Extension of NZ Transport Agency research report 629: System dynamics investigation of freight flows, economic development and network performance

December 2018

George Stuart, Future Impact Ltd, Wellington
Theo Barsanti, Transport Futures Ltd, Wellington
Adolf Stroombergen, Infometrics Consulting Ltd, Wellington

NZ Transport Agency research report 653
Contracted research organisation – Infometrics Consulting Limited

ISBN 978-1-98-856123-3 (electronic)
ISSN 1173-3764 (electronic)

NZ Transport Agency
Private Bag 6995, Wellington 6141, New Zealand
Telephone 64 4 894 5400; facsimile 64 4 894 6100
research@nzta.govt.nz
www.nzta.govt.nz

Stuart, G, T Barsanti and A Stroombergen (2018) Extension of NZ Transport Agency research report 629: System dynamics investigation of freight flows, economic development and network performance. *NZ Transport Agency research report 653.* 23pp.

Infometrics Consulting Limited was contracted by the NZ Transport Agency in 2018 to carry out this research.

Keywords: cost-benefit analysis, destination management, road infrastructure, South Island New Zealand, visitor attractions, tourism, tourism flows model

An important note for the reader

Acknowledgements

The authors would like to gratefully acknowledge the contribution to this research from the following:

Peer reviewer: Anthony Byett, Consulting Economist, Taupo

Members of the Steering Group:

- Tony Brennand, Principal Transport Outcome Planner, NZ Transport Agency - Research Owner & Chair
- Barry Dowsett, Principal Advisor, NZ Transport Agency
- Alistair Talbot, Lead Strategic Planner, NZ Transport Agency
- Bill McMaster, Transport Planning Manager, Waikato Regional Council
- Grant Heather, Senior Strategy Manager, KiwiRail
- Helen Huang, Ministry of Transport (now with Treasury)
- Stephanie Dorne, Ministry of Transport

Abbreviations and acronyms

ALPURT	Albany to Puhoi Realignment (of SH1)
HAT	Auckland–Hamilton–Tauranga triangle
HCV	heavy commercial vehicle, loading capacity 20–50 tonnes, length exceeding 17 metres, (class 4 truck)
PC	principal components
SD	system dynamics
SH	state highway
VAR	vector autoregressive (model)
WHAT	Whangarei–Hamilton–Auckland–Tauranga region

Contents

Executive summary

The purpose of this research was to extend the scope of our previous work, *NZ Transport Agency research report 629* 'System dynamics investigation of freight flows, economic development and network performance' (September 2017), to include the state highway network between Auckland and Northport/Whangarei.

The original research was to investigate if and how system dynamics (SD) modelling could be used for understanding traffic flows at an inter-regional (state highway) level and to assess the performance of the road network. Research report 629 included the triangle of Hamilton–Auckland–Tauranga (HAT) and the state highway network contained within that boundary. This extension covers an area bounded by Whangarei–Auckland–Hamilton–Tauranga (WHAT) and the state highway network contained within. Included in this research is also the impact on State Highway (SH) 1 of diverting some or all of Port of Auckland's imports and exports to Northport. This port is on the Marsden Point Peninsula some 35 kilometres south of the Whangarei CBD. Northport is not currently served by rail.

Traffic flows on SH1 between the Northern Gateway toll road (ALPURT) and Northport, in both directions, were simulated in the SD model using data sourced from NZ Transport Agency telemetry sites along the route. Travel times simulated in the model were within 5-10% of travel time data taken from Google Maps data for the same sample month. Simulating intra-city travel was never part of the design of the model, so travel times between Ports of Auckland's inland port at Wiri and ALPURT (in both directions) are exogenous to the model, with data from Google Maps used for the same sample month.

For a base case the model produces plausible travel times, so these have been used as a basis for various 'simulated scenarios' to be applied to that section of SH1. For the purpose of illustrating the model the scenarios involved the simulation of freight imports and exports arriving at and departing from Northport, rather than through Ports of Auckland. Average freight loads carried by heavy commercial vehicles (HCVs) were deduced by analysing freight arriving at and departing from Port of Tauranga and Northport. The conversion of freight tonnes to the number of HCVs provides the numbers of additional vehicles that would need to be injected onto SH1 between Wiri and Northport and return.

Exports leaving Northport rather than Ports of Auckland would require an additional 6,279 HCVs per month or 202 HCVs per day to travel the 165 kilometre journey on SH1. Imports arriving at Northport rather than Port of Auckland would require an additional 12,793 HCVs per month or 412 HCVs per day. The model results suggest that the additional road space required by the extra trucks does not by itself have a significant impact on travel times. However, if a higher number of trucks reduces overtaking opportunities, travel times would rise – potentially quite considerably.

Within the structure of the SD model is the capability to simulate the effect on road traffic of more or less freight between Wiri and Northport (and return) being carried by rail, should that investment in additional rail infrastructure ever happen.

None of our scenarios should be interpreted as cost-benefit analysis. We do not consider issues such as the change in the cost of freight, changes in greenhouse gas emissions, the amount of land available at each port to cope with increased activity, or investment in road and rail infrastructure. Numerous assumptions are made about what might be possible in the future. They are not based on current government strategy or direction.

In this connection further enhancement of the model could usefully include some key travel cost components such as fuel consumption (and associated emissions) and travel time.

Abstract

In 2017 we developed a system dynamics model to study inter-regional freight and traffic flows in the Auckland–Hamilton–Tauranga triangle. Here we extend the model northward to Whangarei in order to incorporate Northport. This enables us to provide an order of magnitude estimate of how many truck movements might be required to transport freight between Auckland and Northport, if most or all of the exports and imports that currently pass through Ports of Auckland were to enter and leave New Zealand via Northport instead.

Excluding the ALPURT to Wiri route, our results suggest that although there is probably enough road space *per se* to accommodate the extra trucks without significantly affecting travel times, their lower average speed would reduce the speed of other vehicles – and thus increase travel times – if there are insufficient opportunities for overtaking. Most of the road north of Puhoi is one lane in each direction.

1 Introduction

This report describes an extension to the model presented in *NZ Transport Agency research report 629*, to which the reader is referred for model details. The system dynamics (SD) model was developed to analyse travel time scenarios on state highway (SH) routes between Auckland, Hamilton and Tauranga. The model has now been extended to Include the SH link to Whangarei and Northport.

One of the reasons for extending the model northward is to better understand the additional amount of freight and numbers of heavy vehicles that would use the Auckland–Northport road link if significant amounts of freight (exports and imports) that currently flow through Ports of Auckland were instead to leave and enter the country via Northport.

As in *NZ Transport Agency research report 629*, the model is still a high-level experimental tool designed with two purposes in mind:

1. To test whether SD can be a useful tool for analysing traffic flows and congestion along major intercity routes.
2. To obtain some high-level insights to a few broad policy issues that are of current interest.

