some additional capital costs required under Scenario 5 compared to Scenario 4, on a present values basis (including both operating and capital costs) the overall difference between the two Scenarios is negligible. The benefit cost ratio under this scenario is -0.32 based on this economic analysis the Status Quo has greater merit than this scenario.

3 Hub Ports (including Otago)

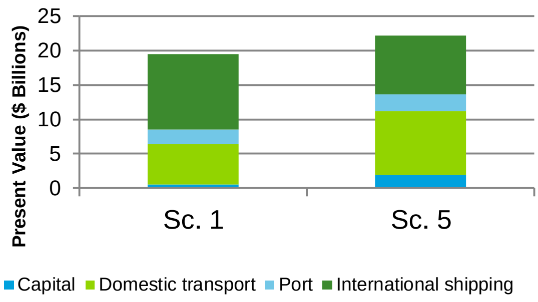
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.) [1]		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Auckland	1.40	1.59	0.64	0.79	1.11	$200
Port of Tauranga	1.24	2.67	0.83	1.45	2.05	$850
Port of Otago	0.39	1.18	0.17	0.61	0.87	$610

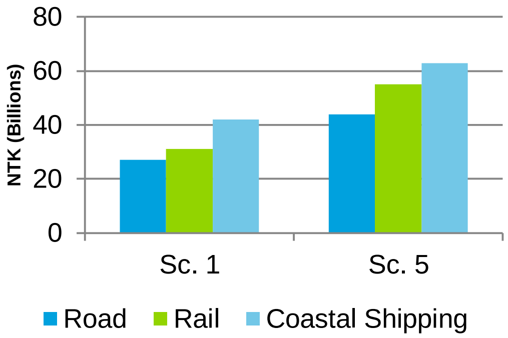
Economic assessment

Benefit cost ratio
-.32

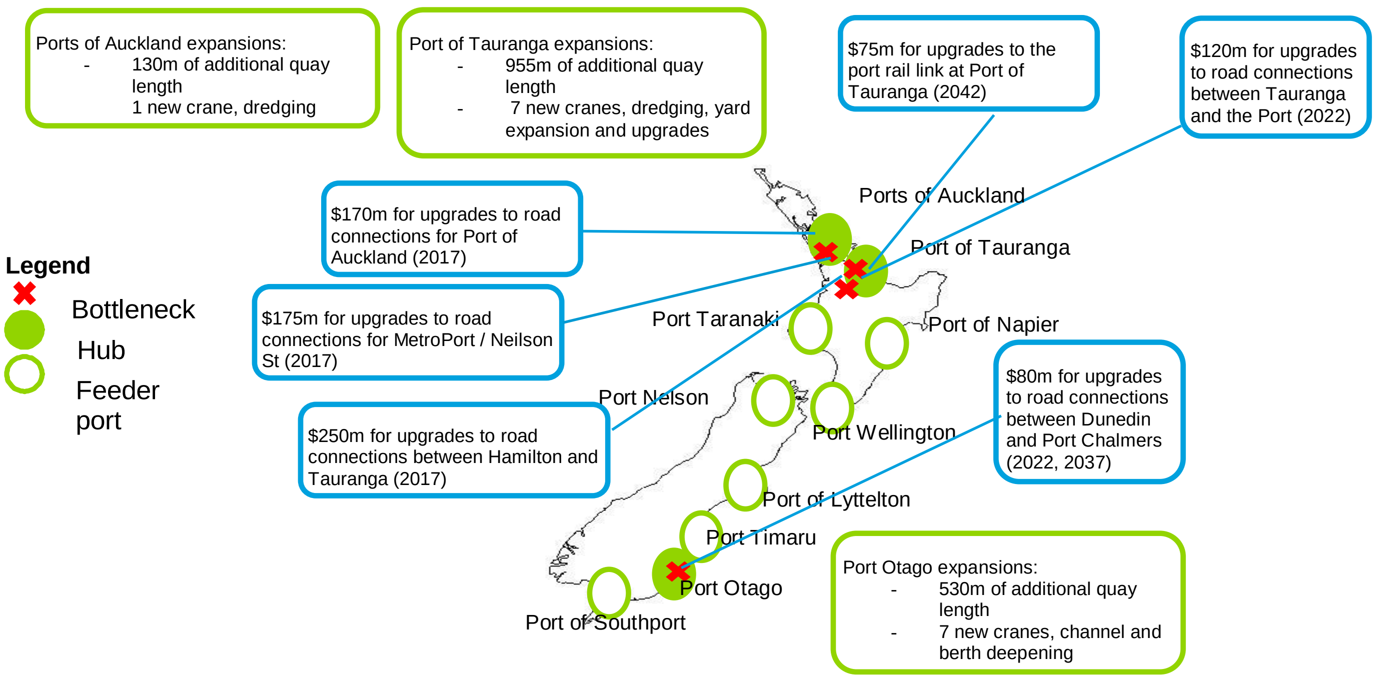
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1 Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 6: Hub and Spoke

Scenario 6: Hub and Spoke - 2 Hub Ports (Auckland/Lyttelton)		
Description		This Scenario assumes one international port in each island serving larger vessels. The remaining ports do not serve international services beyond 2017.
Key Assumptions	Ports	Ports of Auckland and Lyttelton are hub ports. Ports of Tauranga, Napier, Taranaki, CentrePort, Nelson, PrimePort, Otago and SouthPort become feeder ports beyond 2017. The volumes passing through the hub ports increase as trade concentrates on two ports.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there is one hub port in each Island, freight will move over longer distances to reach export ports. We have assumed that this will result in increased volumes on all domestic modes.
	A dedicated coastal shipping service has been assumed	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 10% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Significant port expansion upgrades would be required at both Ports of Auckland and Lyttelton, to accommodate both larger volumes and the larger vessels (particularly for the Asian trades). Ports of Auckland will require the greatest expansion due to significantly higher forecast volumes (from 0.6 million TEU in 2012 to an estimated 3 million TEU in 2042). Lyttelton throughput will expand from 0.3 million TEU to 0.8 TEU over the same period. However, due to the expanded role of coastal shipping under this scenario fewer road upgrades outside of the Auckland area would be required. No rail upgrades will be required under this Scenario.
Findings and implications		Under this Auckland-Lyttelton hub pair Scenario total operating costs is $20.4 billion – an increase of 7% compared with the Status Quo. Overall domestic transport cost increase by over 70% compared to the Status Quo. The road, rail and coastal shipping tasks would increase by 96%, 57% and 53% respectively. This significant increase in road activity is the result of the diversion of Auckland bound freight away from Tauranga to be moved directly through Ports of Auckland and then distributed by road to the Auckland region. As with the other scenarios the increase in domestic transport costs is only partially offset by the savings achieved through the use of larger international vessels. If only 50% of the benefits of larger vessels are realised or passed on to cargo owners, operating costs will increase from $20.4 billion to $21.2 billion – 12% higher than under the Status Quo. The total cost (including operating and capital) increases from $19.5 billion in the Status Quo to $22.4 billion PV in this Scenario. Significant capital cost would be incurred in upgrading both of the hub ports - Ports of Auckland in particular. Furthermore, major road upgrades would be required to road connections to the Port of Auckland. The additional capital costs required under Scenario 6 compared to the other Scenarios are significant. However as the capital costs represent a small percentage of all costs the overall impact is not great. The benefit cost ratio under this scenario is -0.55 - based on this economic analysis the Status Quo has greater merit than this scenario.

2 Hub Ports (Auckland/Lyttelton)

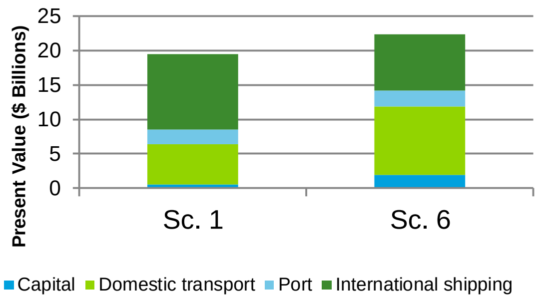
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.)[1]		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Auckland	1.40	3.81	0.64	2.16	3.03	$1,760
Port of Lyttelton	0.47	1.46	0.31	0.53	0.76	465

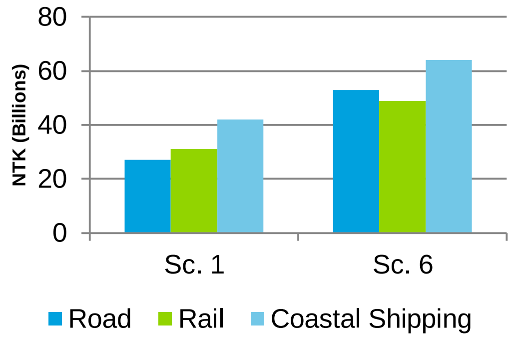
Economic assessment

Benefit cost ratio
-.55

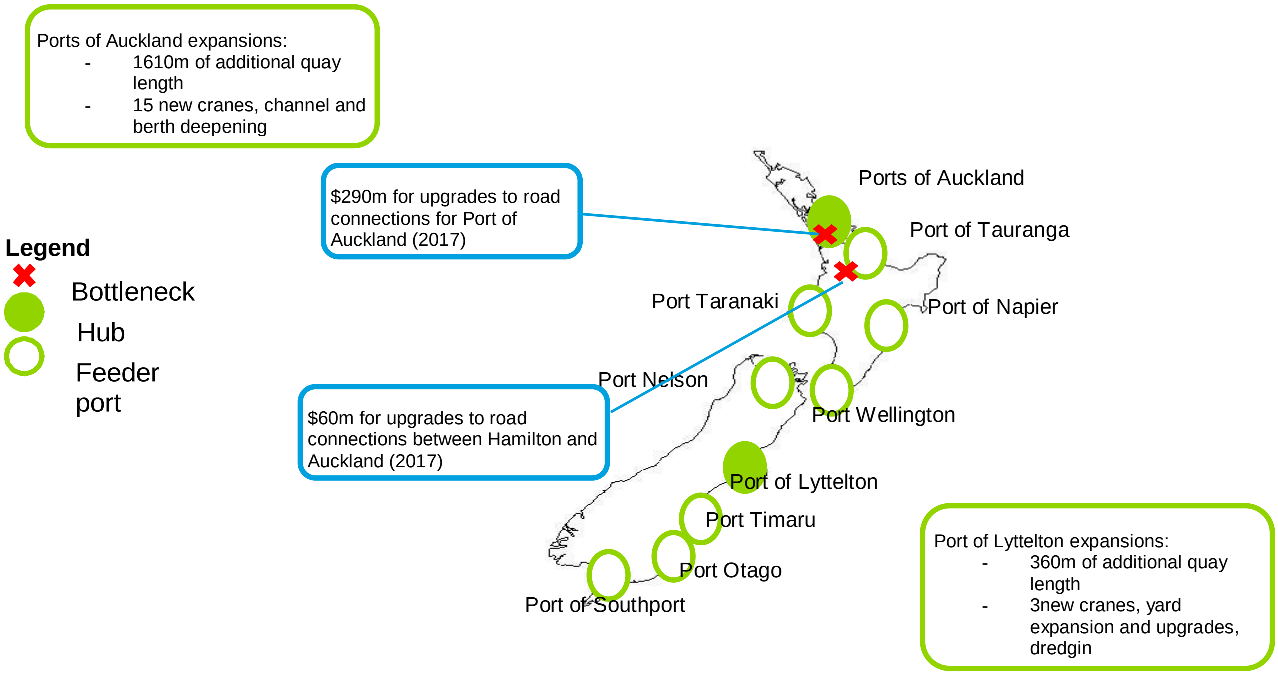
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1 Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 7: Hub and Spoke - 2 Hub Ports (Tauranga/Lyttelton)		
Description		This Scenario assumes one international port in each Island serving larger vessels. The remaining ports do not serve international services beyond 2017
Key Assumptions	Ports	Ports of Tauranga and Lyttelton are hub ports serving international shipping services. Ports of Auckland, Napier, Taranaki, CentrePort, Nelson, PrimePort, Otago and SouthPort become feeder ports beyond 2017. The volumes passing through the hub ports increase as trade concentrates on two ports.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there is one hub port in each Island, freight will move over longer distances to reach export ports. We have assumed that this will result in increased volumes on all domestic modes
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 10% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Significant port expansion upgrades would be required at both Ports of Tauranga and Lyttelton, to accommodate both larger volumes and the larger vessels (particularly for the Asian trades). Port of Tauranga will require the greatest expansion due to significantly higher forecast volumes (from 0.8million TEU in 2012 to an estimated 3.0 million TEU in 2042). Lyttelton throughput will expand from 0.3 million TEU to 0.8 million TEU over the same period). Upgrades will be required to the both the road and rail networks on the Tauranga – Auckland transport corridor to accommodate the increased freight moving over this route.
Findings and implications		Under this Tauranga-Lyttelton hub pair Scenario total operating costs are $20.9 billion – an increase of 10% compared with the Status Quo. Overall domestic transport costs increase by 79% compared to Status Quo (a further 8% higher than for Scenarios 6). Compared to the Status Quo the road, rail and coastal shipping tasks (ntk) would increase by 67%, 173% and 22% respectively. This significant increase in rail activity is the result of transporting the Auckland bound freight by rail from the Port of Tauranga. The increased land transport costs are partially offset by a fall in international shipping cost due the larger vessels assumed in this Scenario. However if only 50% of the benefits of larger vessels are realised or passed on to cargo owners, operating costs will increase from $20.9 billion to $21.7 billion – 14% higher than under Status Quo. The total cost (including operating and capital) increases from $19.5 billion in the Status Quo to $23.4 billion PV in this Scenario. Significant capital cost would be incurred in upgrading both the Ports of Tauranga and Lyttelton. Major upgrades would also be required to both the rail and road connections between Tauranga and Auckland to support the large volumes of imports destined for the Auckland region. The additional capital costs required under Scenario 7 are the third highest of the Scenarios. The benefit cost ratio under this scenario is -0.53 based on this economic analysis the Status Quo has greater merit than this scenario.

2 Hub Ports (Tauranga/Lyttelton)

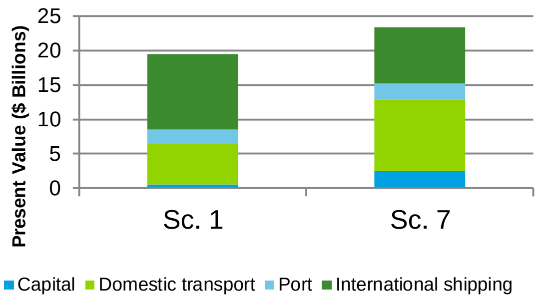
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.) 1		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Port of Tauranga	1.24	3.85	0.83	2.17	3.04	$1,885
Port of Lyttelton	0.47	1.46	0.31	0.53	0.76	$785

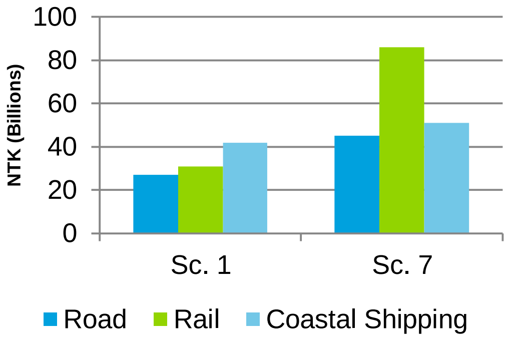
Economic assessment

Benefit cost ratio
-.53

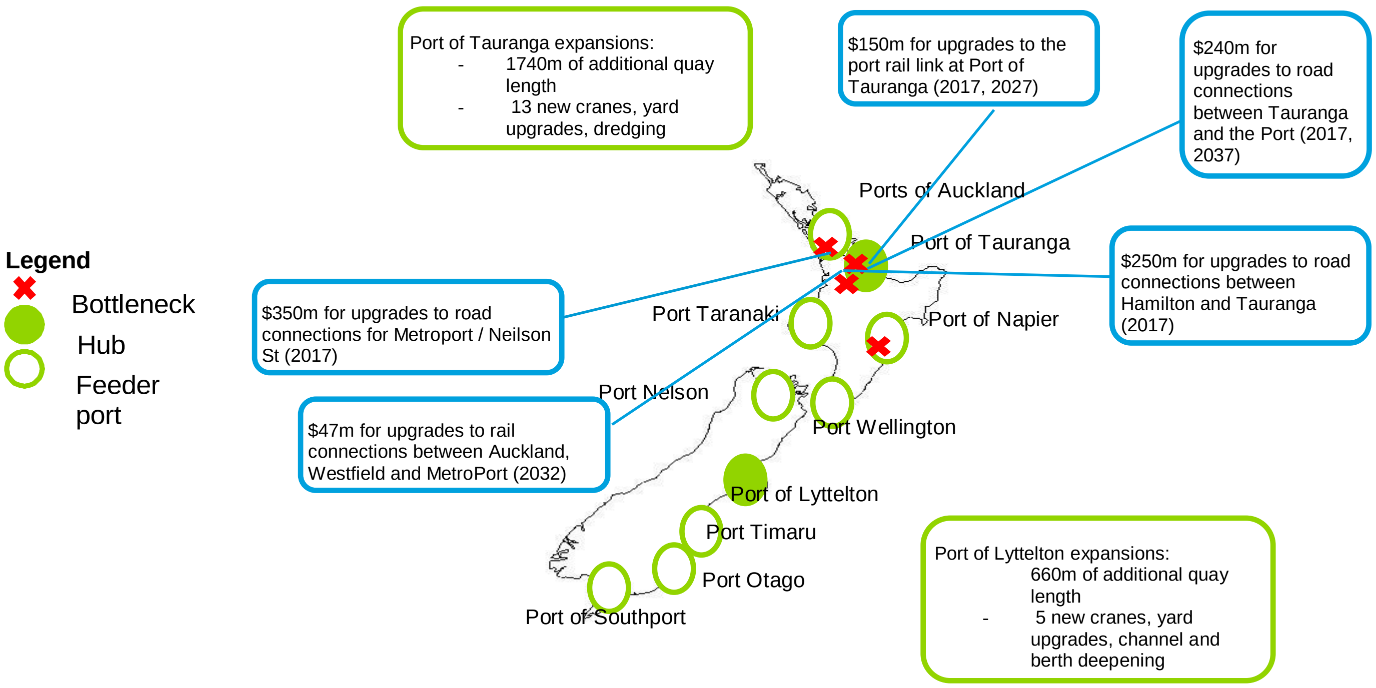
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1 Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 8: Hub and Spoke

Scenario 8: Hub and Spoke - 2 Hub Ports (Auckland/Otago)		
Description		This Scenario assumes one international port in each Island serving larger vessels. The remaining ports do not serve international services beyond 2017.
Key Assumptions	Ports	Ports of Auckland and Otago are hub ports serving international shipping services. Ports of Tauranga, Napier, Taranaki, CentrePort, Nelson, PrimePort, Lyttelton and SouthPort become feeder ports beyond 2017.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there is one hub port in each Island, freight will move over longer distances to reach export ports. We have assumed that this will result in increased volumes on all domestic modes.
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 10% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Significant port expansion upgrades would be required at both Ports of Auckland and Otago, to accommodate both larger volumes and the larger vessels (particularly for the Asian trades). Ports of Auckland will require the greatest expansion due to significantly higher forecast volumes (from 0.6 million TEU in 2012 to an estimated 3.0 million TEU in 2042). Otago throughput will expand from 0.2 million TEU to 0.9 million TEU over the same period. Upgrades will be required on roads connecting to the Ports of Auckland, between Auckland and Hamilton and between Dunedin and Port Otago.
Findings and implications		This Auckland-Otago hub pair Scenario generates a total operating cost of $20.4 billion which is 7% higher than the Status Quo. Overall domestic transport cost increase by 69% compared to the Status Quo with the road, rail and coastal shipping tasks (ntk) increasing by 92%, 39% and 66% respectively. This significant increase in road activity is the result of the diversion of Auckland bound freight away from Tauranga to be moved directly through Ports of Auckland and then distributed by road to the Auckland region. Increased domestic transport costs are partially offset by a fall in international shipping cost due the larger vessels assumed in this Scenario. However, as in the other scenarios the savings in international shipping do not completely compensate for the increased domestic transport costs increases. If only 50% of the benefits of larger vessels are realised or passed on to cargo owners, operating costs will increase from $20.4 billion to $21.2 billion – 12% higher than under Status Quo. Significant capital cost would be incurred in upgrading both the Ports of Auckland and Otago. The road connections to both ports and between Auckland and Hamilton would require upgrades. Total capital upgrades for this Scenario are very similar to Scenario 6. The total cost (including operating and capital) increases from $19.5 billion in the Status Quo to $22.4 billion PV in this Scenario. The benefit cost ratio under this scenario is -0.51 based on this economic analysis the Status Quo has greater merit than this scenario.