The key strength and hence the foremost reason for selecting an SD model for this task is that time is explicit. This means the model can simulate processes such as traffic flows, freight flows, congestion, capacity constraints and travel times. The SD model is a scenario model, not a forecasting model. An SD model emphasises structural accuracy (correct variables and the dynamics of stocks, flows and feedbacks) over statistical accuracy (functional form and econometrically estimated parameter values). Structure is absolutely central to simulation models as their main use is to provide insight and understanding into how the real world works.

Our original intention was to explicitly include rail in the model, but two considerations led to a change of plan:

1. It soon became apparent that a high-level SD model was not a good substitute for the complex capacity modelling and scheduling undertaken by KiwiRail. Therefore explicit inclusion of rail at only a high level would add no value.
2. From the perspective of modelling substitution between Ports of Auckland and Northport, all we really need to know is how much freight is currently transported by rail to and from the Ports of Auckland. Explicit inclusion of rail is not required to simulate the effects of more freight being transported by road.

The changes to the model are outlined in chapter 2, while in chapter 3 we present a few scenarios around shifting exports and imports from Ports of Auckland to Northport. We stress that the scenarios should not be interpreted as a cost-benefit analysis of port restructuring.

Models are abstractions of reality. To produce useful insights they need to contain sufficient detail to capture the main aspects of the policy or shock at issue, without having so much detail that they become unwieldy and generate output that is too dependent on the input assumptions. It is essential therefore that models are designed with a clear purpose in mind. In that context, chapter 4 provides some suggestions for improving model robustness and applicability, should SD modelling be considered as a useful tool for high-level indicative assessments of transport interventions and system shocks.

2 Model extension

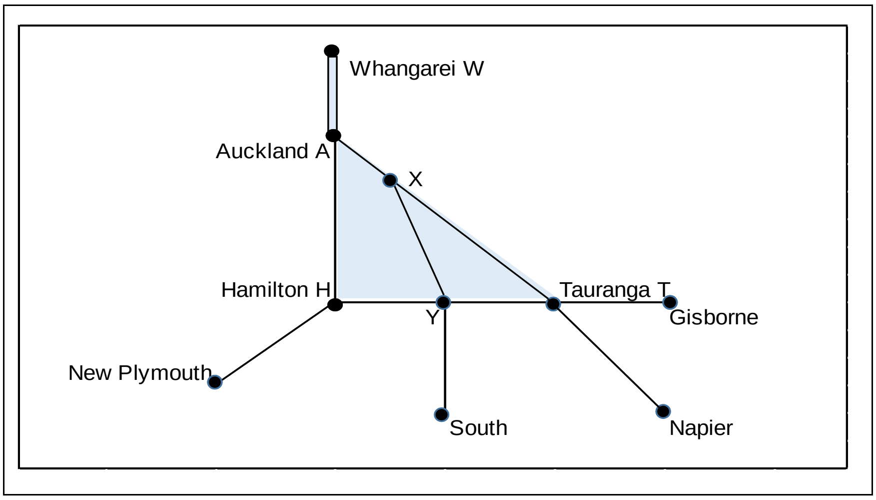
2.1 Geographic coverage

The area covered by the extended model is shown in figure 2.1, with Whangarei (actually Northport) being added to the Auckland–Hamilton–Tauranga (HAT) triangle. The road routes in the model are:

1. Whangarei/Northport to Auckland (WA) along SH1
2. Auckland to X (AX), where X is the intersection between SH2 and SH27
3. X to Y (XY), along SH27
4. X to Tauranga (XT), along SH2 via Waihi
5. Auckland to Hamilton (AH), along SH1 and the Waikato Expressway
6. Hamilton to Y (HY), along SH1. where Y is a general representation of various intersections in the area; 27 and 29, 1 and 29, 1 and 5, 5 and 28, 1 and 28, and 28 and 29.
7. Y to Tauranga (YT), along SH29.

Locations outside the model area are not shaded.

Figure 2.1 Model region



The previous model for the HAT region was calibrated to traffic data for August 2016 (or in some cases September 2016) at the following telemetry sites:

- SH1 - Bombay
- SH1 - Taupiri (between Huntly and Ngaruawahia)
- SH1 - Hamilton
- SH1 - Karapiro
- SH2 - Mangatawhiri (near Maramarua)
- SH2 - Waihi
- SH2 - Te Puna (near Tauranga)

- SH2 - Takitimu Drive (into Tauranga before the port)
- SH27 - Kaihere (just south of intersection SH2/SH27)
- SH29 - Kaimai Ranges

For the model extension traffic data from the following additional sites were collected:

- SH15A - between Ruakaka and Northport
- SH1 - Wellsford
- SH1 - ALPURT toll gantry (near Orewa)
- SH1 - Puwera (not actually used in the model at this stage as the site is north of Northport).

An example relating to northward traffic at Wellsford is shown in figure 2.2. The solid line shows the mean number of vehicles over the month of August 2016, while the bars denote one standard deviation calculated over all 31 days. As a base case we use the mean flows, but the model can be programmed to incorporate alternative traffic flows drawn from these distributions.

Travel between the ALPURT toll gantry and the inland port at Wiri is intra-city traffic and thus is outside the scope of the model. SD modelling is not the preferred methodology to model traffic flows in a dense urban area. Nevertheless this segment of road is a significant component of travel time between Northport and Ports of Auckland (Wiri), accounting for about one hour of a 2.5 hour journey. It therefore needs to be considered even if it is not explicitly modelled. Hence we have sourced average travel time data from Google Maps for every hour on Wednesday 17 August 2016. Because this data is static and not dynamic in the model, the effect of increased traffic volumes or the addition of capacity along the route will not be captured. Similarly, the effect on this route of changes in the amount of traffic elsewhere in the network is also not captured.

The telemetry data from the Transport Agency counts all vehicle traffic on state highways. The data comprises:

- Class 1 = 2 m to 5.5 m
- Class 2 = 5.55 m to 11 m
- Class 3 = 11 m to 17 m
- Class 4 = 17 m and over.

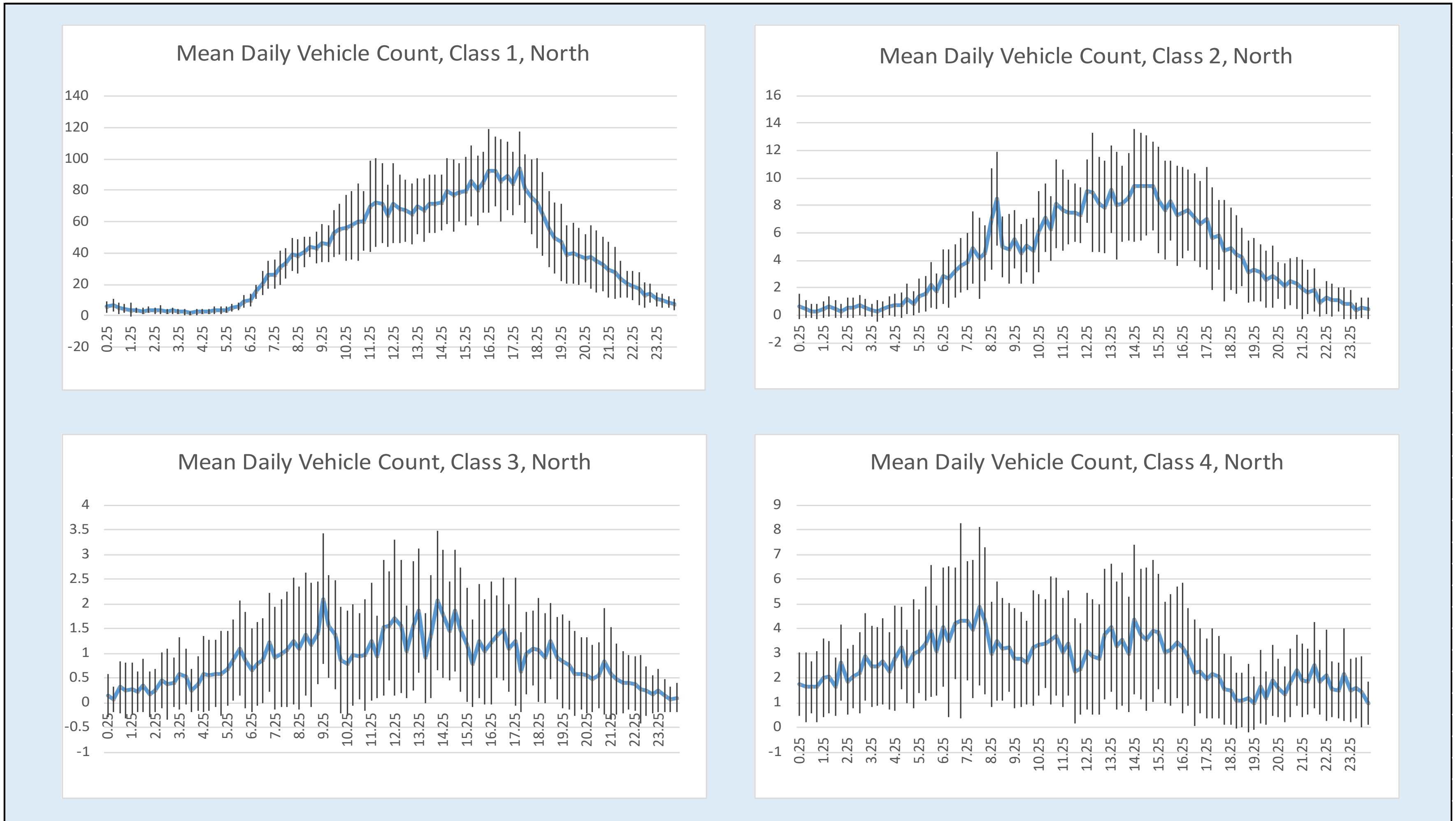
The relative proportions of each vehicle class can be altered in the model, as well as the total number of vehicles on each road segment.

To be consistent with the road data used in the previous project. rail data relates to August 2016. The data has been sourced from KiwiRail for all rail journeys in the North Island. The SD model is not a substitute for the complex capacity modelling and scheduling undertaken by KiwiRail. The rail data we have acquired facilitates our ability to study freight modes and capacities at the ports of Auckland and Tauranga. There is no rail network connection to Northport and there is no recent information in the public domain relating to the cost of upgrading the North Auckland Line (NAL) and connecting it to Northport, although estimates in 2010 indicate that extension of the line would need to occur at the same time as a much more expensive upgrade of the rest of the line to Auckland.[1]

---

[1] See *30 year transport strategy for Northland* produced in 2010. www.nrc.govt.nz/resource-library-summary/transport-publications/30-year-transport-strategy-for-northland

Figure 2.2 Example of mean daily traffic (Wellsford, August 2016)



August 2016 **Site: 01N00336 (WELLSFORD - Telemetry Site 17) location: 319/17.120**

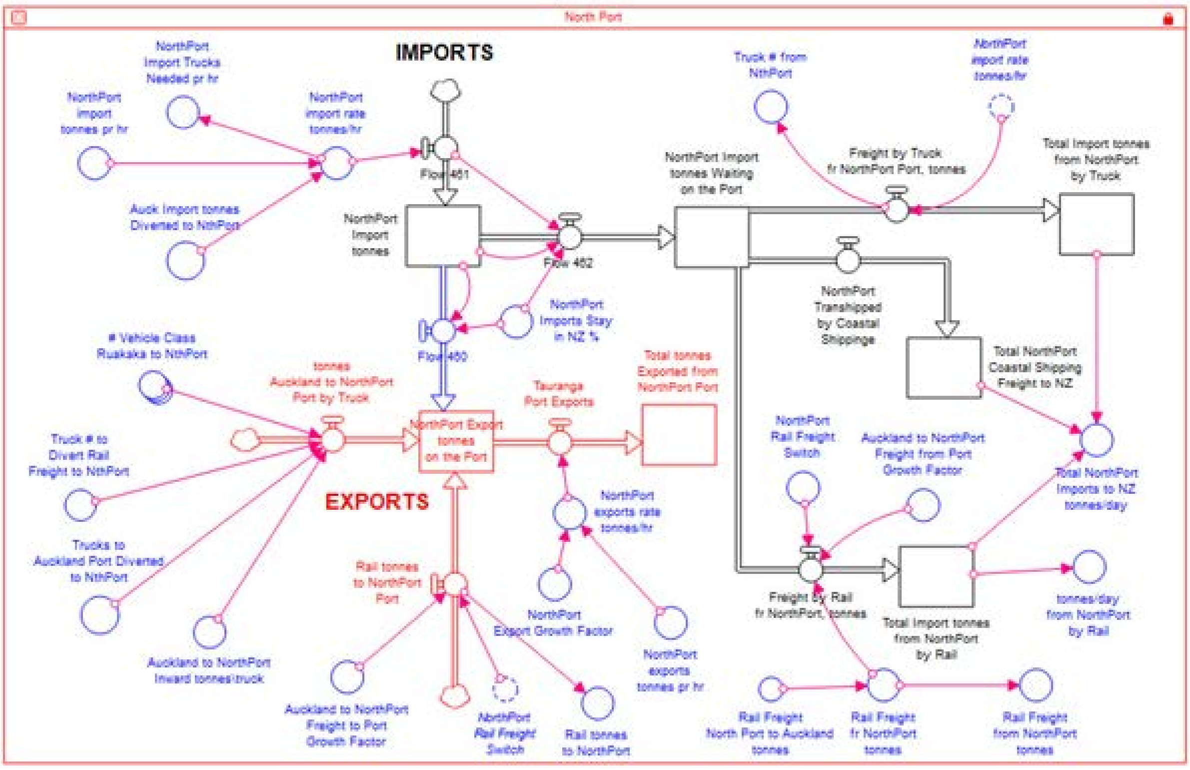
2.2 Northport structures

In the model the freight flows associated with imports and exports at each of the ports at Tauranga, Auckland and Northport are separated. In the case of Northport, structures have been included that allow for the transfer of either imports, exports or both from Ports of Auckland (assuming capacity exists at Northport). Figure 2.3 provides an example for Northport.