2 Hub Ports (Auckland/Otago)

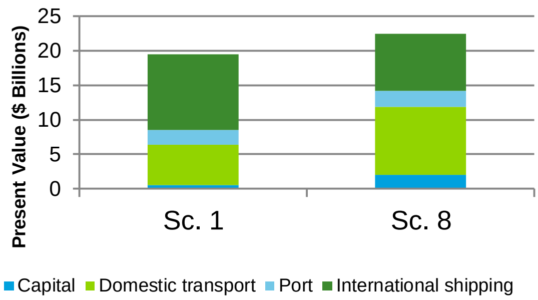
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.)[1]		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Auckland	1.40	3.81	0.64	2.16	3.03	$1,760
Port of Otago	0.39	1.12	0.17	0.61	0.88	$575

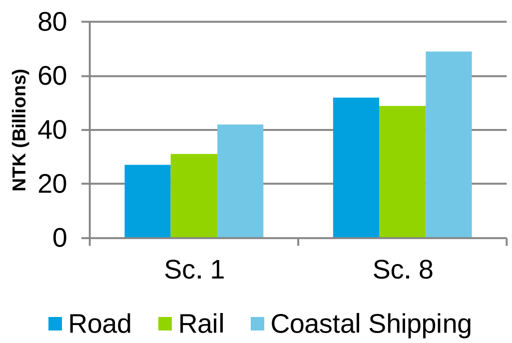
Economic assessment

Benefit cost ratio
-.51

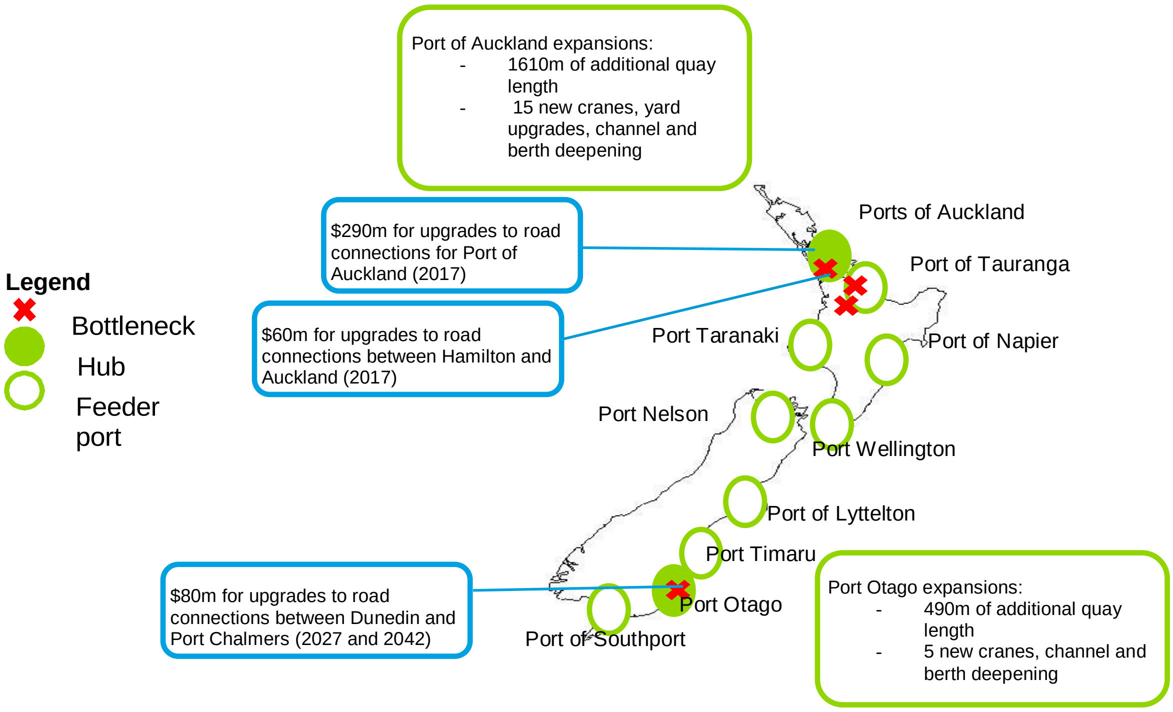
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1 Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 9: Hub and Spoke

Scenario 9: Hub and Spoke - 2 Hub Ports (Tauranga/Otago)		
Description		This Scenario assumes one international port in each Island serving larger vessels. The remaining ports do not serve international services beyond 2017
Key Assumptions	Ports	Ports of Tauranga and Otago are hub ports serving international shipping services. Ports of Auckland, Napier, Taranaki, CentrePort, Nelson, PrimePort, Lyttelton and SouthPort become feeder ports beyond 2017. The volumes passing through the hub ports increase as trade concentrates on two ports
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 8,000 TEU vessel in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there is one hub port in each Island, freight will move over longer distances to reach export ports. We have assumed that this will result in increased volumes on all domestic modes in particular rail and coastal shipping.
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake some coastal container movements between the hub ports and other ports if international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and "dead running" assumptions	For every full container move an associated empty container movement is assumed. A "dead running" factor of 10% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Significant port expansion upgrades would be required at both Ports of Tauranga and Otago, to accommodate both larger volumes and larger vessels (particularly for the Asian trades). Port of Tauranga will require the greatest expansion due to significantly higher forecast volumes (from 0.8million TEU in 2012 to an estimated 3.0 million TEU in 2042). Otago throughput will expand from 0.2 million TEU to 0.9 million over the same period. Upgrades will be required to the both the road and rail networks on the Tauranga – Auckland transport corridor to accommodate the increased freight moving over this route. Upgrades will also be required on road connections to Port Otago.
Findings and implications		The Tauranga-Otago hub pair has the highest level of operating costs for the scenarios where there is one international port in each island. This Scenario generates total operating cost of $20.9 billion, 10% higher than Status Quo. Domestic transport costs increase by 77% in this Scenario compared to the Status quo. The significant increase in rail activity compared to Scenarios 6 and 8 is the result of transporting the Auckland bound freight by rail from the Port of Tauranga. The increases in the road, rail and coastal shipping tasks (ntk) relative to the Status quo are 62%, 174% and 35% respectively. The increased domestic transport costs are partially offset by a fall in international shipping cost due the larger vessels assumed in this Scenario. If only 50% of the benefits of larger vessels are realised or passed on to cargo owners, operating costs for this scenario will increase from $20.9 billion to $21.7 billion – 15% higher than under Status Quo1. The total cost (including operating and capital) increases from $19.5 billion in the Status Quo to $23.5 billion PV in this Scenario. The benefit cost ratio under this scenario is -0.53 based on this economic analysis the Status Quo has greater merit than this scenario.

2 Hub Ports (Tauranga/Otago)

Port capacity and capital assumptions

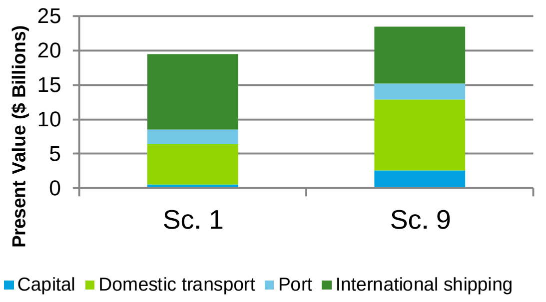
Port	Estimated capacity (TEU million p.a.) 1		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Ports of Tauranga	1.24	3.85	0.83	2.17	3.04	$1,865
Port of Otago	0.39	1.12	0.17	0.61	0.88	$575

Economic assessment

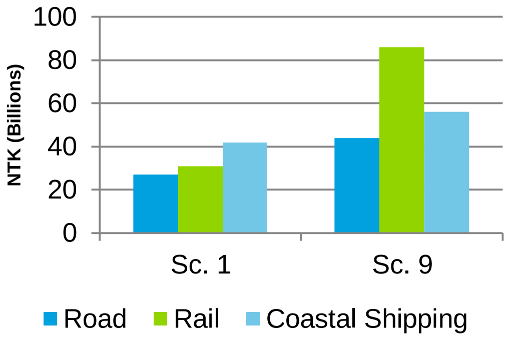
Benefit cost ratio

-.53

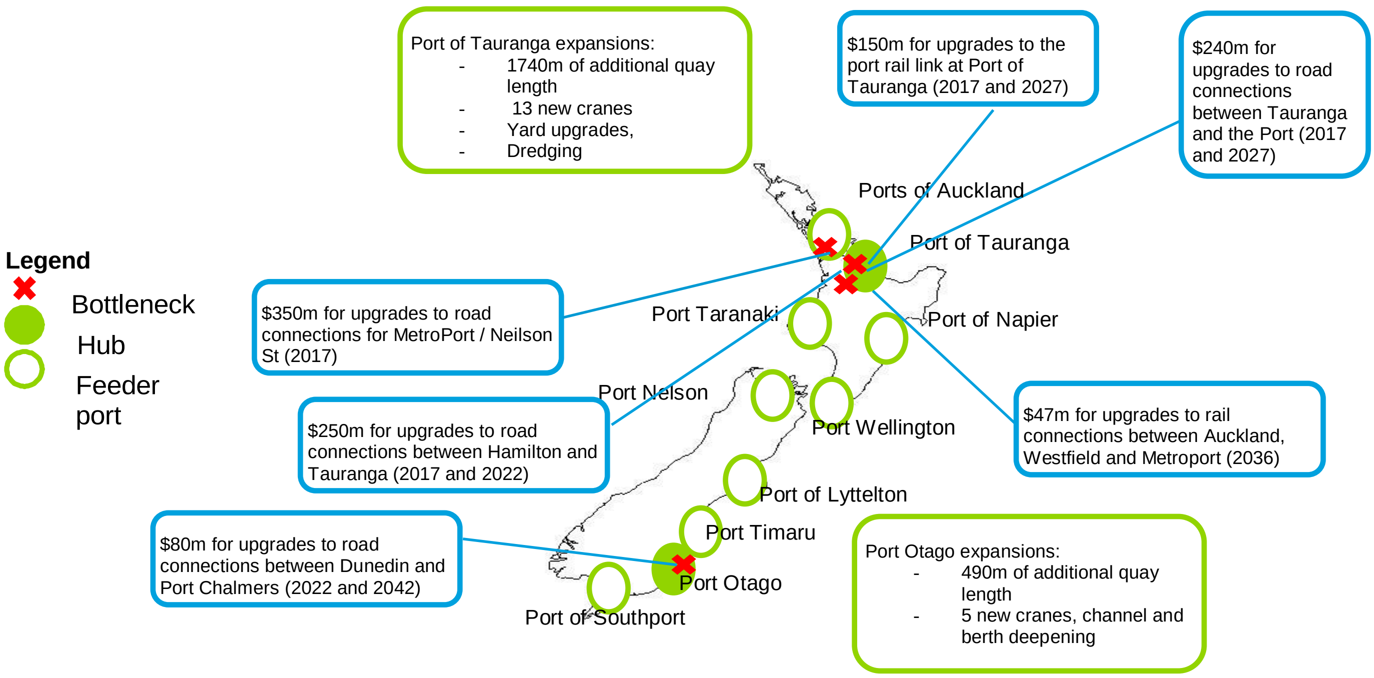
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1. Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

Scenario 10: Single Hub and Spoke

Scenario 10: Single Hub and Spoke - Single Hub Port		
Description		One international port for the whole country and all other ports stop serving international shipping services from 2017.
Key Assumptions	Ports	Single Hub Port of Tauranga – the sole international port. Ports of Auckland, Napier, Taranaki, CentrePort, Nelson, PrimePort, Lyttelton, Otago and SouthPort become feeder ports from 2017. All volumes will pass through the hub port, with a significant role played by the feeder ports.
	International fleet assumptions are based on assigning a reference vessel to each trade. The size of each vessel is measured in vessel capacity (TEU)	North East Asia trade - 6,000 TEU vessel becoming a 8,000 TEU vessel with higher utilisation in 2017 South East Asia Trade – 6,000 TEU vessel becoming a 8,000 TEU vessel with higher utilisation in 2017 North America Trade – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Europe – 2,700 TEU vessel becoming a 3,500 TEU vessel in 2017, 4,500 TEU vessel in 2027 and 6,000 TEU vessel in 2037 Trans-Tasman – 2,500 TEU vessel becoming a 2,700 TEU vessel in 2021 Assumes average vessel load of 60% of nominal container capacity (TEU)
	Domestic Freight Flows	As there is only one hub port for all international trade, freight will move towards this hub utilising road, rail and coastal shipping services.
	A dedicated coastal shipping service has been assumed.	Specialised coastal shipping services undertake coastal container movements between the feeder and the hub port. This is undertaken by a dedicated coastal shipping service as international shipping patterns are no longer suitable to support coastal movements of containers between ports.
	Empty container and “dead running” assumptions	For every full container move an associated empty container movement is assumed. A “dead running” factor of 10% is also applied to account for the repositioning of empty vehicles.
Bottlenecks and capital investment		Significant port expansion upgrades would be required at the single hub port (Port of Tauranga) to accommodate both larger volumes and the larger vessels. Under this Scenario volumes through Tauranga will increase from 0.8milliom TEU in 2012 to an estimated 5.0 million TEU in 2042 (including transhipments from the coastal shipping operations). Upgrades will be required to the both the road and rail networks on the Tauranga – Auckland transport corridor to accommodate the increased freight moving over this route.
Findings and implications		This single hub Scenario has the highest level of overall operating costs of $21.2 billion - 12% higher than for Status Quo and the highest level of total costs – including capital - of $24.3 billion. This Scenario would require the highest level of capital expenditure on road, rail and port infrastructure. Road and rail upgrades will be required to access the hub port, as well as upgrades to the road and rail corridors between Tauranga and Auckland. This Scenario relies heavily on coastal shipping to bring containers to the hub port. The coastal shipping task (NTK) increases by nearly 400% compared to the Status quo and would be nearly 200% higher than the next highest (Scenario 8). The respective increases in the road and rail freight tasks compared to the Status quo are 29% and 129%. The increase in coastal shipping will put additional pressure on capacity on the hub port, which would be required to load and unload both coastal and international vessels. Since the unit transport costs are lower for coastal shipping over long distances than road or rail, the domestic transport costs are lower than for Scenarios 7 and 9. However it is 70% higher than for Status Quo. Even though larger vessels with higher utilisation have been assumed in this Scenario, these benefits do not offset the higher domestic transport costs. If only 50% of the benefits of larger vessels are realised or passed on to cargo owners, operating costs for this scenario will increase from $21.2 billion to $22.1 billion – 17% higher than under Status Quo. The benefit cost ratio under this scenario is -0.32. - based on this economic analysis the Status Quo has greater merit than this scenario. A sensitivity analysis was undertaken to assess the impact if Auckland were the single hub port. The results showed that this would result in total costs (including operating and capital costs) of $29.9 billion – which is 23% higher than if Tauranga were the hub port. The key driver of this result is 50% higher domestic operating costs resulting from an increase of the total domestic freight task (NTK) of 28% combined with a shift from rail to road under this sensitivity. The capital cost for the Auckland option is 9% lower than for the Tauranga option. However, as capital represents 9-13% of total costs this has a negligible effect on the overall outcome. As a result the benefit cost ratio for this scenario (-1.23) indicates the worst outcome of all scenarios.

Single Hub Port

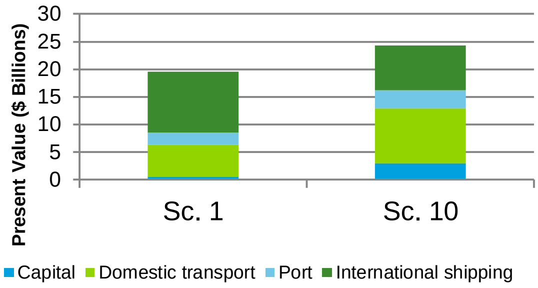
Port capacity and capital assumptions

Port	Estimated capacity (TEU million p.a.)[1]		Throughput (TEU million p.a.)			Capital (real million)
	2012	2042	2012 actual	2017	2042	
Port of Tauranga	1.23	6.01	0.83	3.52	5.00	$3020

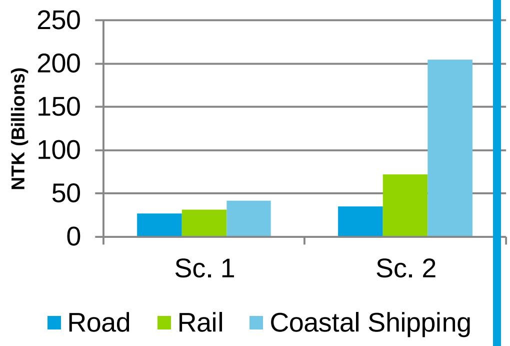
Economic assessment

Benefit cost ratio
-.32

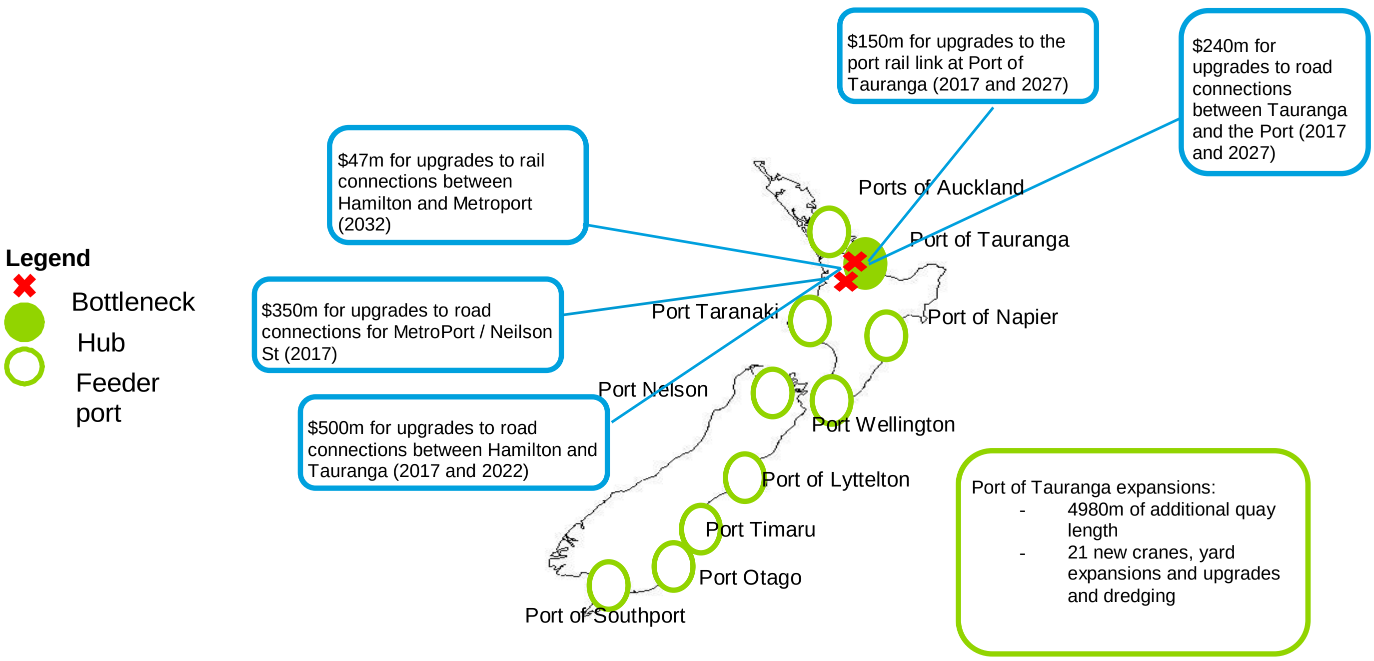
Total cost (Present Value $billions 2017 - 2046)



Cumulative domestic freight task by mode



Capacity constraints and upgrade assumptions



1. Port capacity estimates for 2012 are based quay length and industry benchmarks. Port capacity estimates for 2042 reflects port upgrade assumptions. The study assumes that hub Ports must have sufficient capacity to accommodate monthly seasonal peaks that are 20% to 30% higher than monthly averages.

9 Impacts to Cargo Owners

Each supply chain has its own characteristics, costs and commercial drivers. The impact to cargo owners under port consolidation and hubbing scenarios will be driven largely by how their own supply chain changes. Analysis has been undertaken to assess impact to cargo owners by assessing changes in the average operating costs by region and by commodity. The results (see Figure 28, Figure 29 and Figure 30) highlight the following:

- Impacts to cargo owners are driven primarily by location, rather than commodity:
    - Cargo owners located in regions close to hub ports or currently using hub ports are likely to see a reduction in supply chains costs under hub and spoke Scenarios with larger vessels (Scenarios 3 to 10). Cargo owners close to hub ports will see minimal changes in domestic transport costs but reductions in international shipping costs
    - Cargo owners located in regions close to 'feeder ports or currently using ports that would cease to service international container vessels under hub and spoke Scenarios are likely to see marginal changes or increases in supply chain costs (Scenarios 3 to 10). Cargo owners that have to travel further distances to access a hub port will see an increase in domestic transport costs. This may be offset to some extent by savings in international shipping costs.
- Very few cargo owners experience a reduction in domestic costs (transport or port costs) under any Scenario compared with the Status Quo. Any savings in domestic costs are achieved through port handling efficiencies at the hub ports
- Realising cost savings in international shipping associated with larger vessels are important in limiting the number of cargo owners who experience increased supply chains costs
- Taking into consideration total costs (including international shipping) cargo owners in Wellington and Taranaki are likely to be significantly worse off under port consolidation scenarios considered in this study. Cargo owners in Auckland, Canterbury, Waikato and Bay of Plenty are all better off (with savings greater than 15%) under some of the port hubbing scenarios.

The following trends would also be likely, however are not picked up in isolation within the scope of the FMM and the results:

- Only cargo owners moving cargo on trade routes served by larger vessels (such as the Asian trade routes) will realise cost savings under port hubbing scenarios
- Cargo owners who currently rely on a high frequency, high speed or high reliability of service under the Status Quo may be negatively impacted under port hubbing scenarios with larger vessels. As discussed in Section 4.1and Section 10, a move to larger vessels may result in fewer shipping services for New Zealand on each trade route and a reduced frequency.

Impacts to Cargo Owners by region

Figure 28 Impact by region (average change in operational costs compared to Scenario 1 – Status Quo)*

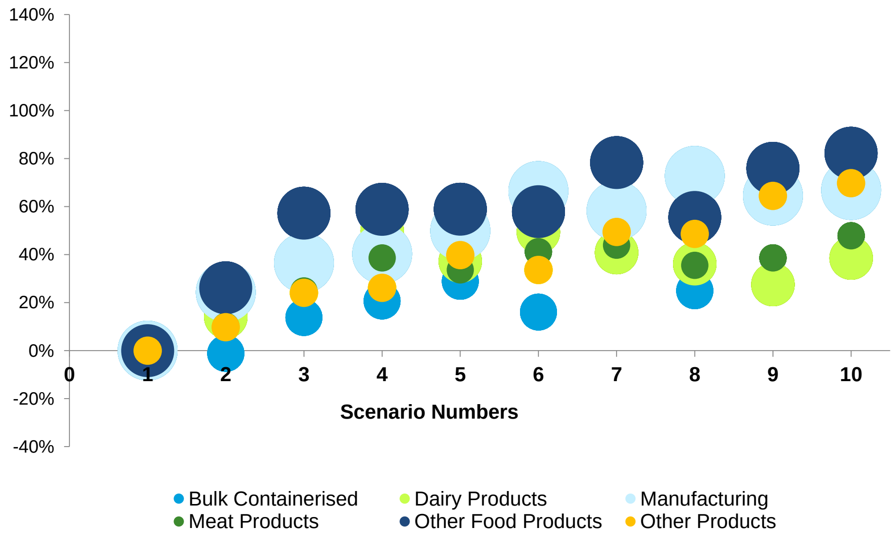
Note: Cost impacts have been derived using a weighted-average modelling technique which uses average costs and makes assumptions about mode and route choice. Therefore for the purposes of this output, a cost impact of ± 10% is not considered to be a significant change.

Colour scale					
Change in costs	Increase by >100%	Increase between 50% and 100%	Increase between 11% and 50%	No material change (change between ±10%)	Decrease by > 10%

*Since the preparation of Figure 28 a minor error in the supporting analysis has been identified related to cargo owners in Otago for Scenario 3. Average impact to total costs (incl. international shipping) for cargo owners in Otago for Scenario 3 was calculated as -10% therefore is categorised as "No material change" in the figure above. The impact is -13% and therefore should be categorised as "Decrease by >10% and should have been represented with the green colour scale.