Structures for a rail link to Northport have been included even though this capability does not currently exist. This functionality is in anticipation of possible changes in the future.

Export freight arrives by truck at Northport. The model incorporates freight that already leaves New Zealand via Northport and can also be used to divert up to 100% of export freight that currently leaves New Zealand via Ports of Auckland – whether it arrives there by truck or by rail. It is assumed that each truck carries 30 tonnes of freight (refer below). For modelling purposes we need to have a mechanism for offloading trucks at the port so we assume that exports depart from the port at a constant rate. This has no effect on the model's operation. It is merely a quick way to incorporate the implicit assumption that there is enough storage capacity at the port to accommodate any timing differences between when trucks unload cargo and when it leaves the port by ship.

Figure 2.3 Model structure for Northport



Similarly the model tracks current imports into Northport and can also handle the diversion of imports currently entering New Zealand via Ports of Auckland. Imports are assumed to arrive at a constant rate, but again this assumption is purely a convenient way of ignoring operations at the port. The model allows for the freight arriving at the port to be distributed by road, rail or coastal shipping, but only the road freight option is currently simulated. Although a considerable proportion of imports into Ports of Auckland are motor vehicles, we again assume an average load of 30 tonnes per truck.

For both imports and exports, the model calculates the traffic volumes and travel times in both directions based on the total number of vehicles travelling between Auckland and Northport in August 2016. This includes the number of vehicles normally on the road, the extra trucks carrying diverted freight from Auckland and the extra trucks required to carry the higher volumes of imported freight south from Northport.

2.3 Freight mode

Rail data has provided us with an insight to freight modes at Tauranga and Auckland and therefore on the impact of transferring import and export freight from Auckland to Northport. As mentioned above the model we have developed here can simulate the effects on the SH 1 network of placing some or all freight onto the SH1 network between Northport and Wiri, and return. We have chosen Wiri simply because we need a destination in Auckland, and currently rail freight to and from Ports of Auckland travels via the inland port at Wiri. Built into the SD model is the capability to demonstrate the theoretical effect of introducing rail capacity to and from Northport.

The average modal ratios of freight to and from Ports of Auckland are shown below. Again this is for August 2016 so it is possible that the modal splits, and indeed the quantities could be different at other times of the year.

Exports:

- Exports from Ports of Auckland for August 2016 = 188,381 tonnes.
- Freighted by rail = 17,994 tonnes = 9.5%.
- Freighted by road = 170,387 tonnes = 90.5%.

Imports:

- Imports into Ports of Auckland for August 2016 = 383,782 tonnes.
- Freighted by rail = 24,938 tonnes = 6.5%.
- Freighted by road = 358,844 tonnes = 93.5%.

Additional detailed port freight transport data (freight movements and HCV volumes) has been obtained from Port of Tauranga and from Northport, from which we calculate that the average HCV load is 30 tonnes per vehicle. Details are provided in appendix A.

2.4 Economic activity projections

The original HAT SD model presented in *NZ Transport Agency research report 629* was accompanied by two vector autoregressive (VAR) models, a principal components (PC) model and a gravity model. Together they could be used to project the amount of traffic in the HAT triangle out to 2025 or beyond, which could then be incorporated into the SD model. The models were as follows:

1 VAR model of GDP by industry, which projects industry shares of GDP (for eight industries) and the level of aggregate GDP based on 16 years of data. The level of GDP can either be endogenously determined by the VAR model or set exogenously.

2 PC model, which reduces an initial matrix of eight industries by 15 regions (by 16 years of data) to a matrix of eight industries by one or two PC regions (by 16 years). This produces an 8x16 matrix for the set

of first PCs (PC1) which typically captures 95% of the variation by region. Adding the second PC (PC2) raises the explanatory power to 99%.

3 VAR model of GDP by PC region, which uses the output from the PC model, notably PC1 and PC2 to obtain projections of industry by PC region share matrices, again with 16 years of data. These projections are then converted back into the full 15 regions by using the eigenvectors from the PC model. Applying the projected industry by region share matrices to the projections of GDP by industry from the first VAR model, yields projections of GDP by region in level form.

4 Gravity model, which relates inter-regional trade (freight) flows to distance and GDP projections (from the VAR model), as desired for input into the SD model.

The design of these models was such that extending the coverage to Northland was relatively straightforward. The results are shown in table 2.1 using endogenous total GDP.

Projected growth along the Auckland–Whangarei route is higher than on the Auckland–Hamilton route, a consequence of stronger GDP growth in Northland than in Waikato, which in turn is largely attributable to forestry growing faster than dairy processing. (Note that logs from Kaingaroa forest, although in the VAR models, are not in the modelled upper North Island region). However, as before, we consider these projections as probably being too high and have not used them in our scenario analysis in chapter 3.

Table 2.1 Changes in freight flows 2012–2025 by WHAT route segment

Route	Direction	Change
WA	S	61.8%
	N	61.8%
AH	S	60.7%
	N	60.2%
HY	E	57.1%
	W	56.4%
AX	S	60.3%
	N	60.0%
XY	S	60.8%
	N	61.6%
XT	S	57.9%
	N	58.2%
YT	E	55.0%
	W	54.0%

3 Port scenarios

We present some scenarios that look at taking the exports and imports that currently flow through Ports of Auckland and routing them through Northport instead. We emphasise that it is not a cost-benefit analysis of such a proposal. It is merely an illustration of how the model could be used to obtain an order of magnitude estimate of the effect on the number of truck movements and travel times between Northport and Auckland.

The scenarios are as follows:

Northward traffic

1 Base case

2 100% of trucks carrying export freight diverted from Ports of Auckland to Northport

3 100% of trucks and rail carrying export freight diverted from Ports of Auckland to Northport.

Southward traffic

1 Base case

2 All Ports of Auckland imports diverted to Northport and transported south by truck

3 Plus an extra 30% class 1 vehicles on SH1 between Auckland and Whangarei

4 Plus a reduction in road efficiency.

For all scenarios where road is substituted for rail we assume 30 tonnes per HCV.

Exports leaving Northport rather than Ports of Auckland would require an additional 6,279 HCVs per month or 202 HCVs per day to travel the 165 kilometre journey on SH1. Imports arriving at Northport rather than Ports of Auckland would require an additional 12,793 HCVs per month or 412 HCVs per day. Each direction is modelled separately so we do not include return journeys of either empty or (partially) full trucks. Accordingly the number of trucks moving in each direction could be understated. On the other hand, insofar as some imports into Auckland are destined for Northland (and some exports through Ports of Auckland come from Northland), we could be overstating the increase in truck numbers.