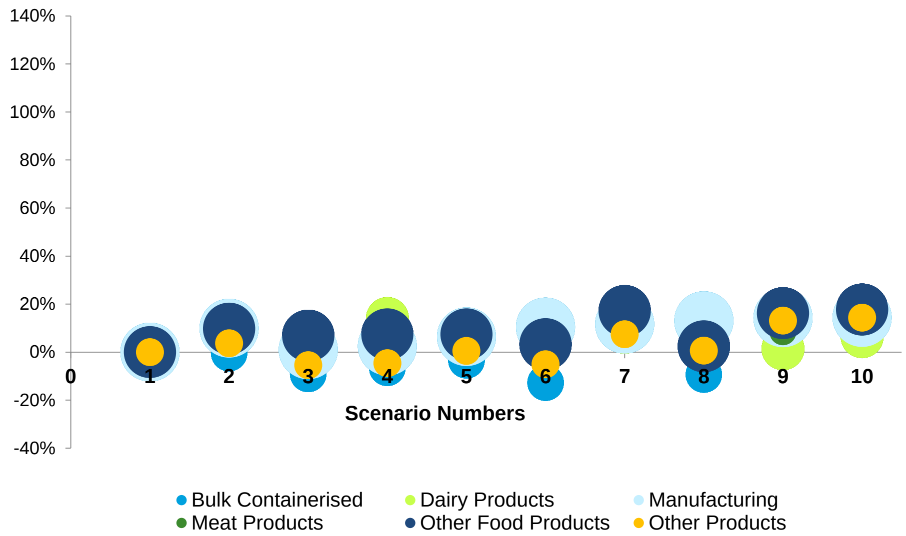
9.1 Impact to Cargo Owners by Commodity

Figure 29 Average change in operating costs compared to Scenario 1 (excluding international shipping costs) *



* Includes domestic transport and port operating costs, exclusive of international shipping
Note: bubble size represents relative size of industry by tonne.

Figure 30 Average change in operating costs compared to Scenario 1 (including international shipping costs) *



*Includes domestic transport, port operating costs and international shipping
Note: bubble size represents relative size of industry by tonne.

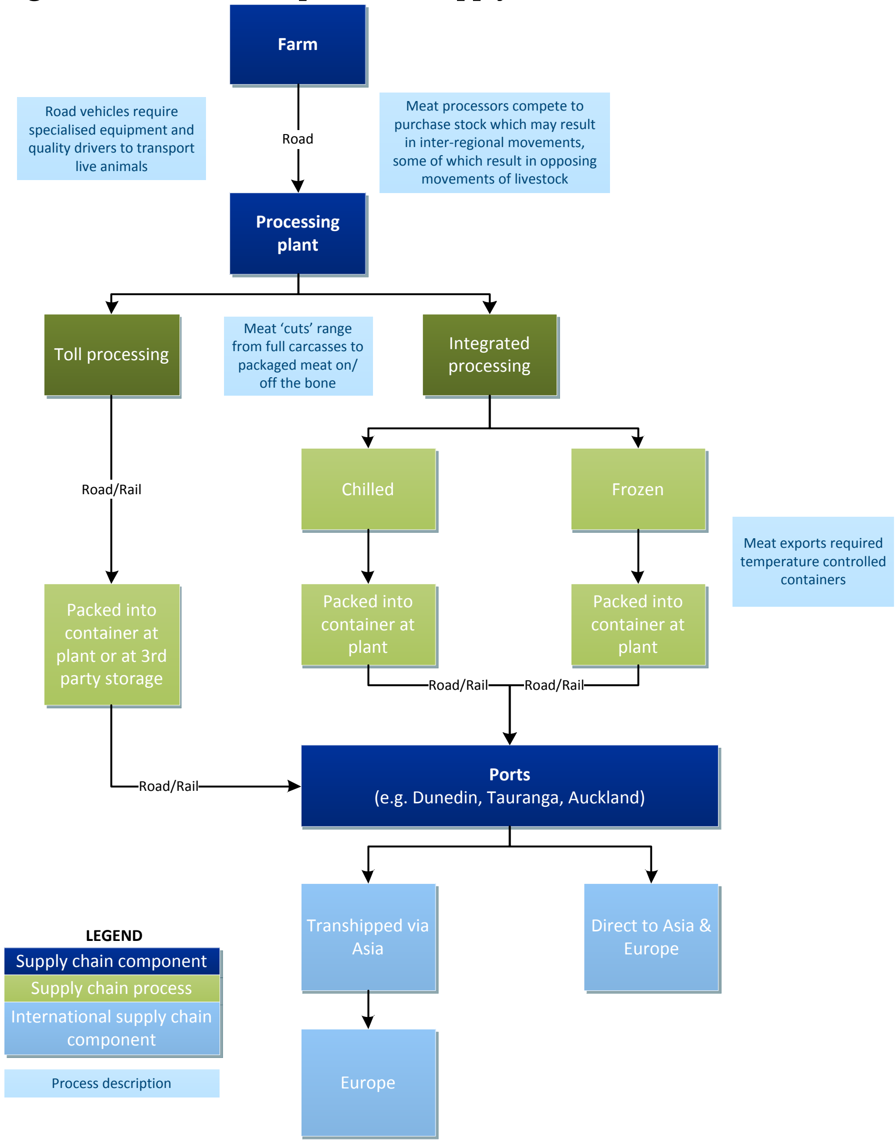
There is a little relation between the type of commodity and supply chain cost impacts, with the exception of those commodities that are concentrated in certain regions. For example, "bulk containerised" commodities tend to be better off than other commodities in Scenarios where Auckland is a hub port. This is because these commodities tend to be inputs to manufacturing and construction which is focussed in the Auckland region. Dairy also tends to be better off compared to other commodities when Port of Tauranga is the hub port, this is due to the concentration of dairy production in the Waikato and Taranaki regions.

10 Impact on export supply chains

As outlined in Section 6 our demand analysis is derived from production volumes by commodity and region. Using this information we are able to assess the impact of the various scenarios on commodity groups and regions.

However, by necessity this assessment is undertaken at a generic level. Every supply chain is different and highly complex. Individual exporters organise their supply chains to best meet the requirements of their specific markets. For example, Figure 31 demonstrates graphically a number of "pathways" export meat can take from farm to international market. As can be seen this is a very complex process with a large number of possible permutations.

Figure 31: Indicative export meat supply chains

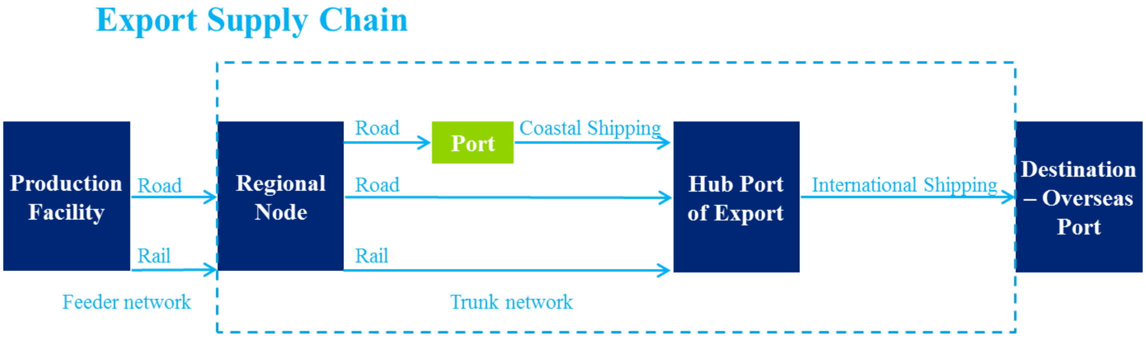


Source: NZTA Supply chain innovation: New Zealand logistics and innovation, Deloitte
http://www.nzta.govt.nz/resources/research/reports/494/

Note: Toll processing is the arrangement where a company with specialist equipment processes meat for another company that markets the product. This process is differentiated from the Integrated processing model, where the marketing and meat processing activities are undertaken by the same company (this is the more common practise in New Zealand).

Given the primary objective of the study is to assess the "whole of system" and understand the impact on the overall system it has not been possible to undertaken detailed analysis of individual supply chains. The following diagram represents the generic supply chain for exports from production facility to destination port. The specific steps identified as the "trunk network" represent the process that has been modelled.

Figure 32 Map of export supply chain



Even though our analysis is at a generic level, we can use the data generated in the modelling to gain insights into the impact of the various Scenarios on a number of selected commodities and regions.

For the purposes of comparison we have specifically selected two generic supply chains to analyse in more detail: dairy originating in Waikato and meat originating in Southland. These have been selected based on the modelling results which indicate that there will be a larger impact on meat exports originating in Southland as compared with dairy exports from Waikato. This difference is primarily driven by geographical location (that is adjacency to hub ports) rather than any specific attributes to do with the commodity. Under a Single Hub and Spoke scenario, product from Southland would be required to undertake an additional step in the process (see Figure 33) and as a result incur additional costs.

Figure 33 Meat and dairy supply chains under differing scenarios

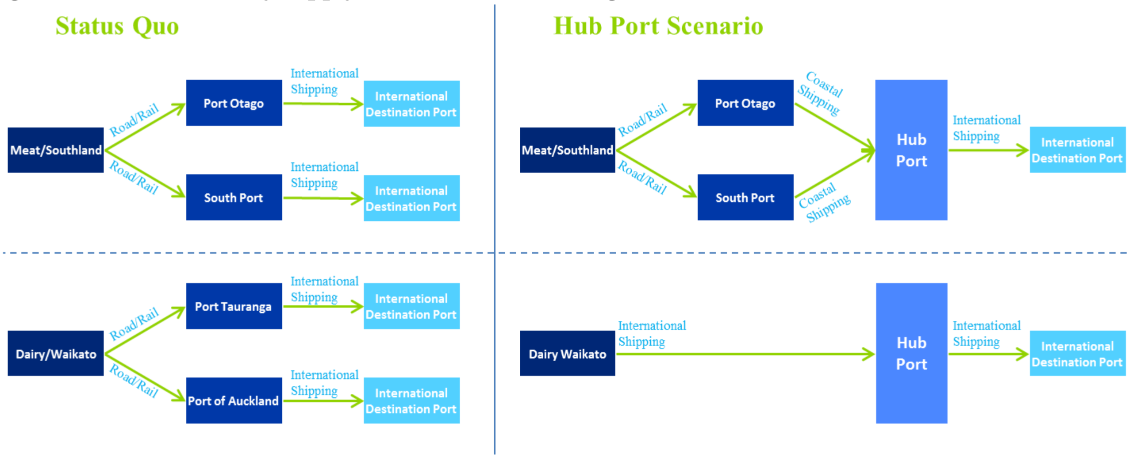


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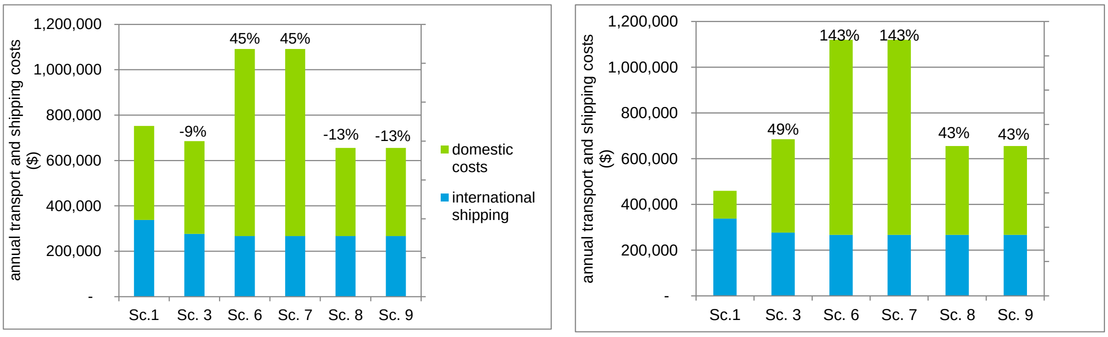
Figure 34 illustrates the impact on supply chains costs for Southland meat producers described in Figure 33. The findings highlight that fact that the impact on a cargo owner is highly dependent on their current supply chain and how this might change under a port hub scenario.

In this example, a meat exporter in Southland using Port Otago would experience a reduction in overall transport operating cost if Port Otago were to become a hub port serviced by larger (lower cost) international vessels (Scenarios 3, 8 and 9). Under scenarios where Port Otago no longer services international vessels, the exporter would experience higher transport operating costs due to having to transport goods from Southland to Lyttelton Port. A meat exporter currently using South Port is likely to have higher overall transport operating costs under all scenarios.

Figure 34 Comparison of costs for Southland meat producer

Estimated transport costs for an exporter currently using Port Otago | **Estimated transport costs for an exporter currently using South Port**



Assumes 10,000 tonnes per annum

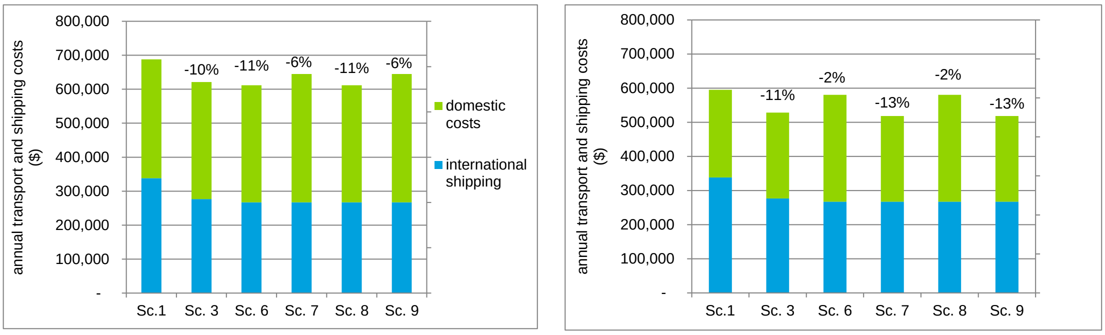
Figure 35 illustrates the impact on supply chains costs for Waikato dairy exporters described in Figure 33. Again, the findings highlight the impact on a cargo owner is highly dependent on their current supply chain and how this might change under a port hub scenario.

In this example, as the exporter is located reasonably close to the hub ports of Ports of Auckland and Port of Tauranga, they are well placed to achieve the savings associated with the larger vessels without incurring any significant increases in domestic transport costs.

In fact, the results indicate that a Dairy exporter located in Waikato currently exporting via Port of Tauranga may be able to achieve savings under all ports hub scenarios.

Figure 35 Comparison of costs for Waikato dairy producer

Estimated transport costs for an exporter currently using Port of Auckland | **Estimated transport costs for an exporter currently using Ports of Tauranga**



Assumes 10,000 tonnes per annum

In the case of a dairy producer in Waikato, it is currently lower cost to export via the Port of Tauranga. Hubbing offers benefits since the cargo owner is able to reduce shipping costs with minimal change to domestic transport costs. There is not a significant difference between the benefits of either hubbing via Auckland or Tauranga. International shipping costs are the same for both ports under all Scenarios.

In addition to the impact on the cost for exporters, transit time to market will also be affected by changes to the port call configurations. At present services to and from New Zealand are operated on a weekly schedule (excluding the Pacific North West US West Coast) service which is operated on a fortnightly basis). For the Asian and North America trades more than one service is operated, which means there is more than one service per week to those regions (but calling at different ports). The Trans-Tasman trade has one dedicated service; however, as many of the other trades rotate through the Australian east coast ports, more services can be accessed. Therefore the only trade with one service per week is the North America East Coast European trade. This service is particularly important for the chilled meat trade to Europe.

The last port of call in New Zealand for the North America East Coast European trade is Lyttelton. The transit time from Lyttelton to Tilbury (UK) is 33 days[20]. Under the status quo, meat would be transported from Southland to Lyttelton to meet the service to Europe. In a single hub and spoke scenario product would be transported by road or rail to either Otago or South Port, for transport by coastal shipping to the hub port for exchange on to the service to Europe. It is estimated that under the Hub and Spoke Scenario an extra 2 – 3 days would be added to the transit time from processing plant to international departure port **Table 24** provides an estimate of the time a container takes to travel from processing plant to international departure port under the Status Quo and under a Hub and Spoke scenario.

Table 24 Estimated transit time from processing plant to international departure port

	Despatch from processing plant	Arrive Port	Coastal Shipping	International departure port
Status Quo	Day 1	Day 2		Day 3 - 4
Single Hub & Spoke	Day 1	Day 2	Day 3 - 4	Day 5 - 6

It should be noted that the direct service transit time from Lyttelton to Tilbury (UK) is 33 days[21]. The transit time from a North Island hub port would be 32 days. So, the additional time spent on the domestic leg of the journey would in part be made up by the shorter international transit time. However, growing volumes of exports bound for Europe are being transhipped via South East Asia, resulting in longer transit times.

For examplethe transit time from Port Otago to the UK via South East Asia is 33 days plus the time spent at a transhipment port such as Singapore or Tanjung Palapas. The time spent at the transit port depends on connections between the services between New Zealand and the transhipment port and the connecting service to Europe. For example using Maersk services from Auckland to Felixstowe optimal transit times at Tanjung Palapas vary between 1 – 4 days, but could be as long as 17 days[22].

Longer transit times are generally not welcomed by exporters particularly for products with a limited shelf life (for example chilled meat) and products with a high holding cost.

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[20] http://www.cma-cgm.com/products-services/line-services/flyer/RTWPAN

[21] http://www.cma-cgm.com/products-services/line-services/flyer/RTWPAN

[22] http://my.maerskline.com/link/?page=brochure&path=/routemaps/newnetwork/asiaeur/AE1%20WEB

11 Summary of Findings

Our analysis has taken a “whole of system” assessment of the impact of port hubbing and the introduction of larger vessels on the New Zealand container trades. The impact of possible changes has been measured in terms of costs and benefits of the total supply chain under differing scenarios.

We found that overall the difference in net costs (capital and operating costs) to supply chains over all the scenarios was 24% between the highest (Sc. 10 – Single Hub Port) and lowest cost (Sc. 1 – Status Quo). Furthermore, the Status Quo Scenario (10 container ports and restrained vessel sizes) generated the lowest overall cost outcome for New Zealand supply chains.

However, industry analysis found that larger vessels are most likely to be introduced to the New Zealand trades. Furthermore, services are likely to concentrate on fewer ports, which will require upgrades to existing port and related infrastructure. This is occurring in the market at present, as international shipping services concentrate on the five main ports (Auckland, Tauranga, Napier, Lyttelton and Otago). This trend will be further accentuated by the recently announced agreement between Port of Tauranga, PrimePort and Kotahi to channel more freight through Port of Tauranga (and PrimePort). As such it seems unlikely that the Status Quo will continue as an option.

Of the scenarios that incorporated port hubbing and the introduction of larger vessels, Scenario 3 (two hub ports in each island) generated the best outcome on a NVP cost basis

In all of the scenarios operating costs were significantly higher than capital costs (between 88% and 97% of total costs). Generally, capital costs increased as the number of hub ports decreased. This is due to the concentration of cargo through fewer ports placing pressure on the road, rail and port capacity (and triggering the requirement for capital investment in upgrades).

Domestic operating costs also increased as the number of hub ports decreased. Reducing the number of ports would require a significant proportion of the cargo to be transported over longer distances (either via land or coastal shipping) within New Zealand to access an international port. There was some variation between hub scenarios, for example, those scenarios which included Ports of Auckland tended to have lower domestic transport costs due to the high proportion of imports destined for the Auckland region.

In the scenarios that included larger vessels (up to 7,000 TEU vessels for Sc.3, 4 and 5 and 8,000 TEU vessels for Sc. 6, 7, 8, 9 and 10), the increase in domestic transport costs was offset to some extent by the realisation of benefits from the larger vessels. However, these benefits are sensitive to the magnitude of the savings realised and passed on to New Zealand cargo owners. Sensitivity analysis suggests that if only 50% of the benefits are realised, this will result in an increase in international shipping costs of approximately 8% to 10% (relative to if all international shipping cost savings were passed on to cargo owners), which in turns leads to a 3% to 4% increase in total operating costs. Furthermore, port hubbing without the realisation of the benefits of larger vessels generates higher total costs for supply chains, due to higher domestic transport costs.

Our capacity analysis showed that there is sufficient capacity on most parts of the transport network to meet forecast demand under the Status Quo Scenario (Sc. 1). However, as cargo becomes more concentrated on fewer ports and vessel size increases there is a growing requirement for new capital expenditure particularly at the hub ports. Generally there is sufficient capacity on the rail and road networks, with the exception of key access routes to Ports of Auckland (road and rail), Tauranga (road and rail) and Port Otago (road). Additional road upgrades will be required on the Auckland to Hamilton route under some scenarios.

Under the one hub port scenario (Sc.10), capital expenditure is 5 times higher than under the Status Quo Scenario (Sc. 1). For all hub scenarios capital requirements at the ports are higher than that required for the other parts of the network. This is illustrated in Figure 8.

The impact of hubbing does not affect all supply chains equally. Generally, the further from a hub port that a producer is located the bigger the impact on their supply chain costs. For example, taking into consideration total costs (including international shipping) cargo owners in Wellington and Taranaki are likely to be significantly worse off under port consolidation scenarios considered in this study. Cargo owners in Auckland, Canterbury, Waikato and Bay of Plenty are all better off (with savings greater than 15%) under the scenarios where hub ports are located adjacent to these regions.

There is a little relation between the type of commodity and supply chain cost impacts, with the exception of those commodities that are concentrated in certain regions. For example, “bulk containerised” commodities tend to be better off than other commodities in scenarios where Auckland is a hub port. This is because these commodities tend to be inputs to manufacturing and construction related activities which are focussed in the Auckland region. Dairy also tends to be better off compared to other commodities when Port of Tauranga is the hub port, this is due to the concentration of dairy production in the Waikato and Bay of Plenty regions.

Analysis of selected supply chains shows that producers in Southland will have both higher costs to get product to market and will incur slower transit times than producers in the Waikato region, particularly under hub scenarios which exclude Port Otago.

The economic cost benefit analysis indicates that the projected benefit cost ratio (BCR) for all scenarios is less than 1 and almost all estimated BCRs are less than zero, an unusual phenomenon. This indicates that the do-something scenario would generate ongoing disbenefits, generally in the form of higher transport costs and associated externalities, on top of the additional quayside and landside infrastructure capital costs that would be incurred with port consolidation. What savings may be gained through lower international shipping transport costs, are outweighted by higher land transport (and associated externalities), coastal shipping, port costs and travel times.

This means that the changes in broader economic costs associated with port hubbing, as well as operating costs and capital investments, do not outweigh the economic benefits (incremental to the Status Quo – Scenario 1) under the port hubbing scenarios.

In general, whilst the CGE modelling suggests an initial boost in economic activity due to an initial increase in construction activity, this boost is offset in the longer term by lower levels of activity relative to the base case. This reflects the higher aggregate transport costs incurred under the do-something scenarios considered, which in turn adversely impacts on the productivity of the broader economy.

12 Limitation of our work

General use restriction

This report is prepared solely for the internal use of Ministry of Transport. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose set out in our contract dated 19th April 2013. You should not refer to or use our name or the advice for any other purpose.

Appendix A The FMM

1 Model Objectives

The Freight Movement Model (FMM) has been developed as a tool to support the Future Freight Scenario Study to achieve the following objectives:

- Provide a high-level, user friendly modelling tool to support the FFSS
- Prepare a robust model that can be transferred to the Ministry to support ongoing analysis of port and landside freight movements
- Generate the inputs required to undertake an economic assessment of different scenarios
- Identify infrastructure bottlenecks on the transport networks and at the ports
- Assess the potential impacts on supply chain costs for a small number of indicative export supply chains
- Flexibility to accommodate a range of port scenarios and demand levels
- Provide the ability to undertake sensitivity analysis on key supply chain variables.

The FMM seeks to replicate the movement of freight around New Zealand and to international ports under a number of port, road, rail and coastal shipping network scenarios. Key metrics for each scenario generated from the FMM include:

- Volume of freight (tonnes and TEU) through the transport and freight network
- Total national operational costs by mode
- Cost for selected supply chains (commodity and region)
- Identification of bottlenecks in the infrastructure and transport networks
- Indicative capital expenditure (and timing) for network upgrades
- Net present value of costs.

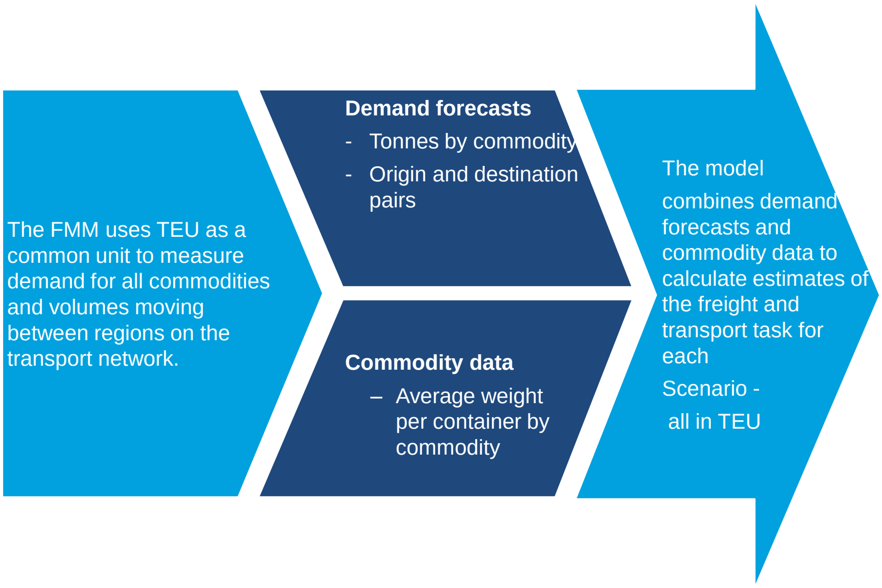
These outputs are then used as inputs to the economic impact assessment. Using the output from these models an assessment has been made of the possible impact of the international port “hubbing” scenarios considered under the FFSS.

2 Modelling approach

The FMM is very detailed but the processes undertaken within the FMM are relatively easy to understand at the conceptual level. At the simplest level, the FMM uses some assumptions and relationships about the transport networks and supply chain practices for New Zealand’s freight industry and models the transport operations required to handle the forecast demand volumes for each port scenario. A large part of the processes undertaken in the FMM is forming the relationships between the data sets in order to estimate the required outputs. The need to form relationships between the data dictates model architecture and the type and format of inputs required.

The flow charts below describe some of the processes that take place within the FMM that have a formative role in model functionality and input data requirements.

Figure 36 Step 1- Estimating the number of containers in the freight task



The movement and repositioning of empty containers plays a significant role in the transport task required to handle container trade. This adds costs to cargo owners and also consumes infrastructure capacity at ports and on the road and rail network. There is some degree of "triangulation" (reuse or sharing of containers between importers and exports located close to each other). The following factors make this practice difficult:

- A mismatch between the types of containers required for imports and exports
- A mismatch of location – much of New Zealand's imports are consumed in cities (mostly Auckland) whereas exports are produced throughout the North and South Island
- Container industry factors – containers are owned by the shipping companies and users
- Lack of information – triangulation requires a high degree of information in order to identify suitable partners coordination
- Lack of commercial drivers to facilitate the triangulation process.

As a result, most cargo owners require that an empty container be delivered/returned to the ports via an additional transport movement between their inland location and an empty container park – typically located close to ports. The impact of this is to effectively double the transport task required to move one full container (i.e. the full container leg and the corresponding delivery/pick-up of the empty container). While this is not always the case, and each supply chain has its own distinctive pattern for empty container movements, it has been used as a simplifying assumption to allow the analysis undertaken as part of this study.

Empty containers are not modelled explicitly as part of demand forecasts in the FMM however their effect on capacity and operating expenditure is considered in a number of ways throughout the analysis:

- Port throughput and capacity is measured by estimating total full container throughput (IMEX and transhipments), and adding on a factor to account for restows and empty container throughput. This factor is based on the average reported across all ports in 2012
- Trips required to handle the freight task - vehicle utilisation (expressed as average load as a percentage of capacity) is set as an input to account for the trips the vehicle makes with

empty containers - these empty movements add to the number of trips required and therefore operational costs and capacity requirements of the transport network

- Using this approach, there is an explicit assumption that empty container movements follow the same OD patterns, mode share and routes and the full container movement. No consideration is made for movements to and from empty container parks
- No assumptions have been made to accommodate changes in the empty container movements - for example triangulation or a shift of empty container parks and repair centres to offshore locations - as seen in other regions such as Australia.

Figure 37 Approximating the start and end point in each supply chain – a central node within each inland geographical region

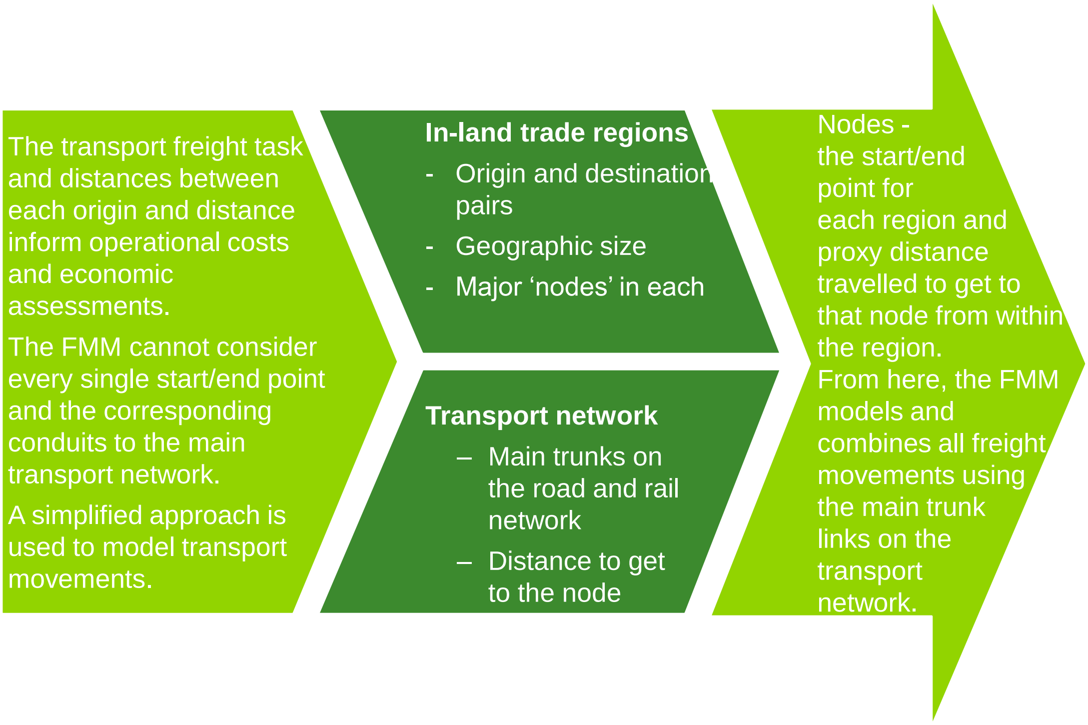


Figure 38 Estimating the routes and mode choices used to move containers from one node to another

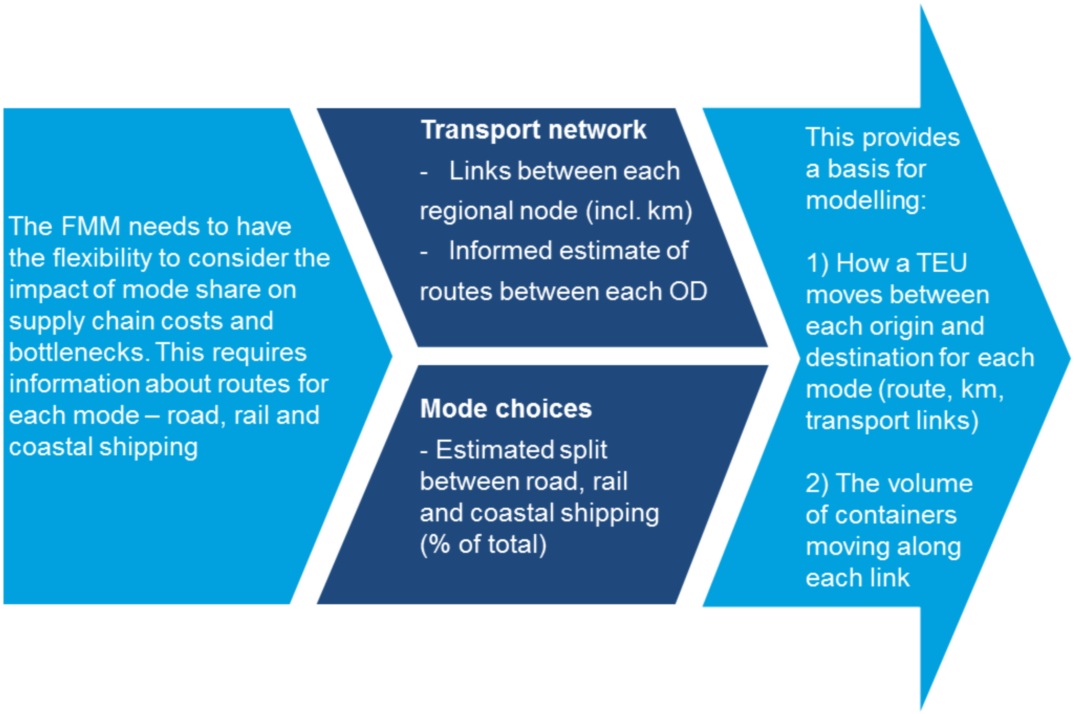


Figure 39 Modelling the supply chain, transport operations and costs required to handle the freight task

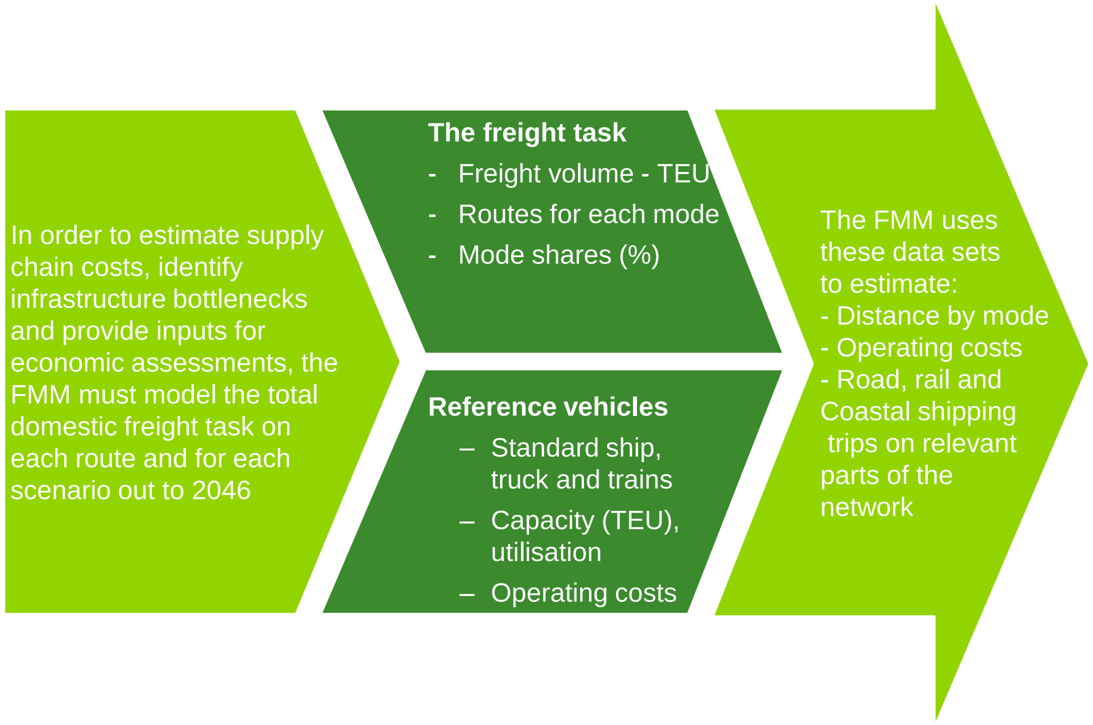


Figure 40 Identifying bottlenecks in the supply chain

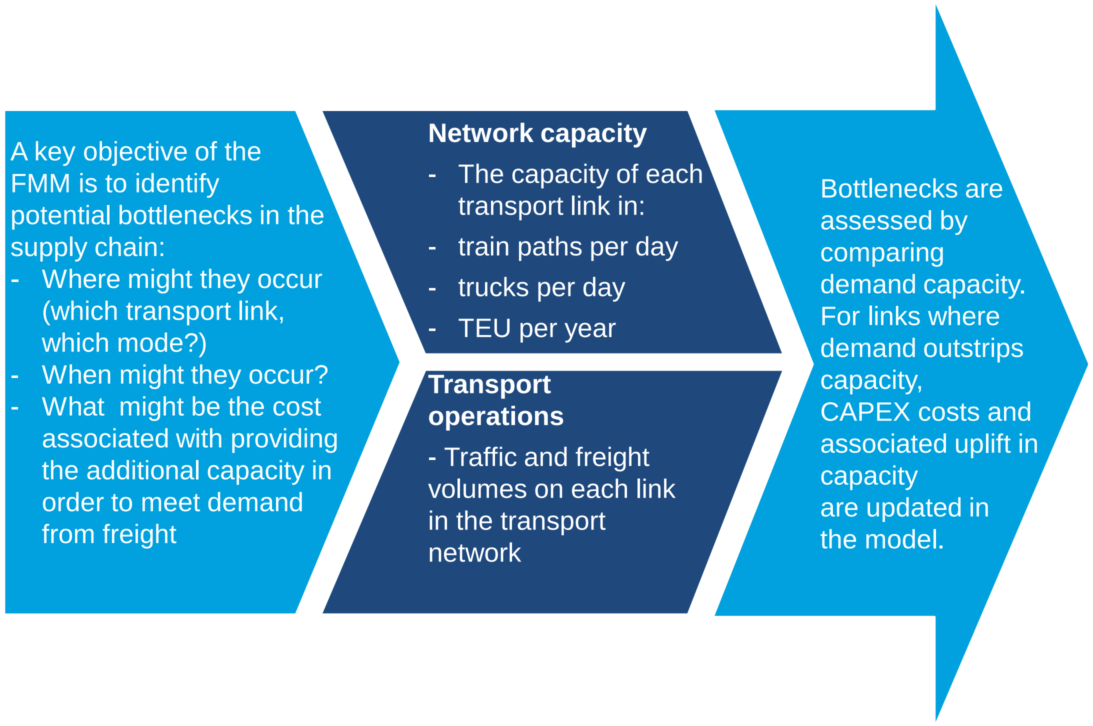
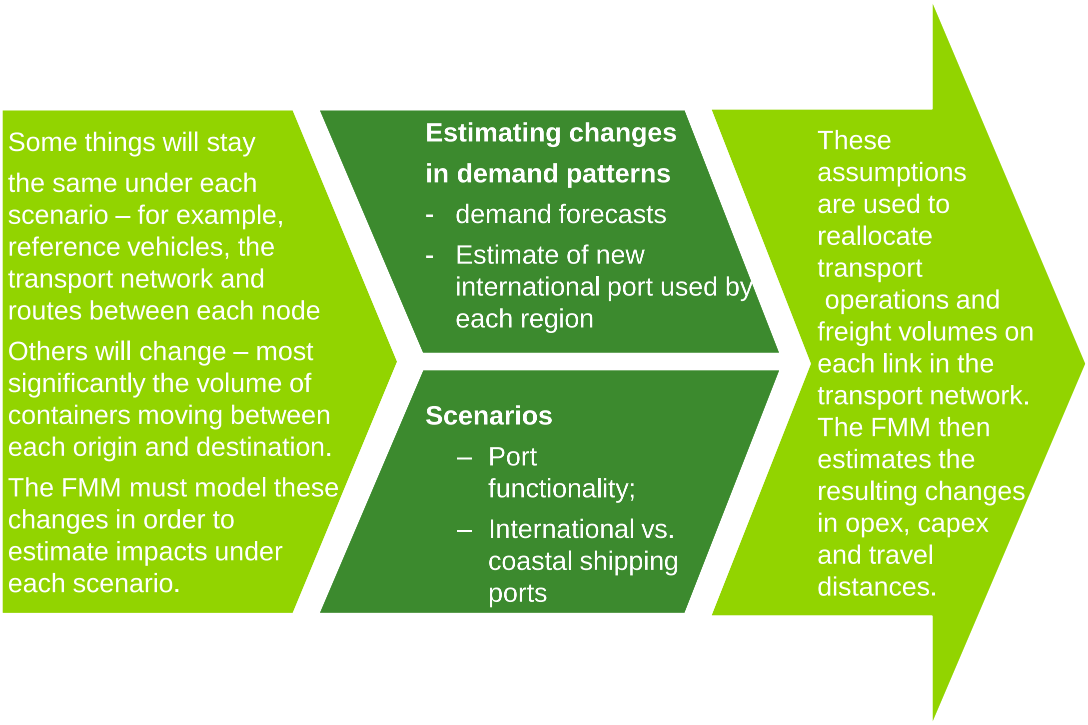


Figure 41 Modelling a new demand pattern under each scenario



3 Assumptions and limitations

3.1 Inherent assumptions

The following features of the methodology are inherent in FMM:

- The Model is underpinned by an assumption that the freight volumes and movements arising under each scenario in the model are feasible. OPEX is calculated on the assumption that sufficient capacity is provided on the transport network and at ports to meet demand. No allowance is made for increases in OPEX associated with congestion leading to higher transport costs as demand increases and bottlenecks arise
- Demand for international container freight remains the same across all scenarios and there is no adjustment in demand under scenarios. However, the freight task (NTK and port throughput) does change depending on the port configuration under each scenario
- Estimated current origin-demand patterns remain the same unless the O-D pair is affected by the FFSS scenario, in which case the volume is reallocated to an alternative IMEX port
- Operation costs are estimated in the FMM however no assessment is made of price or prices that freight customers would pay for port and transport services
- The analysis assumes that all the FMM scenarios would be in place and commence from 2017. In reality, the scenarios (should they eventuate) would not come into force for some years and there would be a staged transition from the current circumstances

- The route and mode assumptions are underpinned by an assumption that freight would continue to use its existing supply patterns unless these supply chains cease to be available under the FFSS scenarios
- Demand inputs in the model for the purposes of the FFSS considers international containerised cargo only, broken down into five major commodities presented within their own categories and another category ('other') used to capture the remainder. Demand inputs are at 5 year intervals from 2012 to 2042
- The model only considers transport demand required to handle to international container freight task. Demand and capacity assessment is based on the capacity available for freight traffic associated with the container freight task only
- Seasonality effects exist for commodities and result in the peak daily volumes being higher than the daily average. The model assumes that seasonality is driven by segment/region, not by commodity.
- Capacity is designed for peak demand – as per the seasonal peak – for port, road and rail.

3.2 Level of detail in the model

The FMM development faced a number of challenges. New Zealand's international supply chains for port freight are varied and complex. There are a large range of choices for supply chains including transport modes, routes and gateway ports where the international shipping vessels visit. Factors that drive these choices largely fit into two categories- physical/operational restrictions and commercial considerations. It is not practical to accurately model each of these individual supply chains or the potential changes to freight movements in response to future changes in port, trade and infrastructure. Nor is it necessary in order to meet the objectives and requirements of this study.

There are challenges and trade-offs associated with developing a high level model for what are nuanced, varied and ever-changing supply chain activates. The FMM is detailed enough to model supply chain operations for the total, national container freight task across all regions and possible transport modes. It must also provide sufficient detail to produce outputs to inform economic assessments and identify capacity and customer impacts. However, the model must also take into consideration the limitations of available data, data accuracy, and uncertainty around how cargo owners and players in the supply chain might actually behave under different scenarios.

To this end, the FMM has been designed to strike the right balance between accuracy and precision, flexibility and robustness, size and usability and accommodating the details of the minutia versus providing the high level macro outputs necessary to inform the study. Some of the more significant assumptions that have been made that limit the level of detail in the model are:

- To ensure that the model can be used by MoT in the future, the FMM has been developed in excel with a simple dashboard and input assumptions for testing and updating in the future. Excel was agreed to be the most user friendly format for the FMM however it introduces limitations associated with data size and model scope
- Supply chains, routes and vehicles assumed in the model are indicative, chosen to represent aggregate freight and transport operations only
- The model is not a transport model and routes and mode choice are static inputs into the model, not outputs based on route optimisation
- TEU is the unit used to convert freight volumes into containerised units that can be transported across the freight networks between origin-destination pairs. Vehicle, train and vessel capacity is also measured in TEU. No consideration is made for different container types or the breakdown of TEU, FEU and the resulting impacts on OPEX. Freight volumes

are estimated by commodity and origin-destination pairs in tonnes and converted into TEU using high level assumptions about the average tonnes per TEU for each commodity.

- Bottlenecks are defined as occurring when demand is greater than capacity. The impacts of congestion on operational costs and levels of service prior to capacity being reached are ignored in the analysis.
- A number of reference vehicles are characterised in the model inputs. Inherent in the model design is the assumption only one reference vehicle can be allocated to each section of the transport network. This reference vehicle is designed to be representative of the type of vehicle operating on a route to handle the container freight task. In reality there would be numerous different types of vehicles operating on the road or rail network at any one time – each with its own OPEX and capacity characteristics.
- Metrics and parameters required as inputs for economic analysis are calculated in the Model at five year periods from 2012 based on the freight volume assumptions for these years. These metrics include OPEX, VTKs and vehicle hours. Annual metrics and costs for years between these periods (e.g. 2013, 2014, 2015 and 2016) are approximated via interpolation assuming a constant incremental annual growth over the five year period.