Figure 3.1 shows the number of class 4 trucks on the ALPURT to Wellsford segment of SH1 for the base case and two scenarios where freight originally destined for export from Ports of Auckland is instead diverted to Northport. (The increase in the number of trucks shown on the graphs is slightly different from that given above due to linearisation error in the model's differential equations – likewise in figure 3.3). The spikes in run 3 correspond to trains, which arrive at discrete intervals, being displaced by trucks. In reality we would expect some rescheduling of truck movements.

Figure 3.2 shows the travel time over the whole distance, including the ALPURT-Wiri segment. The profile over the course of the day is caused almost entirely by variation in travel times over that ALPURT-Wiri segment, the very segment that is not modelled. For the other segments congestion is not an issue – at least not on a typical August day.

The data in the tables to the left and right of the graphs relates to the last scenario plotted; for example run 3 in figure 3.2. There are many other graphs and tables that can be extracted from the model, as well as numerous levers and dials than can be used to run different scenarios, some of which are shown in the figures. We refer the reader to *NZ Transport Agency research report 629*.

Figure 3.1 Number of vehicles travelling northward from ALPURT to Wellsford

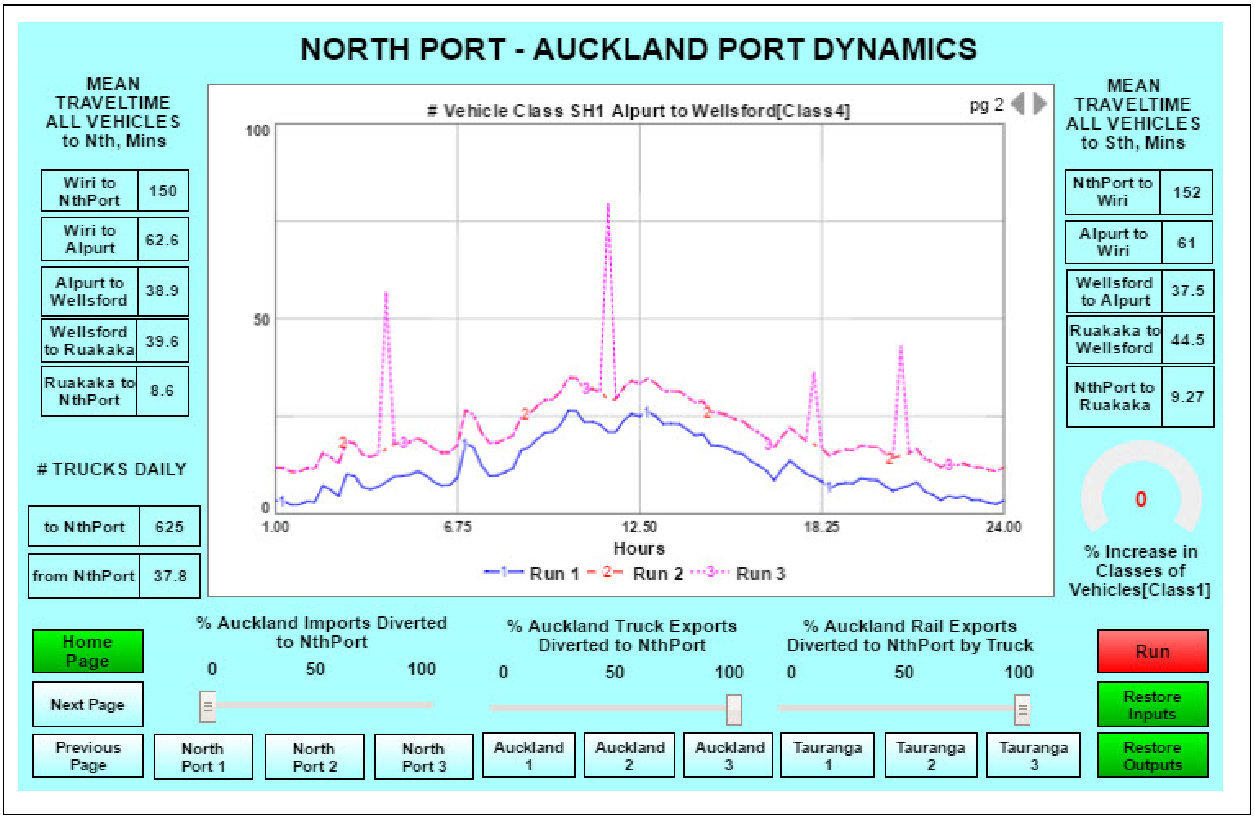


Figure 3.2 Travel time northward from Wiri to Northport

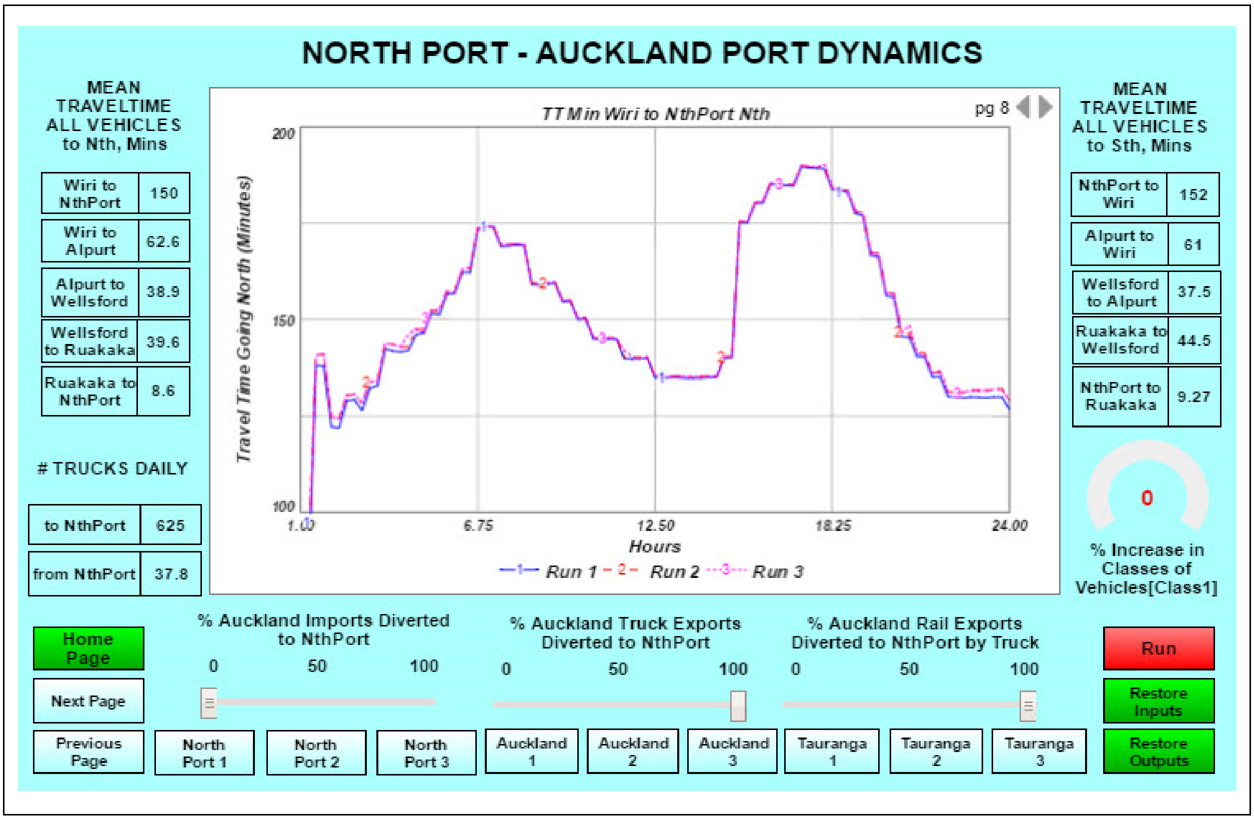


Figure 3.3 Number of vehicles travelling southward from Wellsford to ALPURT

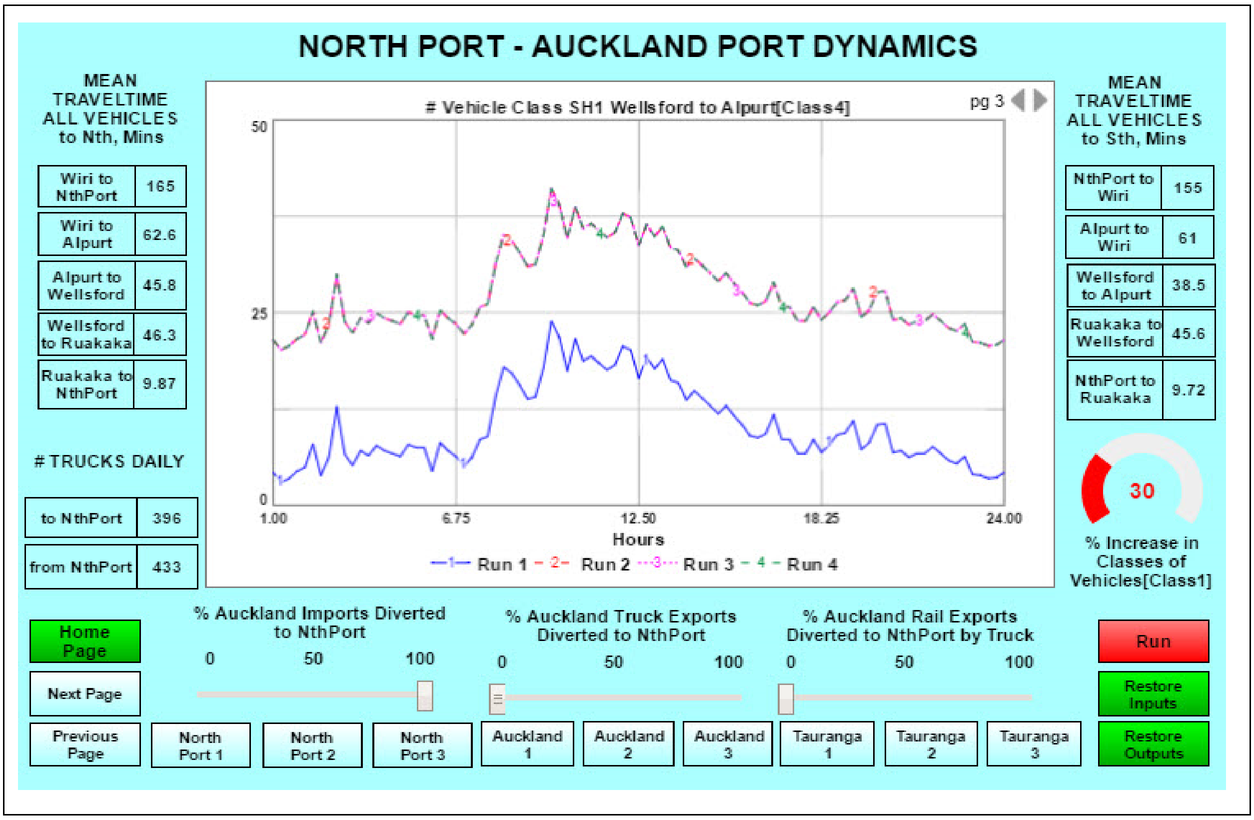
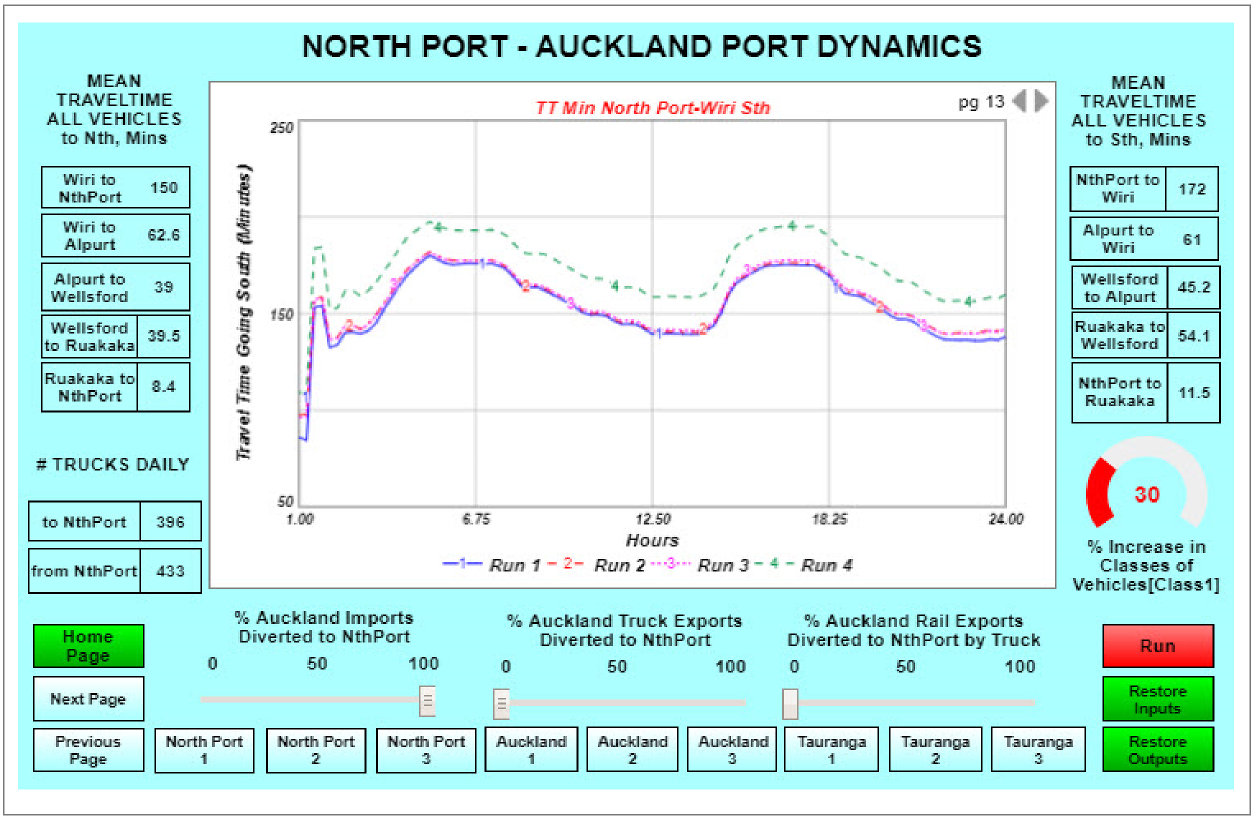


Figure 3.4 Travel time southward from Northport to Wiri



As can be seen in figure 3.2, putting extra trucks on the road has little effect on travel times – their number is simply too low relative to the number of cars to make any appreciable difference to congestion along the Northport to ALPURT segments. The same result occurred with the previous Auckland−Hamilton−Tauranga version of the model.