3.3 Limitations

There are a number of limitations to the model methodology, these include:

- It is important to note that the Model is not a transport model, and mode choice and route selection are inputs and assumptions built into the model rather than outputs produced by the model. Nor does the model consider complete, end-to-end supply chains such as warehouse locations, container staging moves or the first/last distances undertaken from the main nodes on the transport network. It only approximates the most common routes and modes used to move containerised freight from key nodes to international gateway ports under each scenario
- No consideration of change in supply chains under port hub scenarios has been incorporated. It is likely that port hubbing would see some consolidation of freight customers around hub ports. There may also be trends towards use of rail as congestion increases. However, this is not captured in the analysis
- Capital cost estimates are based on high level, desktop analysis only. Due to the whole of system nature of the work (and the scope of the study) it has not been possible to undertake detailed analysis of each individual port or piece of the road and rail networks. The underlying assumption in the modelling methodology is that the capacity upgrades to road, rail and port infrastructure used in the model are all “feasible”. To this end high level “reference” operational and capital upgrade costs have been used across the entire network. No assessment has been made as to the physical, technical or financial ability of asset owner to undertake capacity upgrades. More detailed analysis of individual port’s, road and rail networks could be undertaken and accommodated within the model
- The model does not consider the following supply chain costs:
  - Warehousing/depot and packaging costs in New Zealand
  - Travel costs associated with any container moves from the producer/consumer on the feeder network beyond the main trunk transport infrastructure
  - Taxes and customs charges
  - International port charges

- Transport costs at the international origin/destination.

Appendix B Global assumptions and input datasets

1 Demand

1.1 Data sources

The following sources have been used as a basis to develop the demand data set used in the study:

- Freight Information Gathering System (FIGS)
- Statistics New Zealand
- National Freight Demand Study 2014
- KiwiRail and other industry expertise about major producers and consumers, supply chains and freight operations
- High level input from New Zealand Transport Authority regarding long to capital investment plans for the road network

1.2 Estimating container movements for the base year

FIGS port data provides a basis for assessing the container and commodity volumes currently moving through each container port. Port throughput includes containers that move through the ports as transhipments, restows and empty containers, as well as full import and export containers. Port throughput data has been adjusted to consider only full import and export containers as the base demand data since empty, transhipment and restows demand are derived from the full container supply chains. For consistency with the NFDS, the FFSS adopts 2012 as the base year and uses the same input data, to the extent available.

Data about the where containers start or finish within New Zealand – the domestic origin or destination - for these commodities is not tracked or recorded in the same way as ports data and some additional analysis was required in order to develop the data set required for this study. The NFDS considers OD based on 14 regions within New Zealand however the FMM requires more a granular approach. We defined 24 'nodes' – each located on the main transport network for road and rail – see Figure. All the container import and export containers that move through the New Zealand's ports are considered, under this methodology, to start or finish at one of these 24 locations.

We used data from sources including KiwiRail and local industry knowledge collected during the NFDS about importers, exporters and supply chains to allocate the throughput for each port to each of these 24 regions. This was done for each commodity code (ANSIC HS 1) and each of the major ports, and then aggregated into the following major commodity groups:

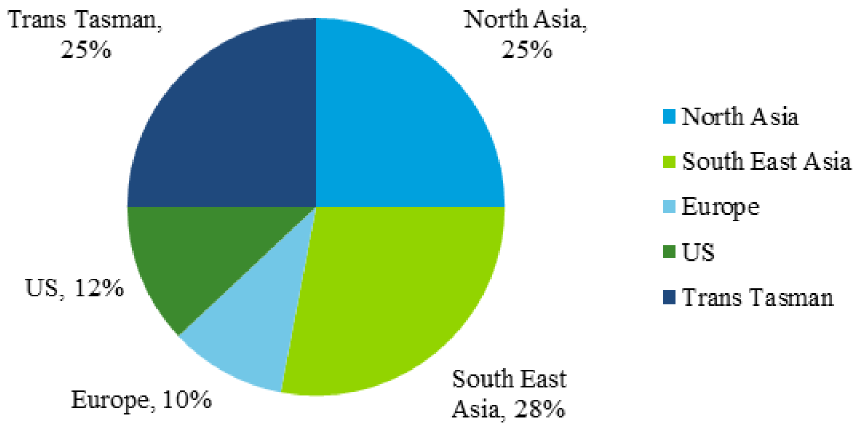
- Dairy (all dairy products)
- Meat (meat and fish products)
- Other food products (including vegetables, fruit, cereals, nuts, sauces, beverages and stock food)
- Manufacturing (including wood, paper, textiles, machinery, chemicals, plastics and rubber)
- Bulk containerised (including minerals, coal, fuel, stone, metals and glass)
- Other products – the remainder of products not captured within the categories above.

Figure 42 – Domestic locations used in the demand forecasts

Source: Image created using Fusion Tables – Google

The international container movement has been estimated at an aggregate level, rather than by commodity or for each individual node. Estimates are based on trade statistics (provided by the Ministry of Transport) for the 5 major trade regions, as reported by TCS. **Error! Reference source not found.** Figure 43 shows the breakdown of the total container freight task by trade region.

Figure 43 Breakdown of the total container freight task by trade region



Source: 2013 trade statistics, based on information provided by the Ministry of Transport

53% of international container freight is shipped to or from ports in Asia, while a further 25% moves between New Zealand and Australia – 'Trans-Tasman'.

Combining this information gives a detailed, evidence based picture of the movement of international containerised freight in 2012 including:

- The volume of international containerised trade broken down by commodity
- An estimate of the total tonnes and container numbers moving between each container port and each of the major nodes on the transport network
- An estimate of the international container movements between New Zealand and the international trade regions

Some limitations associated with this data set and the way the limitation is mitigated in our methodology:

- Empty container tasks - Since demand is forecast based on the tonnes of commodity, it does not provide a direct estimate of the empty container task. The FMM has been designed to account for empty container movements in order to allow for the significant contribution the empty container task has on freight costs and port and transport capacity
- First and last trips off the main transport network: the data does not provide a basis for estimating the precise domestic location where the full container starts or finishes its journey. This does not limit the ability of the study to estimate transport bottlenecks on the main network or to compare the changes in operating costs and economic impacts between each option since these journeys are unlikely to change between each scenario. It does mean however that the total operation costs considered in the FMM are exclusive of costs associated with trips from the main transport network to the final location.

1.3 Forecasting the future freight task

Future demand volumes have been estimated using base year volumes and detailed forecasting undertaken as part of the NFDS. The modelling undertaken as part of the NFDS estimated macro-economic indicators such as population and GDP for New Zealand and its trading partners, elasticity of demand for imports and exports and changes in land use and production practices. This analysis provided growth rates for trade by region and commodity out to 2042.

The national average for growth rates forecast from this analysis is presented in **Table 25**

Table 25 National average growth rates from 2012 by commodity

Commodity	2017	2022	2027	2032	2037	2042
Dairy Products	17.3%	38.4%	45.5%	52.9%	60.6%	68.5%
Meat Products	1.45%	7.02%	12.85%	16.99%	20.00%	22.29%
Other Food Products	10.2%	23.8%	35.7%	43.9%	49.2%	54.3%
Manufacturing	6.7%	14.6%	22.8%	31.3%	39.9%	48.8%
Bulk Containerised	6.3%	13.5%	20.8%	28.1%	35.5%	42.9%
Other Products	18.3%	39.2%	61.0%	84.1%	108.7%	134.5%

Source: Deloitte analysis

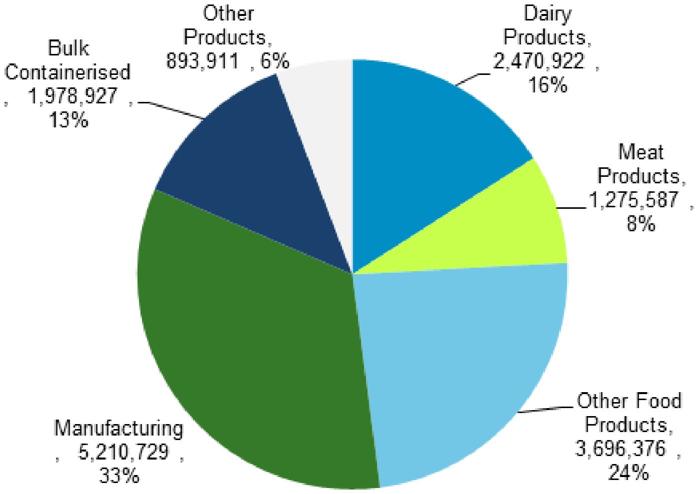
For the commodity categories of other food products and other products, the national average is reflective of the growth rates in each region. For the remaining commodity categories (dairy, meat, manufacturing and bulk containerised), there was significant variation in the growth rates between regions and the specific growth rates for each region/commodity were required in order to forecast the change in demand. This variation in regional growth rates for a given commodity was driven by some of the following indicators captured in the NFDS analysis:

- Changes in farming practices such as irrigation schemes in particular areas increasing productivity from existing farming practices
- Changes in farming practices such as irrigation schemes in particular areas resulting in changes in land use and/or increased land use for farming
- Industrial and manufacturing activities in particular areas driven by population growth, investment in mining or processing machinery or natural disasters such as reconstruction following the Christchurch earthquake
- Major areas of forest reaching maturing resulting in a major increase in yield and demand for a particular area.

1.4 Current volumes

The import and export container freight task is 15.5m tonnes in 2012 – depicted in **Figure 44**. The majority of volume is exports. Dairy, other food products and manufacturing (including wood products) – all mostly export commodities - dominate current volumes making up 73% of current freight volumes. The domestic origin for export container freight is driven by the location where the goods are produced rather than any population trends. The majority of import containers have destinations in Auckland, where the majority of goods are consumed.

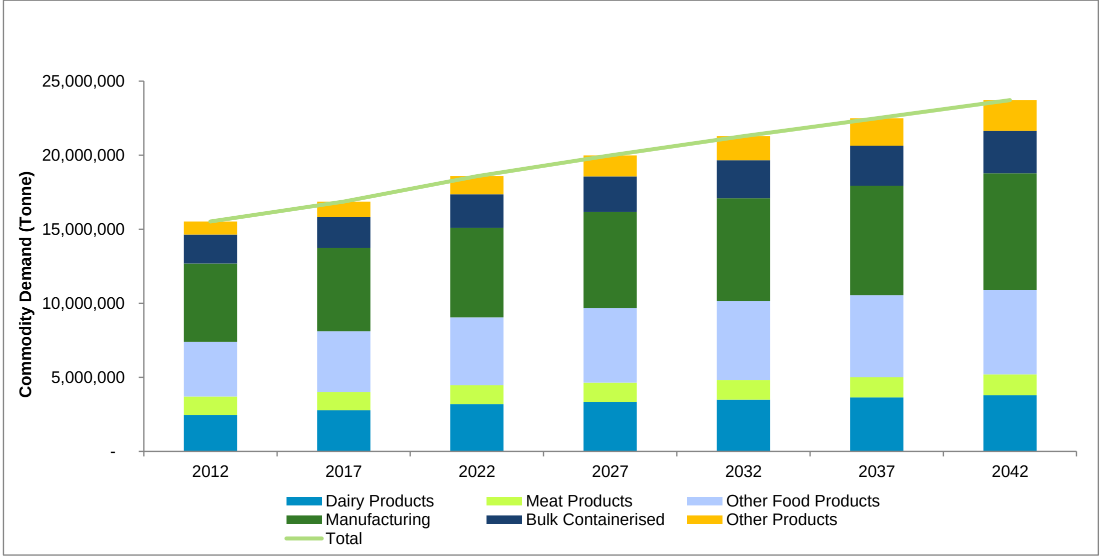
Figure 44 – Current volumes for international containerised freight (tonnes, percentage)



1.5 Forecast volumes

The volume of international containerised freight is expected to grow steadily - reaching a total of 23.7 million tonnes in 2042, representing an increase of 50% from 2012 levels.

Figure 45 Forecast volumes by commodity out to 2042



2 International Shipping

In order to calculate the all of supply chain cost from/to New Zealand from foreign port, the international shipping costs are incorporated into the FMM.

2.1 Reference Vessel Assumptions under the FFSS

The reference vessels adopted for international shipping have been chosen by scenario and trade region, based on input from FIGS, TCS and via discussions with MoT as per the tables below.

Deloitte has developed a simple shipping cost model, which generates estimates of shipping costs unit rate - $/TEU/nautical mile. Costs vary depending on the size of vessel and a number of operating assumptions e.g. ship speed, fuel price etc. The operating costs (outputs of the cost model) assumed for reference vessels considered in the FFSS are presented in the table below.

Table 26 Assumptions for International Ships

Vessel Name	Total capacity (TEU)	Draught	Operating unit cost ($/TEU/Nautical Mile)
Vessel 1 (2,500 TEU, 12m)	2,500	12	0.118
Vessel 2 (2,700 TEU, 12m)	2,700	12	0.113
Vessel 3 (3,500 TEU, 13m)	3,500	13	0.096
Vessel 4 (4,000 TEU, 13m)	4,000	14	0.089
Vessel 5 (4,500 TEU, 13m)	4,500	13	0.082
Vessel 6 (6,000 TEU, 13m)	6,000	13	0.069
Vessel 7 (7,000 TEU, 14m)	7,000	14	0.063
Vessel 8 (8,000 TEU, 15m)	8,000	15	0.058

The reference vessels adopted as reference vessels for international shipping have been chosen by scenario and trade region, based on input from FIGS, TCS and via workshops with MoT as per the tables below.

2.2 Operating assumptions

Estimates for operating costs for international vessels have been developed using a shipping model developed by Deloitte, with the following assumptions for all vessels:

- Fuel costs ($/tonne) according to bunkerworld estimates (http://www.bunkerworld.com/)
- Economic life of 20 years
- Required rate of return of 10% on investments

- Vessel operating speeds of 20 knots - this speed is lower than design speed for most vessels and is consistent with slow steaming practices
- Average vessel load of 60% of nominal container capacity (TEU)
- Time spent steam (vs. at port or in repairs etc.) – 70%.

Table 27 Scenarios 1 and 2 – reference vessel assumptions for international shipping

Trade region	2012 - 2016	2017 - 2021	2022 - 2026	2027 - 2031	2032 - 2036	2037 - 2041	2046 - 2047
North Asia	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)
South East Asia	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)
Europe	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)
US	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)
Trans-Tasman	Vessel 1 (2,500 TEU, 12m)	Vessel 1 (2,500 TEU, 12m)	Vessel 1 (2,500 TEU, 12m)	Vessel 1 (2,500 TEU, 12m)	Vessel 1 (2,500 TEU, 12m)	Vessel 1 (2,500 TEU, 12m)	Vessel 1 (2,500 TEU, 12m)

Table 28 Scenarios 3, 4 and 5 – reference vessel assumptions for international shipping

Trade region	2012 - 2016	2017 - 2021	2022 - 2026	2027 - 2031	2032 - 2036	2037 - 2041	2046 - 2047
North Asia	Vessel 6 (6,000 TEU, 13m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)
South East Asia	Vessel 6 (6,000 TEU, 13m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)	Vessel 7 (7,000 TEU, 14m)
Europe	Vessel 2 (2,700 TEU, 12m)	Vessel 3 (3,500 TEU, 13m)	Vessel 3 (3,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)
US	Vessel 2 (2,700 TEU, 12m)	Vessel 3 (3,500 TEU, 13m)	Vessel 3 (3,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)

Trans-Tasman	Vessel 1 (2,500 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)

Table 29 Scenarios 6, 7, 8 and 9 – reference vessel assumptions for international shipping

Trade region	2012 - 2016	2017 - 2021	2022 - 2026	2027 - 2031	2032 - 2036	2037 - 2041	2046 - 2047
North Asia	Vessel 6 (6,000 TEU, 13m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)
South East Asia	Vessel 6 (6,000 TEU, 13m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)	Vessel 8 (8,000 TEU, 15m)
Europe	Vessel 2 (2,700 TEU, 12m)	Vessel 3 (3,500 TEU, 13m)	Vessel 3 (3,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)
US	Vessel 2 (2,700 TEU, 12m)	Vessel 3 (3,500 TEU, 13m)	Vessel 3 (3,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)
Trans-Tasman	Vessel 1 (2,500 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)	Vessel 2 (2,700 TEU, 12m)

Table 30 Scenarios 10[1] – reference vessel assumptions for international shipping

Trade region	2012 - 2016	2017 - 2021	2022 - 2026	2027 - 2031	2032 - 2036	2037 - 2041	2046 - 2047
North Asia	Vessel 6 (6,000 TEU, 13m)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)
South East Asia	Vessel 6 (6,000 TEU, 13m)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)	Vessel 11 (Vessel 8 with higher utilisation)
Europe	Vessel 2 (2,700 TEU, 12m)	Vessel 3 (3,500 TEU, 13m)	Vessel 3 (3,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)
US	Vessel 2 (2,700 TEU, 12m)	Vessel 3 (3,500 TEU, 13m)	Vessel 3 (3,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 5 (4,500 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)	Vessel 6 (6,000 TEU, 13m)
Trans-	Vessel 1	Vessel 2	Vessel 2	Vessel 2	Vessel 2	Vessel 2	Vessel 2

Tasman	(2,500 TEU, 12m)	(2,700 TEU, 12m)	(2,700 TEU, 12m)	(2,700 TEU, 12m)	(2,700 TEU, 12m)	(2,700 TEU, 12m)	(2,700 TEU, 12m)

Note: 1. Under the single port hub scenario (Scenario 10), larger international vessels would be likely to achieve a higher utilisation and reduced operating costs to service the New Zealand market via a single port.

2. In all scenarios average vessel load of 60% of nominal container capacity (TEU) has been assumed.

3 Ports

All elements of port capacity and capital expenditure considered in the FMM and FFSS have been developed based on the following sources:

- Information provided by the ports during engagement activities undertaken as part of the FFSS
- Advice provided by AmZ Ltd – as specialist port advisor in our project team. Tony has led engagement and data collection activities with the ports and provided advice matters related to ports presented in this memo
- Supplementary analysis undertaken by Deloitte

During the engagement process, ports provided a range of information about container handling including:

- Current physical characteristics including quay length, handling system, crane, channel capacity and yard size
- Estimated existing capacity
- High level description of planned capital works (no cost estimates were provided)

3.1 Estimating OPEX

Port operating costs are unique to each port. For the purposes of this study, port tariffs to freight customers have been used proxy to estimate port operating costs. This analysis has included:

- Review of reported tariffs at all New Zealand's container ports for container services
- Review of annual reports and financial statements in order to estimate the relationship between tariffs and port operating costs for container services
- Estimate of the variation operating costs depending on:
  - Large ports vs smaller ports
  - Large vessels vs. smaller vessels

Based on this analysis, port opex unit rates have been estimated between $67/TEU (large hub port, large vessels) and $83/TEU (small ports and small vessels).

3.2 Capacity and expansion requirements

The ports all provided their own estimates of current estimated capacity, forecasts of future throughputs and planned investment and expansion activities required in order to handle their throughput targets and, in some instance, larger vessels.

For the purposes of the FMM, a standardised approach was adopted, and uniform benchmarks were used to estimate current capacity based on quay length.

The table below presents the maximum throughput per metre of berth length for container port terminals, as estimated by Drewry Shipping Consultants and a UNCTAD report in 2012 considering capacity in container port terminals. This information has been used as a basis to estimate port capacity and future expansion requirements to handle throughputs as projected under the FFSS

Table 31 Maximum throughput per metre of quay length (TEU/m p.a.)

Quay length (m)	Common user terminal
250 – 500	1,300
500 – 1000	1,600
1000+	1,700

Source: Drewry report and UNCTAD report December 2012

Based on these benchmarks we have calculated the current capacity for each port for over its current berths. This analysis suggests that all the ports have the capacity to increase throughput. For example, based on current quay length, Ports of Auckland and Tauranga could increase throughput by 78% and 67% respectively. Lyttelton Port has the lowest latent capacity of all ports reviewed. The ability of ports to match the throughput benchmark is contingent on:

- Total volume of containers moving through the port
- Productivity of quay cranes, stacking equipment, cargo marshalling, yard configuration
- Number of vessels serving the port

Table 32 Port capacity assessment

Port	Container throughput 2012/2013	Quay length	Current throughput /m/year	Potential throughput/m [1]	Max. throughput per metre of quay length	Capacity used % (based on quay length)
Ports of Auckland	780,710	870	897.37	1,600	1,392,000	56%
Port of Tauranga	741,341	770	962.78	1,600	1,232,000	60%
Port of Napier	205,941	390	528.05	1,300	507,000	41%
Port Taranaki	14,274	300	47.58	1,300	390,000	4%
CentrePort	88,335	550	160.61	1,600	880,000	10%
Port Nelson	83,362	375	222.30	1,300	487,500	17%
Lyttelton	359,640	363	990.74	1,300	471,900	76%
PrimePort Timaru	17,484	240	72.85	1,300	312,000	6%
Port Otago	180,849	300	602.83	1,300	390,000	46%
South Port	31,797	300	105.99	1,300	390,000	8%

Source: AmZLtd for MoT, and Drewry

For the major ports considered as hub ports in the port hub scenarios (Scenarios 4 to 10), additional analysis was undertaken to estimate capital expenses required:

- To expand to accommodate larger vessels

- To provide additional container yard facilities to handle significantly increased volumes.
-

The planned expansion projects reported by the ports have been incorporated into the analysis. However in most instances the scenarios considered under the FFSS give rise to throughput projections at levels far beyond the ports' own forecasts.

In order to develop the information required in the FMM, unit rates and metrics have been used to develop a reference project for port expansions – as defined below. This is based on a range of recent major port expansion activities at container ports in Australia to deliver new berths and accommodate larger vessels.

Table 33 Unit rates and metrics used to estimate CAPEX and capacity for port expansions

Parameter	Unit	Rate	Source
Post panamax crane	$/crane	$12 million	Industry data – sourced by AmZ Ltd
Average additional capacity	TEU p.a. per additional meter of quay length	1,500	See analysis below.
Average capital allowance for a major port expansion project	$/m quay length	$916,000	Indicative reference project only

In addition, the following unit rates have been assumed:

Characteristic	Unit	Assumption	Source	Comment
General allowance for dredging costs	$/m3	20	Based on available information only	highly variable depending on each context
Post panamax cranes	$	15,000,000	Based on available information only	
Max throughput - container terminal yard	TEU p.a. per hectare	30,000	Based on Container terminal capacity and performance benchmarks - Drewry	
General cost allowance for quay expansion	$/m	900,000	Based on analysis of port expansion projects	

General cost allowance for land side expansion / yard / reconfiguration works	$/hectare	300,000	highly variable depending on each context

The tables below provide a summary of the assumptions and inputs adopted for port expansion activities.