We explore this result further in the southward scenarios. In run 3 the number of class 1 vehicles (light passenger vehicles) is raised by 30%. Again there is little effect on travel time (figure 3.4) along the ALPURT to Northport route, noting that the Wiri to ALPURT segment is not modelled. Hence north of ALPURT there is enough capacity on the road to accommodate more class 1 vehicles – at least on an average day in August. Summer holiday traffic may well be a different story.

However, as explained in *NZ Transport Agency research report 629,* travel time along a road segment is a function of the length of the segment, its mean free-flow speed (with no congestion) and the number of vehicles on the road, adjusted for vehicle length and following distance. Arguably the effect of a significant increase in the number of large trucks could mean that other vehicles will only maintain their original mean speed if they can easily overtake the extra trucks. On New Zealand's mostly single-lane (per direction) road network, notably much of the highway north of Puhoi, cars cannot easily overtake slow-moving trucks. Hence mean speed would fall, thereby raising travel times by more than the pure effect of the increase in road space required by large trucks.

To simulate this effect we reduce the 'efficiency' of the road – a parameter in the model that can be used to simulate the effects of road realignment, the addition/removal of lanes, traffic disruptions and so on. We assume an arbitrary, but hopefully not unrealistic 20% reduction in efficiency. This is denoted as run 4 in figures 3.3 and 3.4. (The 20% could be varied by road segment.)

The change in road efficiency raises travel time by about 20 minutes, or about 13% on a journey that takes an average 150 minutes or so. If this attempt at simulating the negative effect on mean speed caused by more large trucks on the road (by generating a need for more overtaking to maintain mean speed, as opposed to just requiring more road space) is plausible, any significant rise in the number of large trucks needs to be accompanied by greater investment in infrastructure, eg double lanes, passing lanes or road realignment.

A refinement of this scenario could specifically consider the windy Brynderwyn hills section of SH1 which has few passing opportunities. It might be possible to endogenise the model's efficiency parameter to replicate some of the journey experiences on this road, which would then provide a baseline for testing the effect of more trucks. Nonetheless it seems clear that any serious cost-benefit analysis of transferring port activity from Auckland to Northport must incorporate transport improvements that prevent a potential deterioration in travel time.

As noted above, none of the foregoing analysis is intended to be a cost-benefit analysis of port restructuring. Other factors that would need to be considered include changes in the cost of transportation, changes in greenhouse gas emissions, the amount of land available at each port to cope with increased activity (refer to appendix A), investment in road and rail infrastructure, and so on. These considerations were beyond the scope of this project.

4 Future research

As with *NZ Transport Agency research report 629* the main purpose of this project was to develop a high level SD model of traffic flows along the main road routes in the upper half of the North Island. We have expanded the previous model to include Northland and focused the model more on freight flows in the context of exploring possible port restructuring. Nevertheless the model is still very experimental, being based on data for only one month (August 2016). Other months, such as January which has much more holiday traffic, could show quite different travel time profiles, as might be the case 10 or 20 years in the future. *NZ Transport Agency research report 629* looked at some growth scenarios. More calibration and testing (travel time function, 15-minute pulsing of traffic, length of road segments, etc) are required before one can have high confidence in counterfactual scenarios that diverge from the base case.

With regard to potential model enhancements, the following seem useful:

- Being a high-level SD model, it will never be suitable for thorough cost-benefit analysis of transport scenarios, but incorporation of the main components of travel costs would assist in identifying which scenarios might be worth more detailed cost-benefit analysis. In this connection complementary research using other types of models such as the Waikato regional transport model could be worthwhile.
- The model includes the potential for rail to and from Northport and also to simulate coastal shipping. If activated these routines could provide valuable contributions to the discussion about the future development of Northport.
- Should large-scale substitution between Ports of Auckland and Northport ever occur there may be a need to investigate the viability of an inland port north of Auckland. From an SD modelling perspective this is relatively straightforward.
- The model has complex internal mechanisms, but also a user friendly interface designed to answer a wide range of questions easily and quickly. There is further scope to tailor the interface to specific user needs.
- Not explicitly including the ALPURT to Wiri route in the model may cause it to understate congestion effects. Although it was noted earlier that an SD model is not well suited to analysing traffic flows in a dense urban area, it may be viable to include at least the main SH1 route between Wiri and ALPURT.

It is important to emphasise that the developed modelling system is specific to the issues and locations in the upper North Island for which the project was commissioned. The model will not immediately be applicable to other areas, nor to all issues within the WHAT area. Nevertheless the modelling system is adaptable to other areas such as the lower North Island, although this would require more data gathering and model testing.

Appendix A: Port summaries

A1 Ports of Auckland

Ports of Auckland's main cargo wharves are located at the northern edge of the Auckland CBD. It is New Zealand's most significant port for imports when measured by value – around $22 billion annually. It is also the country's largest vehicle import port and handles about 100 cruise ships each year. The value of imports is roughly three times larger than the value of exports flowing through the port.

The port has good rail access to the south and is close to the SH1. There is intensive development around the port with many commercial and residential buildings on its perimeter (in some cases on what was once port land). Geographical enlargement of the port is severely constrained.

Ports of Auckland operates an inland port at Wiri in South Auckland. It is essentially an interchange facility that reduces the number of trucks that have to travel to and from the port by replacing them with trains running between the inland port and the wharves.

Imports

Tonnes imported August 2016	Tonnes freighted out by road	Tonnes freighted out by rail
For annual totals see https://figure.nz/chart/6M0O2rIDd6mJRJxj-eBWhfRefju8dtV7Q		
383,782	**358,844**	**24,938**

Exports

Tonnes exported August 2016	Tonnes freighted in by road	Tonnes freighted in by rail
For annual totals see https://figure.nz/chart/yjH1DohCAXxm31Jp-KJZz1Uai1wpArl1d		
188,381	**170,387**	**17,994**

Port of Tauranga

Port of Tauranga is New Zealand's largest port. Exports have grown from 2,647,564 tonnes in 1989 to 14,284,710 in 2017.