3.2.1 Ports of Auckland

Expansion project options assumed

Project	Cost allowance	Capacity uplift (TEU per annum)	Source
1 new crane, 50m additional quay length	$58m	75,000	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
80m additional berth length	$73m	120,000	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
Yard expansions	$20m	nil	Based on reference project developed by Deloitte
Reference project - 3 new cranes and 360m berth length	$365m	540,000	Based on reference project developed by Deloitte

Expansion projects assumed to accommodate bigger vessels

Vessel size	Project	Cost allowance	Capacity uplift (TEU per annum)	Source
7000 + TEU 320m long 14.5m deep	Channel widening Berth pocket deepening 3 new cranes 130 m new berth length	$200m	195,000	High level estimate only based on available information
8000 + TEU 350m long 15m deep	Channel widening Berth pocket deepening 3 new cranes 170m new berth length	$298m	255,000	High level estimate only based on available information

3.2.2 Port of Tauranga

Expansion project options assumed

Project	Cost allowance	Capacity uplift (TEU per annum)	Source
1 new crane, 150m additional quay length	$150m	255,000	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
2 new cranes, 235m additional quay length	$239m	352,000	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
Yard expansions	$20m	nil	Based on reference project developed by Deloitte
Reference project - 3 new cranes and 360m berth length	$365m	540,000	Based on reference project developed by Deloitte

Expansion projects assumed to accommodate bigger vessels

Vessel size	Project	Cost allowance	Capacity uplift (TEU per annum)	Source
7000 + TEU 320m long 14.5m deep	Channel widening Berth pocket deepening 235 m new berth length	$80m	352,000	High level estimate only based on available information
8000 + TEU 350m long 15m deep	Channel widening Berth pocket deepening 2 new cranes 130m new berth length	$385m	450,000	High level estimate only based on available information

3.2.3 Port Otago

Expansion project options assumed

Project	Cost allowance	Capacity uplift (TEU per annum)	Source

130m additional quay length	$119m	195,000	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
Yard expansions	$20m	nil	Based on reference project developed by Deloitte
Reference project - 3 new cranes and 360m berth length	$365m	540,000	Based on reference project developed by Deloitte

Expansion projects assumed to accommodate bigger vessels

Vessel size	Project	Cost allowance	Capacity uplift (TEU per annum)	Source
7000 + TEU 320m long 14.5m deep	Channel widening Berth pocket deepening 2 new cranes 40m new berth length	$100m	60,000	High level estimate only based on available information
8000 + TEU 350m long 15m deep	Channel widening Berth pocket deepening 2 new cranes 130m new berth length	$207m	195,000	High level estimate only based on available information

3.2.4 Lyttelton Port

Expansion project options assumed

Project	Cost allowance	Capacity uplift (TEU per annum)	Source
2 new cranes, 230m additional quay length	$235m	345,000	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
1 new crane, 110m additional quay length	$113m	165,000	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and

			AmZ Ltd
Yard expansions	$20m	nil	Based on reference project developed by Deloitte
Reference project - 3 new cranes and 360m berth length	$365m	540,000	Based on reference project developed by Deloitte

Expansion projects assumed to accommodate bigger vessels

Vessel size	Project	Cost allowance	Capacity uplift (TEU per annum)	Source
7000 + TEU 320m long 14.5m deep	Channel widening Berth pocket deepening 2 new cranes 230m	$80m	345,000	High level estimate only based on available information
8000 + TEU 350m long 15m deep	Channel widening Berth pocket deepening 2 new cranes 300m new berth length	$400m	450,000	High level estimate only based on available information

Metrics to guide capacity analysis for FFSS

Characteris	Unit	Assumption	Source	Comment
General allo	$/m3	20	Based on avalaible inf	highly variable depending on each context
Post panam	$	15,000,000	Based on avalaible inf	New Zealand Shippers' Council - 2010
Max through	TEU p.a. pe	1,300	Drewry report and UNCTAD report	
Max through	TEU p.a. pe	1,600	Drewry report and UNCTAD report	
Max through	TEU p.a. pe	30,000	Based on Container terminal capacity and performance	
General cos	$/m	900,000	Based on analysis of port expansion	
General cos	$/hectare	300,000		highly variable depending on each context

Current characteristics

characteris	definition	current	max. capacity
Max draugh	max vessel (	13.9	
Max draugh	max vessel \	11.4	
Berth pocke	depth (m)	14.3	
Vessel lengt	max vessel l	350	
Quay length	container sp	870	1,392,000
Cranes - pa	no.	3	
Cranes - po	no.	5	
Storage lan	container ya	116	3,480,000

Expansions required to accommodate larger vessels

Vessel cha	Vessel 1	Vessel 2
Name	[redacted]	
TEU capaci	8200	7403
Draught/dep	15	14.5
Width (m)	42.8	42.8
Length (m)	347	318

Works required			
Channel de	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth pocke	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth length	170	130	*Source - New Zealand Shippers' Council - 2010*
New cranes	3	3	*Source - New Zealand Shippers' Council - 2010*
Port estimat	unknown	200	*Source - New Zealand Shippers' Council - 2010*
Estimate	see table be	N/A	Assumption

Basis of es	Unit	unti rate	Qty	Cost	uplift in capacity* (based on quay length)	
Channel de	m3	20	5,000,000	$ 100,000,000		
Berth pocke	m3	20		$ -		
New cranes	no	15,000,000	3	$ 45,000,000		
Quay length	m	900,000	170	$ 153,000,000		
Estimate				**$ 298,000,000**	**255,000**	(TEU p.a.)

Bottleneck and capacity analysis - lookup table

Assume por Yes 1

Throughpu	Yard area	Yard capacity	Bottleneck	Quay length	Quay capacity	Bottleneck	Yard expan	Quay expansion (m)		Capital cost*
1,100,000	116	3,480,000	No	1040	1,664,000	No				$ -
1,200,000	116	3,480,000	No	1040	1,664,000	No				$ -
1,300,000	116	3,480,000	No	1040	1,664,000	No				$ -
1,400,000	116	3,480,000	No	1040	1,664,000	No				$ -
1,500,000	116	3,480,000	No	1040	1,664,000	No				$ -
1,600,000	116	3,480,000	No	1040	1,664,000	No		360		$ 367,200,000
1,700,000	116	3,480,000	No	1400	2,240,000	No				$ -
1,800,000	116	3,480,000	No	1400	2,240,000	No				$ -
1,900,000	116	3,480,000	No	1400	2,240,000	No				$ -
2,000,000	116	3,480,000	No	1400	2,240,000	No				$ -
2,100,000	116	3,480,000	No	1400	2,240,000	No				$ -
2,200,000	116	3,480,000	No	1400	2,240,000	No		360		$ 367,200,000
2,300,000	116	3,480,000	No	1760	2,816,000	No				$ -
2,400,000	116	3,480,000	No	1760	2,816,000	No				$ -
2,500,000	116	3,480,000	No	1760	2,816,000	No				$ -
2,600,000	116	3,480,000	No	1760	2,816,000	No				$ -
2,700,000	116	3,480,000	No	1760	2,816,000	No				$ -
2,800,000	116	3,480,000	No	1760	2,816,000	No		360		$ 367,200,000
2,900,000	116	3,480,000	No	2120	3,392,000	No				$ -
3,000,000	116	3,480,000	No	2120	3,392,000	No				$ -
3,100,000	116	3,480,000	No	2120	3,392,000	No				$ -
3,200,000	116	3,480,000	No	2120	3,392,000	No				$ -
3,300,000	116	3,480,000	No	2120	3,392,000	No				$ -
3,400,000	116	3,480,000	No	2120	3,392,000	Yes		360		$ 367,200,000
3,500,000	116	3,480,000	Yes	2480	3,968,000	No	20			$ 6,000,000
3,600,000	136	4,080,000	No	2480	3,968,000	No				$ -
3,700,000	136	4,080,000	No	2480	3,968,000	No				$ -
3,800,000	136	4,080,000	No	2480	3,968,000	No				$ -
3,900,000	136	4,080,000	No	2480	3,968,000	No				$ -
4,000,000	136	4,080,000	No	2480	3,968,000	Yes		360		$ 367,200,000
4,100,000	136	4,080,000	Yes	2840	4,544,000	No				$ -
4,200,000	136	4,080,000	Yes	2840	4,544,000	No				$ -
4,300,000	136	4,080,000	Yes	2840	4,544,000	No				$ -
4,400,000	136	4,080,000	Yes	2840	4,544,000	No	100			$ 30,000,000
4,500,000	236	7,080,000	No	2840	4,544,000	No		360		$ 367,200,000
										$ -

***New quay exapansion includes allowance for cranes**

Port of Tauranga

Metrics to guide capacity analysis for FFSS

Characteristic	Unit	Assumption	Source	Comment
General allowance for dredging cos	$/m3	20	Based on avalaible	highly variable depending on each context
Post panamax cranes	$	15,000,000	Based on avalaible	New Zealand Shippers' Council - 2010
Max throughput - quay length (<500	TEU p.a. per m	1,300	Drewry report and UNCTAD report	
Max throughput - quay length (>500	TEU p.a. per m	1,600	Drewry report and UNCTAD report	
Max throughput - container termina	TEU p.a. per hectare	30,000	Based on Container terminal capacity and	
General cost allowance for quay ex	$/m	900,000	Based on analysis of port expansion	
General cost allowance for land sid	$/hectare	300,000		highly variable depending on each context

Current characteristics

characteristic	definition	current	max. capacity
Max draught high tide	max vessel draft (m)	13	
Max draught low tide	max vessel width (m)	11.7	
Berth pocket draught	depth (m)	13	
Vessel length	max vessel LOA (m)	300	
Quay length	container specific bert	770	1,232,000
Cranes - panamax	no.	1	
Cranes - post panamax	no.	5	
Storage land	container yard (hectar	45	1,350,000

Expansions required to accommodate larger vessels

Vessel characteristics	Vessel 1	Vessel 2
Name	[redacted]	
TEU capacity	8200	7403
Draught/depth (m)	15	14.5
Width (m)	42.8	42.8
Length (m)	347	318

Works required			
Channel deepening	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth pocket deepening	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth length expansion	300	235	*Source - New Zealand Shippers' Council - 2010*
New cranes required	1	0	*Source - New Zealand Shippers' Council - 2010*
Port estimate of costs ($ millions)	unknown	80	*Source - New Zealand Shippers' Council - 2010*
Estimate ($ millions)	see table below	80	

Basis of estimate - Vessel 1	Unit	unti rate	Qty	Cost	(based on quay length) uplift in capacity*	
Channel deepening	m3	20	5,000,000	$ 100,000,000		
Berth pocket deepening	m3	20		$ -		
New cranes required	no	15,000,000	1	$ 15,000,000		
Quay length extensions	m	900,000	300	$ 270,000,000		
Estimate				**$ 385,000,000**	**450,000**	(TEU p.a.)

Bottleneck and capacity analysis - lookup table

Assume port is expanded for larger Yes 1

Throughput	Yard area	Yard capacity	Bottleneck	Quay length	Quay capacity	Bottleneck	Yard expansion (hectares)	Quay expansion (m)
1,100,000	45	1,350,000	No	1070	1,712,000	No		
1,200,000	45	1,350,000	No	1070	1,712,000	No		
1,300,000	45	1,350,000	No	1070	1,712,000	No		
1,400,000	45	1,350,000	Yes	1070	1,712,000	No	20	
1,500,000	65	1,950,000	No	1070	1,712,000	No		360
1,600,000	65	1,950,000	No	1430	2,288,000	No		
1,700,000	65	1,950,000	No	1430	2,288,000	No		
1,800,000	65	1,950,000	No	1430	2,288,000	No		
1,900,000	65	1,950,000	No	1430	2,288,000	No		
2,000,000	65	1,950,000	Yes	1430	2,288,000	No	20	
2,100,000	85	2,550,000	No	1430	2,288,000	No		360
2,200,000	85	2,550,000	No	1790	2,864,000	No		
2,300,000	85	2,550,000	No	1790	2,864,000	No		
2,400,000	85	2,550,000	No	1790	2,864,000	No		
2,500,000	85	2,550,000	No	1790	2,864,000	No		
2,600,000	85	2,550,000	Yes	1790	2,864,000	No	20	360
2,700,000	105	3,150,000	No	2150	3,440,000	No		
2,800,000	105	3,150,000	No	2150	3,440,000	No		
2,900,000	105	3,150,000	No	2150	3,440,000	No		
3,000,000	105	3,150,000	No	2150	3,440,000	No		
3,100,000	105	3,150,000	No	2150	3,440,000	No		
3,200,000	105	3,150,000	Yes	2150	3,440,000	No	20	360
3,300,000	125	3,750,000	No	2510	4,016,000	No		
3,400,000	125	3,750,000	No	2510	4,016,000	No		
3,500,000	125	3,750,000	No	2510	4,016,000	No		
3,600,000	125	3,750,000	No	2510	4,016,000	No		
3,700,000	125	3,750,000	No	2510	4,016,000	No		
3,800,000	125	3,750,000	Yes	2510	4,016,000	No	20	360
3,900,000	145	4,350,000	No	2870	4,592,000	No		
4,000,000	145	4,350,000	No	2870	4,592,000	No		
4,100,000	145	4,350,000	No	2870	4,592,000	No		
4,200,000	145	4,350,000	No	2870	4,592,000	No	20	
4,300,000	165	4,950,000	No	2870	4,592,000	No		
4,400,000	165	4,950,000	No	2870	4,592,000	No		360
4,500,000	165	4,950,000	No	3230	5,168,000	No		

Lyttelton Port

Metrics to guide capacity analysis for FFSS

Characteristic	Unit	Assumption	Source	Comment
General allowance for dredging costs	$/m3	20	Based on avalaible informat	highly variable depending on each context
Post panamax cranes	$	15,000,000	Based on avalaible informat	New Zealand Shippers' Council - 2010
Max throughput - quay length (<500m)	TEU p.a. per m	1,300	Drewry report and UNCTAD report December	
Max throughput - quay length (>500m)	TEU p.a. per m	1,600	Drewry report and UNCTAD report December	
Max throughput - container terminal yard	TEU p.a. per hectar	30,000	Based on Container terminal capacity and performance benchmarks -	
General cost allowance for quay expansion	$/m	900,000	Based on analysis of port expansion projects	
General cost allowance for land side expansion	$/hectare	300,000		highly variable depending on each context

Current characteristics

characteristic	definition	current	max. capacity	Source
Max draught high tide	max vessel draft (m)	12.4		FFSS
Max draught low tide	max vessel width (m	10.8		FFSS
Berth pocket draught	depth (m)	12.4		New Zealand Shippers' Council - 2010
Vessel length	max vessel LOA (m)	345		FFSS
Quay length	container specific b	363	580,800	
Cranes - panamax	no.	1		
Cranes - post panamax	no.	2		
Storage land	container yard (hec	12	360,000	

Expansions required to accommodate larger vessels

Vessel characteristics	Vessel 1	Vessel 2
Name		
TEU capacity	8200	7403
Draught/depth (m)	15	14.5
Width (m)	42.8	42.8
Length (m)	347	318

Works required			
Channel deepening	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth pocket deepening	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth length expansion	300	235	*Source - New Zealand Shippers' Council - 2010*
New cranes required	2	2	*Source - New Zealand Shippers' Council - 2010*
Port estimate of costs ($ millions)	unknown	80	*Source - New Zealand Shippers' Council - 2010*
Estimate ($ millions)	**see table below**	**80**	

Basis of estimate	Unit	unti rate	Qty	Cost	uplift in capacity* (based on quay length)		
Channel deepening	m3	20	5,000,000	$ 100,000,000			
Berth pocket deepening	m3	20		$ -			
New cranes required	no	15,000,000	2	$ 30,000,000			
Quay length extensions	m	900,000	300	$ 270,000,000			
Estimate				**$ 400,000,000**	**450,000**		(TEU p.a.)

Bottleneck and capacity analysis - lookup table

Assume port is expanded for larger vessels? Yes 1

Throughput	Yard area	Yard capacity	Bottleneck	Quay length	Quay capacity	Bottleneck	Yard expansion (hectares)	Quay expansion (m)		Capital cost*
400,000	12	360,000	Yes	663	1,060,800	No	20			$ 6,000,000
500,000	32	960,000	No	663	1,060,800	No				$ -
600,000	32	960,000	No	663	1,060,800	No				$ -
700,000	32	960,000	No	663	1,060,800	No				$ -
800,000	32	960,000	No	663	1,060,800	No				$ -
900,000	32	960,000	No	663	1,060,800	No				$ -
1,000,000	32	960,000	Yes	663	1,060,800	No	20			$ 6,000,000
1,100,000	52	1,560,000	No	663	1,060,800	Yes		360		$ 367,200,000
1,200,000	52	1,560,000	No	1023	1,636,800	No				$ -
1,300,000	52	1,560,000	No	1023	1,636,800	No				$ -
1,400,000	52	1,560,000	No	1023	1,636,800	No				$ -
1,500,000	52	1,560,000	No	1023	1,636,800	No				$ -
1,600,000	52	1,560,000	Yes	1023	1,636,800	No	20			$ 6,000,000
1,700,000	72	2,160,000	No	1023	1,636,800	Yes		360		$ 367,200,000
1,800,000	72	2,160,000	No	1383	2,212,800	No				$ -
1,900,000	72	2,160,000	No	1383	2,212,800	No				$ -
2,000,000	72	2,160,000	No	1383	2,212,800	No				$ -
2,100,000	72	2,160,000	No	1383	2,212,800	No				$ -
2,200,000	72	2,160,000	Yes	1383	2,212,800	No	20			$ 6,000,000
2,300,000	92	2,760,000	No	1383	2,212,800	Yes		360		$ 367,200,000
2,400,000	92	2,760,000	No	1743	2,788,800	No				$ -
2,500,000	92	2,760,000	No	1743	2,788,800	No				$ -
2,600,000	92	2,760,000	No	1743	2,788,800	No				$ -
2,700,000	92	2,760,000	No	1743	2,788,800	No				$ -
2,800,000	92	2,760,000	Yes	1743	2,788,800	Yes	20	360		$ 373,200,000
2,900,000	112	3,360,000	No	2103	3,364,800	No				$ -
3,000,000	112	3,360,000	No	2103	3,364,800	No				$ -
3,100,000	112	3,360,000	No	2103	3,364,800	No				$ -
3,200,000	112	3,360,000	No	2103	3,364,800	No				$ -
3,300,000	112	3,360,000	No	2103	3,364,800	No				$ -
3,400,000	112	3,360,000	Yes	2103	3,364,800	Yes	20	360		$ 373,200,000
3,500,000	132	3,960,000	No	2463	3,940,800	No				$ -
3,600,000	132	3,960,000	No	2463	3,940,800	No				$ -
3,700,000	132	3,960,000	No	2463	3,940,800	No				$ -
3,800,000	132	3,960,000	No	2463	3,940,800	No				$ -
3,900,000	132	3,960,000	No	2463	3,940,800	No				$ -
4,000,000	132	3,960,000	Yes	2463	3,940,800	Yes	20	360		$ 373,200,000
4,100,000	152	4,560,000	No	2823	4,516,800	No				$ -
4,200,000	152	4,560,000	No	2823	4,516,800	No				$ -
4,300,000	152	4,560,000	No	2823	4,516,800	No				$ -
4,400,000	152	4,560,000	No	2823	4,516,800	No				$ -
4,500,000	152	4,560,000	No	2823	4,516,800	No				$ -
										$ -

Port Otago

Metrics to guide capacity analysis for FFSS

Characteristic	Unit	Assumption	Source	Comment
General allowance for dredging costs	$/m3	20	Based on avalaib	highly variable depending on each context
Post panamax cranes	$	15,000,000	Based on avalaib	New Zealand Shippers' Council - 2010
Max throughput - quay length (<500m)	TEU p.a. per m	1,300	Drewry report and UNCTAD	
Max throughput - quay length (>500m)	TEU p.a. per m	1,600	Drewry report and UNCTAD	
Max throughput - container terminal yard	TEU p.a. per he	30,000	Based on Container terminal	
General cost allowance for quay expansion	$/m	900,000	Based on analysis of port	
General cost allowance for land side expansion	$/hectare	300,000		highly variable depending on each context

Current characteristics

characteristic	definition	current	max. capacity	Source
Max draught high tide	max vessel draft	13.5		FFSS
Max draught low tide	max vessel width	11.9		FFSS
Berth pocket draught	depth (m)	12.5		New Zealand Shippers' Council - 2010
Vessel length	max vessel LOA	340		FFSS
Quay length	container specif	600	960,000	
Cranes - panamax	no.	1		
Cranes - post panamax	no.	2		
Storage land	container yard (	29	870,000	

Expansions required to accommodate larger vessels

Vessel characteristics	Vessel 1	Vessel 2
Name	[redacted]	
TEU capacity	8200	7403
Draught/depth (m)	15	14.5
Width (m)	42.8	42.8
Length (m)	347	318

Works required			
Channel deepening	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth pocket deepening	Yes	Yes	*Source - New Zealand Shippers' Council - 2010*
Berth length expansion	130	40	*Source - New Zealand Shippers' Council - 2010*
New cranes required	2	2	*Source - New Zealand Shippers' Council - 2010*
Port estimate of costs ($ millions)	unknown	100	*Source - New Zealand Shippers' Council - 2010*
Estimate ($ millions)	**see table below**	**80**	

Basis of estimate - Vessel 1	Unit	unti rate	Qty	Cost	(based on quay length) uplift in capacity*	
Channel deepening	m3	20	3,000,000	$ 60,000,000		
Berth pocket deepening	m3	20		$ -		
New cranes required	no	15,000,000	2	$ 30,000,000		
Quay length extensions	m	900,000	130	$ 117,000,000		
Estimate				**$ 207,000,000**	**195,000**	(TEU p.a.)