The port is well served with land transport infrastructure. The rail link Auckland–Hamilton–Tauranga carries more freight than any other rail connection in New Zealand. In 2016 over 10 million tonnes of freight were moved on this rail link. Rail links from Kinleith and Murupara to Port of Tauranga carry bulk logs for export.

In August 2016 there were 326 scheduled freight trains to the port carrying 270,398 tonnes of freight.

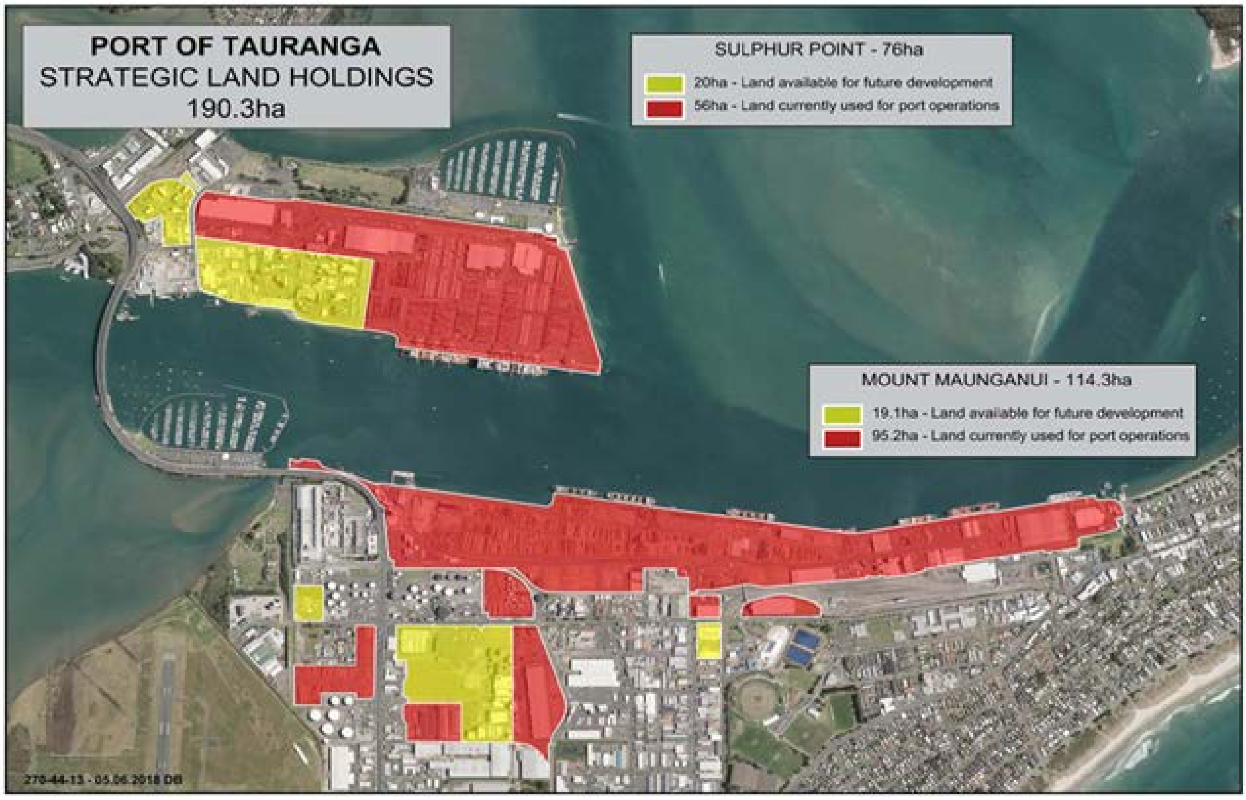
There are some pinch points on the Auckland–Hamilton–Tauranga line and KiwiRail has forward planning and investment to address these issues.

State highway infrastructure servicing the port comprises SH1, SH2, SH27, SH29, SH33 and SH36. Significant improvements to the Waikato Expressway will see a four-lane highway connection from Bombay Hills to South of Cambridge – expected date of completion December 2020. It is envisaged these improvements will remove significant traffic from the SH2 route. These improvements will also create a pinch point on SH29, over the Kaimai Ranges.

The port has provided the research team with a map of expansion plans both for the container port at Sulphur Point and the bulk port at Mt Maunganui. See figure A.1.

Port of Tauranga operates an inland port – MetroPort – in South Auckland.

Figure A.1 Port of Tauranga land holdings



Imports

Tonnes imported August 2016 (data sourced from Port of Tauranga)		Tonnes freighted out by road	Tonnes freighted out by rail
Chemicals dry	13,993		
Fertilisers	84,005		
Frozen meat	10,204		
Grain	31,632		
Liquid bulk	12,587		
Oil products	132,269		
Palm kernel	53,714		
All other goods	312,252		
Total	**649,656**	**526,273**	**123,383**

Exports

Tonnes exported August 2016 (data sourced from Port of Tauranga)		Tonnes freighted in by road	Tonnes freighted in by rail
Logs	586,441		
Apples	2,107		
Cars	92		
Chemicals	7,722		
Fertilisers	13,783		
Frozen meat	26,077		
Kiwifruit	122,617		
Dairy	127,106		
Paper products	45,654		
Salt	4,853		
Sawn timber	72,035		
Steel	21,207		
Wood panels	11,842		
Wood pulp	43,991		
Other goods	162,847		
Total	**1,248,374**	**977,976**	**270,398**

Northport

Northport, previously Port of Whangarei, is a natural deep-water port located on the Marsden Point Peninsula. Exports have risen from 443,407 tonnes in 1989 to 3,531,420 tonnes in 2017. In 2017 imports were 5,704,766 tonnes, more (by weight) than any other port in New Zealand.

Northport has significant land footprint options. There are 75 hectares of current port land and over 180 hectares of land outside the port, which are available for port-related ventures and operations. More than 120 hectares are zoned as commercial zone four, meaning they are suitable for heavy industrial businesses.

Northport is served by the State Highway network. Distances include:

- Northport via SH15A to SH1 at Ruakaka – 8.7 km
- Northport to Whangarei via SH15A & SH1 - 35.3 km
- Northport to Wiri via SH15A, SH1 & SH20 – 165 km

There is no rail link to Northport, although it is not far from the main trunk line.

Imports

Tonnes imported August 2016 (data sourced from Northport)		Tonnes freighted out by road	Tonnes freighted out by rail
Coal	36,047		
Fertiliser	613		
Total (excl oil)	**36,660**	**36,660**	**Nil**

Exports

Tonnes exported August 2016 (data sourced from Northport)		**Tonnes freighted in by road**	**Tonnes freighted in by rail**
Logs	293,412		
Laminated veneer lumber	5,608		
Sawn lumber	182		
Woodchip	15,543		
Veneer	5,562		
Triboard	4,866		
Kiwifruit	945		
Other	1,445		
Total	**327,563**	**327,563**	**Nil**