Bottleneck and capacity analysis - lookup table

Assume port is expanded for larger vessels? Yes 1

Throughput	Yard area	Yard capacity	Bottleneck	Quay length	Quay capacity	Bottleneck	Yard expansion (hectare	Quay expansion (m)		Capital cost*
400,000	29	870,000	No	730	1,168,000	No				$ -
500,000	29	870,000	No	730	1,168,000	No				$ -
600,000	29	870,000	No	730	1,168,000	No				$ -
700,000	29	870,000	No	730	1,168,000	No				$ -
800,000	29	870,000	No	730	1,168,000	No				$ -
900,000	29	870,000	Yes	730	1,168,000	No	20			$ 6,000,000
1,000,000	49	1,470,000	No	730	1,168,000	No				$ -
1,100,000	49	1,470,000	No	730	1,168,000	No				$ -
1,200,000	49	1,470,000	No	730	1,168,000	Yes		360		$ 367,200,000
1,300,000	49	1,470,000	No	1090	1,744,000	No				$ -
1,400,000	49	1,470,000	No	1090	1,744,000	No				$ -
1,500,000	49	1,470,000	Yes	1090	1,744,000	No	20			$ 6,000,000
1,600,000	69	2,070,000	No	1090	1,744,000	No				$ -
1,700,000	69	2,070,000	No	1090	1,744,000	No				$ -
1,800,000	69	2,070,000	No	1090	1,744,000	Yes		360		$ 367,200,000
1,900,000	69	2,070,000	No	1450	2,320,000	No				$ -
2,000,000	69	2,070,000	No	1450	2,320,000	No				$ -
2,100,000	69	2,070,000	Yes	1450	2,320,000	No	20			$ 6,000,000
2,200,000	89	2,670,000	No	1450	2,320,000	No				$ -
2,300,000	89	2,670,000	No	1450	2,320,000	No				$ -
2,400,000	89	2,670,000	No	1450	2,320,000	Yes		360		$ 367,200,000
2,500,000	89	2,670,000	No	1810	2,896,000	No				$ -
2,600,000	89	2,670,000	No	1810	2,896,000	No				$ -
2,700,000	89	2,670,000	Yes	1810	2,896,000	No	20			$ 6,000,000
2,800,000	109	3,270,000	No	1810	2,896,000	No				$ -
2,900,000	109	3,270,000	No	1810	2,896,000	Yes		360		$ 367,200,000
3,000,000	109	3,270,000	No	2170	3,472,000	No				$ -
3,100,000	109	3,270,000	No	2170	3,472,000	No				$ -
3,200,000	109	3,270,000	No	2170	3,472,000	No				$ -
3,300,000	109	3,270,000	Yes	2170	3,472,000	No	20			$ 6,000,000
3,400,000	129	3,870,000	No	2170	3,472,000	No				$ -
3,500,000	129	3,870,000	No	2170	3,472,000	Yes		360		$ 367,200,000
3,600,000	129	3,870,000	No	2530	4,048,000	No				$ -
3,700,000	129	3,870,000	No	2530	4,048,000	No				$ -
3,800,000	129	3,870,000	No	2530	4,048,000	No				$ -
3,900,000	129	3,870,000	Yes	2530	4,048,000	No	20			$ 6,000,000
4,000,000	149	4,470,000	No	2530	4,048,000	No				$ -
4,100,000	149	4,470,000	No	2530	4,048,000	Yes		360		$ 367,200,000
4,200,000	149	4,470,000	No	2890	4,624,000	No				$ -
4,300,000	149	4,470,000	No	2890	4,624,000	No				$ -
4,400,000	149	4,470,000	No	2890	4,624,000	No				$ -
4,500,000	149	4,470,000	Yes	2890	4,624,000	No				$ -
										$ -

4 Road segments

4.1 Segments considered

As the FMM seeks to map out the operations of New Zealand's international containerised freight task at a strategic level, an understanding of freight flows by transport mode from inland point of origin to port of export and vice versa needs to be modelled and analysed to understand the ramifications on volume flows and capacity depending on the options being evaluated under the Future Freight Scenarios.

This data set comprises of 52 unique origin-destination (O-D) road segments consisting of primarily state highways and 'last mile' roads to ports. The road segments assumed in the FMM are presented below.

Table 34 Road Segments in the FMM

O-D segment	Road	Distance (km)
Whangarei - Auckland	SH1	158.0
Auckland - Hamilton	SH1	127.0
Hamilton - Taupo	SH1	152.0
Taupo - Palmerston North	SH1	242.0
Palmerston North - Wellington	SH1	141.0
Picton - Christchurch	SH1	338.0
Christchurch - Temuka	SH1	146.0
Temuka - Timaru	SH1	18.5
Timaru - Oamaru	SH1	85.1
Oamaru - Dunedin	SH1	112.0
Dunedin - Balclutha	SH1	79.5
Balclutha - Invercargill	SH1	125.0
Whangarei - Northport	Port Rd	4.0
Auckland - Ports of Auckland	SH16	3.4
Tauranga - Port Tauranga	SH29-SH2	13.9
Gisborne - Port Gisborne	Esplanade	1.9
Hastings - Port Napier	SH50A-Prebensen Rd	25.2
New Plymouth - Port Taranaki	Breakwater Rd	4.3
Wellington - Port Wellington	Aotea Quay	2.0
Nelson - Port Nelson	SH6-Vickerman St	1.3
Picton - Port Marlborough	SH1	1.0

Christchurch - Lyttelton Port	SH74-Brownham Rd/SH76	12.0
Timaru - Port Timaru	Port Loop Rd/SH78	2.2
Dunedin - Port Otago	Ravensbourne Rd/SH88	13.5
Invercargill - Port South Port	SH1	27.3
Hamilton - New Plymouth	SH3	240.0
New Plymouth - Hawera	SH3	70.7
Hawera - Whanganui	SH3	88.9
Whanganui - Palmerston North	SH3	73.5
Picton - Blenheim	SH1	27.9
Picton - Nelson	SH6	107.0
Christchurch - Darfield	SH73	45.0
Darfield - Greymouth	SH73	201.0
Hamilton - Tauranga	SH1-SH29	105.0
Tauranga - Kawerau	SH2	95.4
Hastings - Napier	SH2	22.1
Hamilton - Kawerau	SH1-SH30	159.0
Taupo - Hastings	SH5	157.0
Taupo - Gisborne	SH5-SH2	328.0
Taupo - Napier	SH5-SH2	141.0
Palmerston North - Hastings	SH2-SH3	157.0
Palmerston North - Masterton	SH2	107.0
Masterton - Wellington	SH4	98.1
Auckland - MetroPort (Neilson St)	Port Road	15.5
Blenheim - Christchurch	SH1	310
Blenheim - Nelson	SH6	114

4.2 Estimating capacity

Capacity estimates have been developed based on the following factors:

- Number of lanes at the smallest point (no.) – based on desktop route analysis
- Average capacity provided per lane (Passenger Car Unit (PCU)/hour)
- Capacity available for freight (based on road type and level of passenger demand) (Deloitte assumption)

Assumptions for these factors are provided below.

Table 35 Lane numbers and capacity benchmarks

Total lanes	Capacity (PCU/hour)
2	4,500
3	6,900
4	9,600

Source: NZTA (2010) Economic evaluation manual (volume 1) - A3.9 Determining the capacity of motorways

Table 36 Estimated capacity available for freight

Road type	% of total capacity available for container freight
Trunk – metro area	3%
Trunk – regional area	5%
Port access road	5%

Source: conservative-high level assumptions developed with reference to NZTA AADT statistics

4.3 Effects of congestion

The effects of congestion on key routes in and around Auckland are considered in the FMM in the following ways:

- Impacts to vehicle operating costs
- Changed travel times
- Economic analysis – including environmental externality costs

Transport modelling undertaken to support the preparation of the Auckland Plan has been used as the basis for developing estimates of future travel speeds on congested routes in Auckland. This transport modelling considered a range of population, capital expenditure and policy scenarios and the results generally found that congestion would result in reduction in average travel speeds of 6km/hour by 2041.

Congestion also increases operating costs for supply chains. To allow for these in the modelling, a separate vehicle operating cost unit rate has been applied for vehicles operating in congested areas of Auckland. See Section 6 of this appendix – Vehicles.

Table 37 Auckland network-wide average travel speed in AM peak

	2006	2021	2031	2041
Average speed – km/hr	41.16	42.70	39.64	35.07

Source: MoT – modelling undertaken as part of preparation of Auckland Plan (Scenario H)

5 Rail

5.1 Capacity

The capability and capacity of the rail network is determined by a number of factors such as:

- Allowable axle loads – primarily dictated by the standard of the track and bridges
- Type of track – double track versus single track
- Length of train – a function of gradient and locomotive effort, or crossing loop length
- Track clearances – for example height restrictions due to tunnels, overhead lines, bridges etc.
- Train control and signalling systems
- Line speed and curvature

Table 38 Routes considered and capacity

Route	Current use	Maximum capacity
Westfield – Auckland Port[1,2]	119	720
Westfield – Wiri[1,2]	268	720
Papakura – Paerata[2]	26	960
Paerata – Hamilton[3]	31	171
Hamilton - Waharoa	33	100
Waharoa - Tauranga	25	92
Hamilton – Marton	24	60
Marton – Palmerston Nth	43	133
Palmerston North – Oringi	18	48
Oringi –Hastings	8	27
Hastings – Napier	8	85
Palmerston Nth – Waikanae	15	120
Waikanae – Wellington[3]	88	200
Picton – Christchurch	11	42
Christchurch –Lyttelton[3]	26	200
Christchurch – Greymouth	16	37
Christchurch – Rolleston[3]	35	133
Rolleston – Temuka	15	57
Oamaru – Dunedin	9	40
Dunedin – Balclutha	31	75
Balclutha – Invercargill	11	30

Source: KiwiRail, and Consultant analysis
1. Includes proposed electric passenger timetable.
2. Double track routes. Westfield –Auckland Port may eventually need grade separation of the Westfield Junction to achieve high capacity. Note that Britomart Station, beyond Auckland Port, is currently a constraint on the number of passenger trains on this line
3. Largely double tracked. The capacities are constrained by short single track sections.

Capacity can be increased on critical sections as outlined in **Table 39Error! Reference source not found.**.

Table 39 Possible capacity increases on rail

Section	Action	Extra trains/day	Indicative extra cost
Westfield to Port	Third track	80	$60m
Otahuhu to Wiri	Third Track	150	Nil, already planned
Wiri to Papakura	Third Track	110	$47m
Hamilton – Waharoa	1 crossing loop	33	$3.5
Waharoa – Tauranga	2km double track	28	$7m

Source: KiwiRail

Train loads vary by route and locomotive type, as a result of the grades and curvature. As well, trains are limited to a maximum size on each route, which varies with braking capability, coupler type and train make-up.

To simplify the analysis in the model, a number of typical “reference” trains were created, each with a nominal number of container wagons and an achievable gross load over the whole route. Even so, there cannot be a single standard train, but a number are required. Note that for parts of the route and in some circumstances larger trains might be possible, but that added too much complication.

6 Vehicles

A diverse fleet of trucks, trains and vessels are used by operators to handle the container freight task. In order to estimate capacity and costs for each mode (road, rail and coastal shipping) a range of reference vehicles have been identified to represent the type of vehicles operating on each section of the transport network.

6.1 Reference Trucks

5 types of reference trucks are included in the FMM.

This reflects three different types of vehicles, operating in either non-congested or congested areas. For each of these vehicles, an operating cost model has been developed in order to produce a $/km operating unit rate. This model includes assumptions for:

- Operating times and average driving speed
- Equipment prices and useful life
- Fuel and oil consumption and prices
- Driver costs per hour
- Insurance
- Required rate of return

- Maintenance costs
- Road user charges

Transport modelling undertaken to support the preparation of the Auckland Plan has been used as the basis for developing estimates of future travel speeds on congested routes in Auckland. This transport modelling considered a range of population, capital expenditure and policy scenarios and the results generally found that congestion would result in reduction in average travel speeds of 6km/hour by 2041.

Table 40 Auckland Network-wide average travel speed in AM peak

	2006	2021	2031	2041
Average speed – km/hr	41.16	42.70	39.64	35.07

Source: MoT – modelling undertaken as part of preparation of Auckland Plan (Scenario H)

These speed estimates have been used to model the impact of congestion on truck operating costs. For other trucks, an average speed of 57km/hour has been assumed reflective of averages across the freight network.

Table 41 Reference Trucks

	Rigid – non congested areas	Rigid – in congestion	Semi-Articulated – non congested areas	Semi-Articulated – in congested areas	Heavy combination
TEU slots	1	1	2	2	3
Tare weight	10	10	13	13	15
PCU	3	3	6	6	8
Average operating speed*	57km/hr	41km/hr	57km/hr	41km/hr	57km/hr
Operating unit rate - $/km	2.35	2.95	2.65	3.30	3.14

*2012 speeds, estimates based on transport modelling provided by MoT undertaken as part of preparation of the Auckland Plan

6.2 Reference Trains

The table below shows the reference trains that are accommodated in the FMM analysis.

Table 42 Reference trains in the FMM

Reference trains – principal parameters				
Section	**Gross weight**	**Net weight**	**TEU**	**Length**
North Island	(t)	(t)	(no)	(m)
MetroPort	2000	1036	106	721
NIMT	1700	1079	60	543
Marton – New	1400	883	50	457

Plymouth				
Rest of NI*	2000	1172	80	709
South Island				
Picton – Blenheim	1600	979	60	540
Blenheim – Christchurch	1800	1076	70	624
Hokitika – Christchurch	1900	1176	70	624
Lyttelton – Oamaru	2000	1172	80	690
Oamaru – Dunedin	1800	1076	70	624
South of Dunedin (northbound)	2500	1569	90	792
South of Dunedin (southbound)	1900	1176	70	624

Source: KiwiRail, consultant analysis

- *except for North Auckland, where loads and clearances are limited
- Net weight is weight of freight, i.e. excluding weight of container and wagon

6.3 Reference Coastal shipping vessels

Vessels currently undertaking coastal shipping movements have capacity to carry between 200 TEU to 450 TEU. If the mode share for coastal shipping increases under port hubbing scenarios then it is likely that coastal shipping vessels will increase in size. The reference vessels for coastal shipping are identified in the table below

Table 43 Reference vessels – coastal shipping

Vessel	TEU Capacity (TEU)	Average operating cost ($/ nautical mile)
1	300	69.89
2	450	94.59
3	600	117.79
4	1,100	189.31
5	1,700	269.05

7 Mode Share

Mode share represents the mode for the line haul movement between each origin-destination (O-D) pair. For example, coastal shipping mode from Greymouth to Auckland is defined by a rail movement to Christchurch and a coastal shipping line haul movement to Auckland. Mode share assumptions in the FMM impact:

- the traffic volumes on the various parts of the road and rail network, as well as transhipment volumes through ports
- operational costs – which vary for road, rail and coastal shipping

Mode share is an input to the FMM based on O-D pairs and the inputs are estimates only - based on industry knowledge developed by Deloitte, Murray King and Andrew Cooper.

Table 44 Mode Share assumptions

Origin-Destination	Road	Rail	Coastal Shipping
Ports of Auckland - Auckland	90.0%	10.0%	0.0%
Ports of Auckland - Balclutha	0.0%	0.0%	100.0%
Ports of Auckland - Christchurch	0.0%	0.0%	100.0%
Ports of Auckland - Dunedin	0.0%	0.0%	100.0%
Ports of Auckland - Gisborne	100.0%	0.0%	0.0%
Ports of Auckland - Greymouth	0.0%	0.0%	100.0%
Ports of Auckland - Hamilton	50.0%	50.0%	0.0%
Ports of Auckland - Hastings	20.0%	20.0%	60.0%
Ports of Auckland - Hawera	50.0%	50.0%	0.0%
Ports of Auckland - Invercargill	0.0%	0.0%	100.0%
Ports of Auckland - Kawerau	50.0%	50.0%	0.0%
Ports of Auckland - Masterton	50.0%	50.0%	0.0%
Ports of Auckland - Napier	20.0%	20.0%	60.0%
Ports of Auckland - Nelson	0.0%	0.0%	100.0%
Ports of Auckland - New Plymouth	50.0%	50.0%	0.0%
Ports of Auckland - Oamaru	0.0%	0.0%	100.0%
Ports of Auckland - Palmerston North	50.0%	50.0%	0.0%
Ports of Auckland - Picton	50.0%	50.0%	0.0%
Ports of Auckland - Taupo	100.0%	0.0%	0.0%
Ports of Auckland - Tauranga	50.0%	50.0%	0.0%
Ports of Auckland - Timaru	0.0%	0.0%	100.0%
Ports of Auckland - Wellington	40.0%	40.0%	20.0%
Ports of Auckland - Whanganui	50.0%	50.0%	0.0%
Ports of Auckland - Whangarei	50.0%	50.0%	0.0%
Port Otago - Balclutha	50.0%	50.0%	0.0%

Port Otago - Christchurch	40.0%	40.0%	20.0%
Port Otago - Dunedin	100.0%	0.0%	0.0%
Port Otago - Greymouth	0.0%	100.0%	0.0%
Port Otago - Invercargill	30.0%	70.0%	0.0%
Port Otago - Nelson	0.0%	0.0%	100.0%
Port Otago - Oamaru	70.0%	30.0%	0.0%
Port Otago - Picton	0.0%	100.0%	0.0%
Port Otago - Timaru	60.0%	40.0%	0.0%
Port Napier - Auckland	30.0%	20.0%	50.0%
Port Napier - Christchurch	0.0%	10.0%	90.0%
Port Napier - Gisborne	100.0%	0.0%	0.0%
Port Napier - Hamilton	50.0%	50.0%	0.0%
Port Napier - Hastings	90.0%	10.0%	0.0%
Port Napier - Hawera	30.0%	70.0%	0.0%
Port Napier - Kawerau	100.0%	0.0%	0.0%
Port Napier - Masterton	90.0%	10.0%	0.0%
Port Napier - Napier	50.0%	50.0%	0.0%
Port Napier - New Plymouth	30.0%	70.0%	0.0%
Port Napier - Palmerston North	50.0%	50.0%	0.0%
Port Napier - Taupo	100.0%	0.0%	0.0%
Port Napier - Timaru	0.0%	0.0%	100.0%
Port Napier - Wellington	50.0%	40.0%	10.0%
Port Napier - Whanganui	50.0%	50.0%	0.0%
Port Nelson - Christchurch	100.0%	0.0%	0.0%
Port Nelson - Greymouth	100.0%	0.0%	0.0%
Port Nelson - Nelson	100.0%	0.0%	0.0%
Port Nelson - Picton	100.0%	0.0%	0.0%
Lyttelton Port - Balclutha	30.0%	50.0%	20.0%
Lyttelton Port - Christchurch	90.0%	10.0%	0.0%
Lyttelton Port - Dunedin	30.0%	40.0%	30.0%
Lyttelton Port - Greymouth	0.0%	100.0%	0.0%

Lyttelton Port - Invercargill	30.0%	50.0%	20.0%
Lyttelton Port - Nelson	30.0%	50.0%	20.0%
Lyttelton Port - Oamaru	50.0%	50.0%	0.0%
Lyttelton Port - Picton	50.0%	50.0%	0.0%
Lyttelton Port - Timaru	50.0%	50.0%	0.0%
Port South Port - Balclutha	80.0%	20.0%	0.0%
Port South Port - Dunedin	30.0%	60.0%	10.0%
Port South Port - Invercargill	100.0%	0.0%	0.0%
Port Taranaki - Hastings	50.0%	50.0%	0.0%
Port Taranaki - Hawera	70.0%	30.0%	0.0%
Port Taranaki - Masterton	70.0%	30.0%	0.0%
Port Taranaki - New Plymouth	50.0%	50.0%	0.0%
Port Taranaki - Palmerston North	50.0%	50.0%	0.0%
Port Taranaki - Whanganui	90.0%	10.0%	0.0%
Port Tauranga - Auckland	10.0%	90.0%	0.0%
Port Tauranga - Balclutha	0.0%	0.0%	100.0%
Port Tauranga - Christchurch	0.0%	0.0%	100.0%
Port Tauranga - Dunedin	0.0%	0.0%	100.0%
Port Tauranga - Gisborne	100.0%	0.0%	0.0%
Port Tauranga - Greymouth	0.0%	0.0%	100.0%
Port Tauranga - Hamilton	50.0%	50.0%	0.0%
Port Tauranga - Hastings	20.0%	20.0%	60.0%
Port Tauranga - Hawera	50.0%	50.0%	0.0%
Port Tauranga - Invercargill	0.0%	0.0%	100.0%
Port Tauranga - Kawerau	40.0%	60.0%	0.0%
Port Tauranga - Masterton	50.0%	50.0%	0.0%
Port Tauranga - Napier	20.0%	20.0%	60.0%
Port Tauranga - Nelson	0.0%	0.0%	100.0%
Port Tauranga - New Plymouth	50.0%	50.0%	0.0%
Port Tauranga - Oamaru	0.0%	0.0%	100.0%
Port Tauranga - Palmerston North	50.0%	50.0%	0.0%

Port Tauranga - Picton	20.0%	80.0%	0.0%
Port Tauranga - Taupo	100.0%	0.0%	0.0%
Port Tauranga - Tauranga	100.0%	0.0%	0.0%
Port Tauranga - Timaru	0.0%	0.0%	100.0%
Port Tauranga - Wellington	20.0%	50.0%	30.0%
Port Tauranga - Whanganui	50.0%	50.0%	0.0%
Port Tauranga - Whangarei	20.0%	80.0%	0.0%
Port Timaru - Balclutha	50.0%	50.0%	0.0%
Port Timaru - Christchurch	50.0%	50.0%	0.0%
Port Timaru - Dunedin	50.0%	50.0%	0.0%
Port Timaru - Greymouth	50.0%	50.0%	0.0%
Port Timaru - Invercargill	50.0%	50.0%	0.0%
Port Timaru - Nelson	50.0%	50.0%	0.0%
Port Timaru - Oamaru	50.0%	50.0%	0.0%
Port Timaru - Picton	50.0%	50.0%	0.0%
Port Timaru - Timaru	100.0%	0.0%	0.0%
Port Wellington - Christchurch	0.0%	0.0%	100.0%
Port Wellington - Gisborne	100.0%	0.0%	0.0%
Port Wellington - Hamilton	20.0%	80.0%	0.0%
Port Wellington - Hawera	20.0%	80.0%	0.0%
Port Wellington - Kawerau	50.0%	50.0%	0.0%
Port Wellington - Masterton	100.0%	0.0%	0.0%
Port Wellington - Napier	20.0%	50.0%	30.0%
Port Wellington - Nelson	0.0%	0.0%	100.0%
Port Wellington - New Plymouth	50.0%	50.0%	0.0%
Port Wellington - Palmerston North	50.0%	50.0%	0.0%
Port Wellington - Picton	50.0%	50.0%	0.0%
Port Wellington - Timaru	0.0%	0.0%	100.0%
Port Wellington - Wellington	100.0%	0.0%	0.0%
Port Wellington - Whanganui	50.0%	50.0%	0.0%

Appendix C Capital Costs

1 Background

Capital cost estimates are based on high level, desktop analysis only. Due to the whole of system nature of the work (and the scope of the study) it has not been possible to undertake detailed analysis of each individual port or piece of the road and rail networks. The underlying assumption in the modelling methodology is that the capacity upgrades to road, rail and port infrastructure used in the model are all “feasible”. To this end high level “reference” operational and capital upgrade costs have been used across the entire network. No assessment has been made as to the physical, technical or financial ability of asset owner to undertake capacity upgrades. More detailed analysis of individual port’s, road and rail networks could be undertaken and accommodated within the model.

Estimates are high level only – indicative of the type of works that could be carried out to remove bottlenecks on the road and rail network under the scenarios considered in the FFSS.

2 Sources and assumptions

Refer to Section 4 for analysis of existing capacity at the ports and on the road and rail networks

3 Scenario 1

3.1 Scenario 1 - Port throughput

Port Throughput for Scenario 1 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland	673,892	786,288	865,265	933,312	993,912	1,048,117	1,102,544
Port Chalmers	145,858	163,205	183,896	195,562	206,674	217,440	228,499
Port Napier	212,825	229,447	254,441	273,406	289,362	303,010	316,793
Port Nelson	80,647	86,937	94,585	101,698	107,714	112,861	118,027
Port of Lyttelton	194,894	215,332	240,596	260,957	280,272	298,889	317,997
Port Southport	26,446	28,572	31,163	33,031	34,673	36,176	37,714
Port Taranaki	20,947	23,046	25,556	27,802	29,911	31,931	34,016
Port Tauranga	729,463	905,810	995,872	1,073,716	1,145,719	1,213,079	1,281,325
Port Timaru	37,412	41,747	47,583	51,852	56,039	60,213	64,560
Port Wellington	85,762	120,328	133,987	147,352	160,673	174,123	188,097

Note: includes IMEX, transhipments, empties and restows

3.2 Scenario 1 - Port CAPEX

Scenario 1 – Port CAPEX

Year	Port	Project	Capital allowance	Source
2027	Port of Tauranga	1 new crane and 150m of additional berth length	$149m	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
2037	Port of Tauranga	2 new cranes and 235m of additional berth length	$249m	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd

3.3 Scenario 1 - Road and Rail CAPEX

Years	Segment	Capital allowance	Basis of estimate
2017	Road - Auckland – Ports of Auckland	$170m	Upgrades to SH 16 - based on project under consideration by NZTA to provide cut and cover for4 lane divided carriageway. Assumes 30% of estimated total project costs are attributable to freight
2017	Road – MetroPort/Neilson St	$175m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight
2022	Road - Hastings – Napier	$50m	High level assumption only - highway upgrades to increase capacity at bottleneck – based on a generic reference project of $500m where 10% of estimated total project costs are attributable to freight
2022	Road – Napier – Port of Napier	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2042	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2042	Road - Hastings – Napier	$50m	High level assumption only - highway upgrades to increase capacity at bottleneck – based on a generic reference project of $500m where 10% of estimated total project costs are attributable to freight

4 Scenario 2

4.1 Scenario 2 - Port throughput

Port Throughput for Scenario 2 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland	673,898	803,676	884,648	953,990	1,015,658	1,070,751	1,126,074
Port Chalmers	181,759	203,721	229,834	244,616	258,533	271,892	285,609
Port Napier	270,449	298,848	330,179	354,674	375,612	393,814	412,193
Port Nelson	43,443	46,832	50,895	54,706	57,953	60,756	63,572
Port of Lyttelton	265,461	305,203	339,589	368,454	395,385	420,953	447,159
Port Southport	2,994	3,017	3,034	3,034	3,023	3,015	3,010
Port Taranaki							
Port Tauranga	750,410	967,303	1,063,810	1,147,005	1,223,980	1,296,048	1,369,109
Port Timaru	6,962	6,787	6,902	7,169	7,415	7,646	7,882
Port Wellington	5,948	6,355	6,872	7,360	7,813	8,240	8,672

Note: includes IMEX, transhipments, empties and restows

4.2 Scenario 2 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2022	Port of Tauranga	1 new crane and 150m of additional berth length	$149m	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
2027	Port of Lyttelton	2 new cranes and 230m new berth length	$255m	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
2032	Port of Tauranga	2 new cranes and 235m of additional berth length	$239m	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
2042	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion

4.3 Scenario 2 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2017	Road - Auckland – Ports of Auckland	$170m	Upgrades to SH 16 - based on project under consideration by NZTA to provide cut and cover for4 lane divided carriageway. Assumes 30% of estimated total project costs are attributable to freight
2017	Road – MetroPort/Neilson St	$175m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight
2017	Road - Hastings – Napier	$50m	High level assumption only - highway upgrades to increase capacity at bottleneck – based on a generic reference project of $500m where 10% of estimated total project costs are attributable to freight

2017	Road – Napier – Port of Napier	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2027	Road – Hastings-Napier	$50m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2037	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2037	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight
2037	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard
2042	Road – Napier – Port of Napier	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2042	Road – Hastings-Napier	$50m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight

5 Scenario 3

5.1 Scenario 3 - Port throughput

Port Throughput for Scenario 3 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland	673,929	803,645	884,615	953,955	1,015,621	1,070,711	1,126,031

Port Chalmers	181,759	203,721	229,834	244,616	258,533	271,892	285,609
Port Napier	111,120	119,977	134,574	145,394	154,682	162,801	171,018
Port Nelson	43,443	46,832	50,895	54,706	57,953	60,756	63,572
Port of Lyttelton	251,670	288,849	321,000	347,505	371,946	394,877	418,308
Port Southport	2,994	3,017	3,034	3,034	3,023	3,015	3,010
Port Taranaki							
Port Tauranga	1,094,321	1,514,469	1,670,562	1,804,461	1,925,529	2,036,761	2,149,728
Port Timaru	20,798	22,546	24,888	27,495	30,211	33,060	36,050
Port Wellington	14,107	15,113	16,408	17,615	18,729	19,769	20,822

Note: includes IMEX, transhipments, empties and restows

5.2 Scenario 3 - Port CAPEX

Scenario 3 – Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2017	Ports of Auckland	Expansion to accommodate 7000+ TEU vessels including additional 130m of berth length, 3 new cranes and deepening of channel and berth pocket	$200m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Lyttelton	Expansion to accommodate bigger ships –2 x new cranes, dredging	$80m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Expansion to accommodate bigger ships – 235m berth length, 1 x new crane, dredging	$80m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates

2017	Port Chalmers	Expansion to accommodate 7000+ TEU vessels including additional 40m of berth length, 2 new cranes and deepening of channel and berth pocket	$100m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2017	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2027	Port of Tauranga	Expansion including 3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2032	Port of Lyttelton	2 new cranes and 230m new berth length	$255m	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
2037	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2042	Port of Lyttelton	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion

5.3 Scenario 3 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2017	Road - Auckland – Ports of Auckland	$170m	Upgrades to SH 16 - based on project under consideration by NZTA to provide cut and cover for4 lane divided carriageway. Assumes 30% of estimated total project costs are attributable to freight
2017	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight

2017	Road – MetroPort/Neilson St	$175m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight
2022	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2022	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard

6 Scenario 4

6.1 Scenario 4 - Port throughput

Port Throughput for Scenario 4 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland	673,855	794,884	874,851	943,538	1,004,665	1,059,305	1,114,172
Port Chalmers	34,279	58,537	65,700	70,290	74,539	78,555	82,673
Port Napier	111,120	119,977	134,574	145,394	154,682	162,801	171,018
Port Nelson	43,443	46,832	50,895	54,706	57,953	60,756	63,572
Port of Lyttelton	438,547	518,432	579,272	622,279	662,208	699,978	738,645
Port Southport	18,400	20,062	22,008	23,087	24,092	25,062	26,056
Port Taranaki							

Port Tauranga	1,099,193	1,484,153	1,636,701	1,767,556	1,885,822	1,994,422	2,104,698
Port Timaru	21,301	23,041	25,392	28,018	30,753	33,621	36,630
Port Wellington	16,858	18,185	19,831	21,259	22,540	23,705	24,880

Note: includes IMEX, transhipments, empties and restows

6.2 Scenario 4 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2017	Ports of Auckland	Expansion to accommodate 7000+ TEU vessels including additional 130m of berth length, 3 new cranes and deepening of channel and berth pocket	$200m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Lyttelton	Expansion to accommodate bigger ships –2 x new cranes, dredging	$80m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Expansion to accommodate bigger ships – 235m berth length, 1 x new crane, dredging	$80m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2017	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2017	Port of	2 new cranes and 230m new	$255m	Project based on information provided by the port. Cost estimates based on industry benchmarks and

	Lyttelton	berth length		analysis by Deloitte and AmZ Ltd
2017	Port of Lyttelton	130m new berth length	$110m	Project based on information provided by the port. Cost estimates based on industry benchmarks and analysis by Deloitte and AmZ Ltd
2017	Port of Lyttelton	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2032	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference project port expansion for berth expansion
2037	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion

6.3 Scenario 4 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2017	Road - Auckland – Ports of Auckland	$170m	Upgrades to SH 16 - based on project under consideration by NZTA to provide cut and cover for4 lane divided carriageway. Assumes 30% of estimated total project costs are attributable to freight
2017	Road – MetroPort/Neilson St	$175m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight
2017	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight
2027	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight

2042	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard

7 Scenario 5

7.1 Scenario 5 - Port throughput

Port Throughput for Scenario 5 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland	673,929	794,963	874,936	943,629	1,004,762	1,059,409	1,114,282
Port Chalmers	461,269	605,048	675,642	727,047	774,746	819,809	865,903
Port Napier	111,120	119,977	134,574	145,394	154,682	162,801	171,018
Port Nelson	75,096	80,979	88,109	94,742	100,335	105,105	109,890
Port of Lyttelton	49,568	53,891	59,800	64,951	69,610	73,903	78,289
Port Southport	2,849	2,863	2,868	2,856	2,833	2,812	2,794
Port Taranaki							
Port Tauranga	1,084,129	1,445,174	1,594,073	1,721,799	1,837,281	1,943,367	2,051,108
Port Timaru	21,301	23,041	25,392	28,018	30,753	33,621	36,630
Port Wellington	1,868	1,976	2,104	2,232	2,355	2,475	2,597

Note: includes IMEX, transhipments, empties and restows

7.2 Scenario 5 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2017	Ports of Auckland	Expansion to accommodate 7000+ TEU vessels including additional 130m of berth length, 3 new cranes and deepening of channel and berth pocket	$200m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Expansion to accommodate bigger ships – 235m berth length, 1 x new crane, dredging	$80m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2017	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2017	Port Chalmers	Expansion to accommodate 7000+ TEU vessels including additional 40m of berth length, 2 new cranes and deepening of channel and berth pocket	$100m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port Chalmers	Additional 130m of berth length and 2 x new cranes	$145m	Deloitte analysis incorporating data collected by AmZ Ltd
2017	Port Chalmers	3 new cranes and 360m berth length	$365m	Based on reference project port expansion for berth expansion
2032	Port of	3 new cranes and 360m	$365m	Based on reference port expansion project

	Tauranga	berth length		
2042	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion

7.3 Scenario 5 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2017	Road - Auckland – Ports of Auckland	$170m	Upgrades to SH 16 - based on project under consideration by NZTA to provide cut and cover for4 lane divided carriageway. Assumes 30% of estimated total project costs are attributable to freight
2017	Road – MetroPort/Neilson St	$175m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight
2017	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight
2022	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2022	Road – Dunedin – Port Chalmers	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2037	Road – Dunedin – Port Chalmers	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2042	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard

8 Scenario 6

8.1 Scenario 6 - Port throughput

Port Throughput for Scenario 6 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland	1,736,916	2,158,487	2,376,580	2,562,774	2,729,100	2,879,332	3,030,961
Port Chalmers	34,279	55,646	62,483	66,828	70,854	74,662	78,566
Port Napier	111,120	119,977	134,574	145,394	154,682	162,801	171,018
Port Nelson	43,443	46,832	50,895	54,706	57,953	60,756	63,572
Port of Lyttelton	452,886	529,539	592,073	637,080	679,174	719,285	760,424
Port Southport	18,400	20,062	22,008	23,087	24,092	25,062	26,056
Port Taranaki							
Port Tauranga							
Port Timaru	6,962	6,787	6,902	7,169	7,415	7,646	7,882
Port Wellington	9,405	10,075	10,939	11,744	12,486	13,180	13,881

Note: includes IMEX, transhipments, empties and restows

8.2 Scenario 6 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate

2017	Ports of Auckland	Expansion to accommodate 8000+ TEU vessels including additional 170m of berth length, 3 new cranes and deepening of channel and berth pocket	$300m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Lyttelton	Expansion to accommodate 8000+ TEU vessels including additional 300m of berth length, 2 new cranes and deepening of channel and berth pocket	$400m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Ports of Auckland	2 x (3 new cranes and 360m berth length)	$730m	Based on reference port expansion project
2017	Port of Lyttelton	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2022	Ports of Auckland	3 new cranes and 360m berth length)	$365m	Based on reference port expansion project
2032	Ports of Auckland	3 new cranes and 360m berth length)	$365m	Based on reference port expansion project
2032	Port of Lyttelton	3 new cranes and 360m berth length)	$365m	Based on reference port expansion project

8.3 Scenario 6 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate

2017	Road - Auckland – Hamilton	$60m	Upgrades to SH 1 - based on project under consideration by NZTA to widen 4 lane motorway to 6 lanes and upgrade interchanges from Constellation Drive to Greville Road. Assumes 30% of estimated total project costs are attributable to freight
2017	Road - Auckland – Ports of Auckland	$290m	Upgrades to SH 16 - based on project under consideration by NZTA to provide cut and cover for4 lane divided carriageway. Assumes 30% of estimated total project costs are attributable to freight Upgrades to SH 16 - based on project under consideration by NZTA to 8 lane a 6 lane section of the motorway between Grafton Gully and Mt Wellington with steep gradients. Assumes 20% of estimated total project costs are attributable to freight

9 Scenario 7

9.1 Scenario 7 - Port throughput

Port Throughput for Scenario 7 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland							
Port Chalmers	34,279	55,646	62,483	66,828	70,854	74,662	78,566
Port Napier	111,120	119,977	134,574	145,394	154,682	162,801	171,018
Port Nelson	43,443	46,832	50,895	54,706	57,953	60,756	63,572
Port of Lyttelton	452,886	529,539	592,073	637,080	679,174	719,285	760,424
Port Southport	18,400	20,062	22,008	23,087	24,092	25,062	26,056
Port Taranaki							

Port Tauranga	1,740,691	2,168,107	2,387,115	2,574,132	2,741,219	2,892,164	3,044,513
Port Timaru	6,962	6,787	6,902	7,169	7,415	7,646	7,882
Port Wellington	14,107	15,113	16,408	17,615	18,729	19,769	20,822

Note: includes IMEX, transhipments, empties and restows

9.2 Scenario 7 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2017	Port of Lyttelton	Expansion to accommodate 8000+ TEU vessels including additional 300m of berth length, 2 new cranes and deepening of channel and berth pocket	$400m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Expansion to accommodate 8000+ TEU vessels including additional 300m of berth length, 1 new cranes and deepening of channel and berth pocket	$385m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Lyttelton	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2017	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2017	Port of	2 x (3 new cranes and 360m	$730m	Based on reference port expansion project

	Tauranga	berth length)		
2022	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2032	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2037	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2037	Port of Lyttelton	3 new cranes and 360m berth length	$365m	Based on reference port expansion project

9.3 Scenario 7 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2017	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2017	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight
2017	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard
2017	Road – MetroPort/Neilson St	$350m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight. Investment is assumed to be double the level planned for this project in order to meet capacity demands.

2027	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard
2032	Rail – Auckland/Westfield/MetroPort	$47m	Based on cost estimated to provide a third main line from Wiri to Papakura
2037	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight

10 Scenario 8

10.1 Scenario 8 - Port throughput

Port Throughput for Scenario 8 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland	1,735,988	2,157,024	2,375,083	2,561,215	2,727,485	2,877,666	3,029,244
Port Chalmers	476,165	608,103	679,515	732,073	781,182	827,897	875,765
Port Napier	111,120	119,977	134,574	145,394	154,682	162,801	171,018
Port Nelson	75,096	80,979	88,109	94,742	100,335	105,105	109,890
Port of Lyttelton	49,197	53,525	59,426	64,561	69,206	73,487	77,859
Port Southport	2,849	2,863	2,868	2,856	2,833	2,812	2,794

Port Taranaki							
Port Tauranga							
Port Timaru	6,962	6,787	6,902	7,169	7,415	7,646	7,882
Port Wellington	9,405	10,075	10,939	11,744	12,486	13,180	13,881

Note: includes IMEX, transhipments, empties and restows

10.2 Scenario 8 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2017	Ports of Auckland	Expansion to accommodate 8000+ TEU vessels including additional 170m of berth length, 3 new cranes and deepening of channel and berth pocket	$300m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Ports of Auckland	2 x (3 new cranes and 360m berth length)	$730m	Based on reference port expansion project
2017	Port Chalmers	Expansion to accommodate 8000+ TEU vessels including additional 130m of berth length, 2 new cranes and deepening of channel and berth pocket	$210m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port Chalmers	3 new cranes and 360m berth length	$365m	Based on reference port expansion project

2022	Ports of Auckland	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2032	Ports of Auckland	3 new cranes and 360m berth length	$365m	Based on reference port expansion project

10.3 Scenario 8 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2017	Road - Auckland – Hamilton	$60m	Upgrades to SH 1 - based on project under consideration by NZTA to widen 4 lane motorway to 6 lanes and upgrade interchanges from Constellation Drive to Greville Road. Assumes 30% of estimated total project costs are attributable to freight
2017	Road - Auckland – Ports of Auckland	$290m	Upgrades to SH 16 - based on project under consideration by NZTA to provide cut and cover for4 lane divided carriageway. Assumes 30% of estimated total project costs are attributable to freight Upgrades to SH 16 - based on project under consideration by NZTA to 8 lane a 6 lane section of the motorway between Grafton Gully and Mt Wellington with steep gradients. Assumes 20% of estimated total project costs are attributable to freight
2027	Road – Dunedin – Port Chalmers	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2042	Road – Dunedin – Port Chalmers	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight

11 Scenario 9

11.1 Scenario 9 - Port throughput

Port Throughput for Scenario 9 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland							
Port Chalmers	476,165	608,103	679,515	732,073	781,182	827,897	875,765
Port Napier	111,422	120,273	134,876	145,707	155,007	163,137	171,366
Port Nelson	75,096	80,979	88,109	94,742	100,335	105,105	109,890
Port of Lyttelton	49,197	53,525	59,426	64,561	69,206	73,487	77,859
Port Southport	2,849	2,863	2,868	2,856	2,833	2,812	2,794
Port Taranaki							
Port Tauranga	1,740,489	2,167,672	2,386,672	2,573,672	2,740,742	2,891,671	3,044,003
Port Timaru	6,459	6,293	6,398	6,646	6,873	7,086	7,303
Port Wellington	14,107	15,113	16,408	17,615	18,729	19,769	20,822

Note: includes IMEX, transhipments, empties and restows

11.2 Scenario 9 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2017	Port Chalmers	Expansion to accommodate 8000+ TEU vessels including additional 130m of berth length, 2 new cranes and deepening of channel and berth pocket	$210m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port Chalmers	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2017	Port of Tauranga	Expansion to accommodate 8000+ TEU vessels including additional 300m of berth length, 1 new cranes and deepening of channel and berth pocket	$385m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2017	Port of Tauranga	2 x (3 new cranes and 360m berth length)	$730	Based on reference port expansion project
2022	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2037	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project

11.3 Scenario 9 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2012 - 2016	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2017	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight
2017	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard
2017	Road – MetroPort/Neilson St	$350m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight. Investment is assumed to be double the level planned for this project in order to meet capacity demands.
2022	Road – Dunedin – Port Chalmers	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic reference project of $80m where 50% of estimated total project costs are attributable to freight
2027	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard
2032	Rail – Auckland/Westfield/MetroPort	$47m	Based on cost estimated to provide a third main line from Wiri to Papakura
2027	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2042	Road – Dunedin – Port Chalmers	$40m	High level assumption only –port road upgrades to increase capacity at bottleneck – based on a generic

reference project of $80m where 50% of estimated total project costs are attributable to freight

12 Scenario 10

12.1 Scenario 10 - Port throughput

Port Throughput for Scenario 10 – TEU per year

Port	2012	2017	2022	2027	2032	2037	2042
Ports of Auckland							
Port Chalmers	86,441	96,244	108,256	116,033	123,168	129,831	136,641
Port Napier	111,120	119,977	134,574	145,394	154,682	162,801	171,018
Port Nelson	75,096	80,979	88,109	94,742	100,335	105,105	109,890
Port of Lyttelton	153,586	168,635	188,564	204,670	220,096	235,094	250,503
Port Southport	69,196	75,835	83,497	87,558	91,507	95,452	99,517
Port Taranaki							
Port Tauranga	2,509,584	3,517,058	3,900,941	4,204,802	4,482,705	4,740,615	5,002,905
Port Timaru	84,800	93,885	107,514	116,586	125,283	133,766	142,553
Port Wellington	14,107	15,113	16,408	17,615	18,729	19,769	20,822

12.2 Scenario 10 - Port CAPEX

Year	Port	Project	Capital allowance	Basis of estimate
2017	Port of Tauranga	Expansion to accommodate 8000+ TEU vessels including additional 300m of berth length, 1 new cranes and deepening of channel and berth pocket	$385m	Incorporating estimates from New Zealand Shippers' Council – 2010, port data collected by AmZ Ltd and Deloitte estimates
2017	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2017	Port of Tauranga	4 x (3 new cranes and 360m berth length)	$1460m	Based on reference port expansion project
2022	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2022	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2027	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2027	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion
2037	Port of Tauranga	3 new cranes and 360m berth length	$365m	Based on reference port expansion project
2037	Port of Tauranga	Yard expansion/upgrade works	$20m	Based on reference project for yard expansion

12.3 Scenario 10 - Road and Rail CAPEX

Year	Segment	Capital allowance	Basis of estimate
2017	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight
2017	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight
2017	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard
2017	Road – MetroPort/Neilson St	$350m	Neilson St and East West Link - Upgrades to Motorway to Motorway connection (based on project under consideration by NZTA to provide 4 lane divided carriageway grade separated expressway) from SH20 (SW motorway) to SH1 (Southern motorway). Assumes 50% of estimated total project costs are attributable to freight. Investment is assumed to be double the level planned for this project in order to meet capacity demands.
2022	Road - Hamilton – Tauranga	$250m	Upgrades on SH1 - based on project under consideration by NZTA to add new lanes to steep gradient highway to provide crawler lanes and capacity. Assumes 20% of estimated total project costs are attributable to freight
2027	Rail - Tauranga –Port of Tauranga	$75m	High level assumption only - Provision of additional track, 2 sidings and rail yard
2032	Rail – Hamilton - MetroPort	$47m	Based on cost estimated to provide a third main line from Wiri to Papakura
2027	Road – Tauranga – Port of Tauranga	$120m	Upgrades to Hewletts Road - based on project under consideration by NZTA to Convert peak arterial road to grade separated expressway for urban access into Port - currently the final link to Port for SH2 and SH29. Assumes 60% of estimated total project costs are attributable to freight