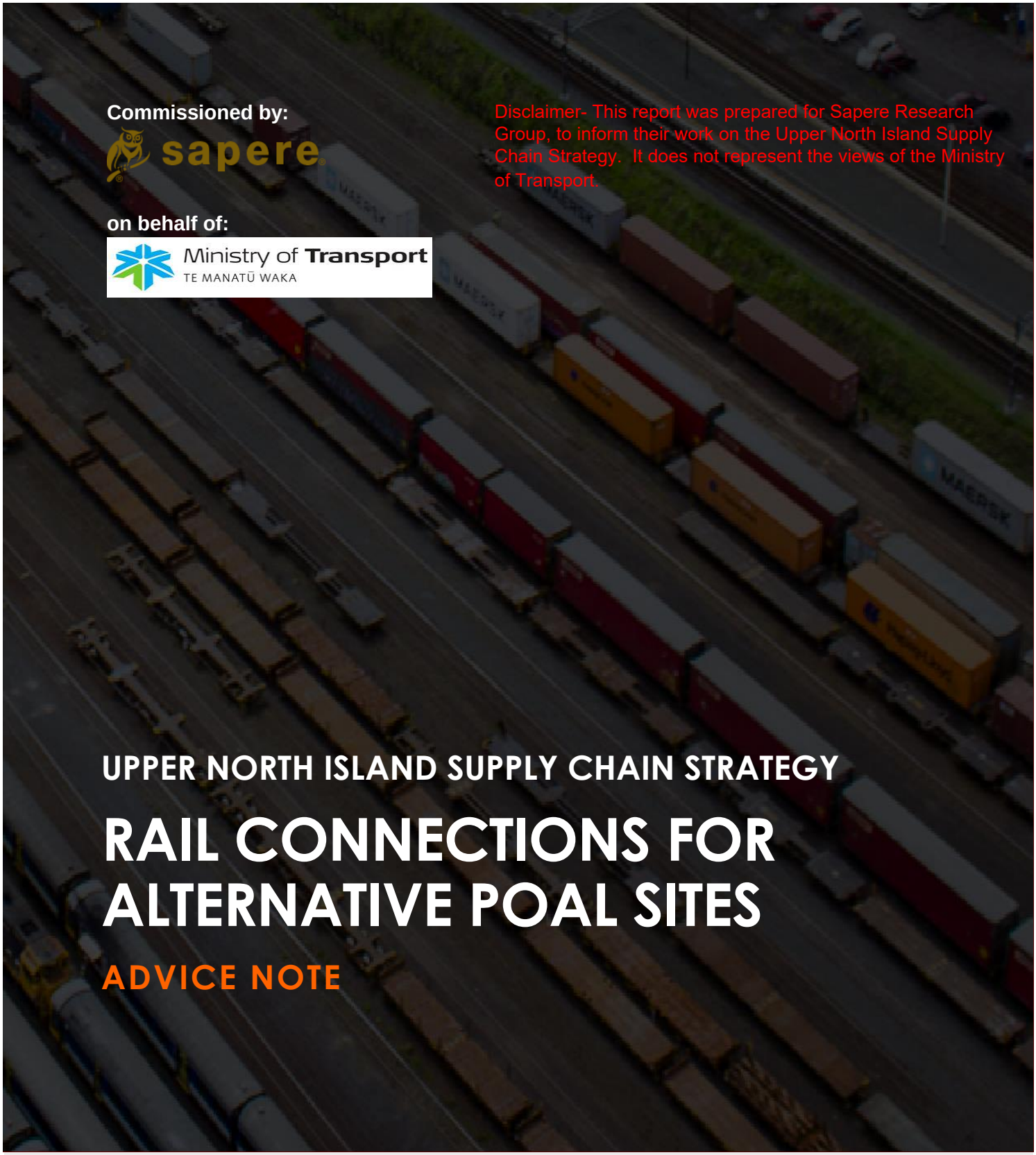


Commissioned by:

sapere

on behalf of:

Ministry of Transport
TE MANATŪ WAKA

Disclaimer- This report was prepared for Sapere Research Group, to inform their work on the Upper North Island Supply Chain Strategy. It does not represent the views of the Ministry of Transport.

UPPER NORTH ISLAND SUPPLY CHAIN STRATEGY

RAIL CONNECTIONS FOR ALTERNATIVE POAL SITES

ADVICE NOTE

Date
April 2020

Reference
MOT-POA-GEN-RIC-MEM-000001

Issue
3.1 - FINAL

RAIL INFRASTRUCTURE CONSULTANTS (NZ)

Change History and Approval

REVISION NUMBER	ISSUE DATE	PRODUCED BY	REVIEWED BY	SUMMARY OF REVISION
1.0	March 2020	Stephen Knight Desiree French	Rob French	Working draft for internal discussion
2.0	March 2020	Stephen Knight Desiree French	Rob French	Final Draft for review
3.1	April 2020	Stephen Knight Desiree French	Rob French	FINAL

Approvals

ROLE	NAME	ORGANISATION	SIGNATURE	DATE
Principal	Gary Blick	Sapere		

Contents

1 Executive Summary

This report has been commissioned to inform an officials-led Upper North Island Supply Chain Strategy (UNISCS) Work Programme that is assessing the options for a full move of the Ports of Auckland freight operations. The options in scope are:

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

Sapere was engaged as the lead consultancy to prepare a cost benefit analysis of these options. Sapere commissioned RIC NZ Ltd to consider indicative rail alignments that would be required under some of the options and to prepare high-level costings of those alignments.

The rail alignments in scope for this report are those for a new port on the Manukau Harbour and the Firth of Thames, at sites identified in the 2016 Port Future Study. The locations are listed below (and annotated on the map on the following page):

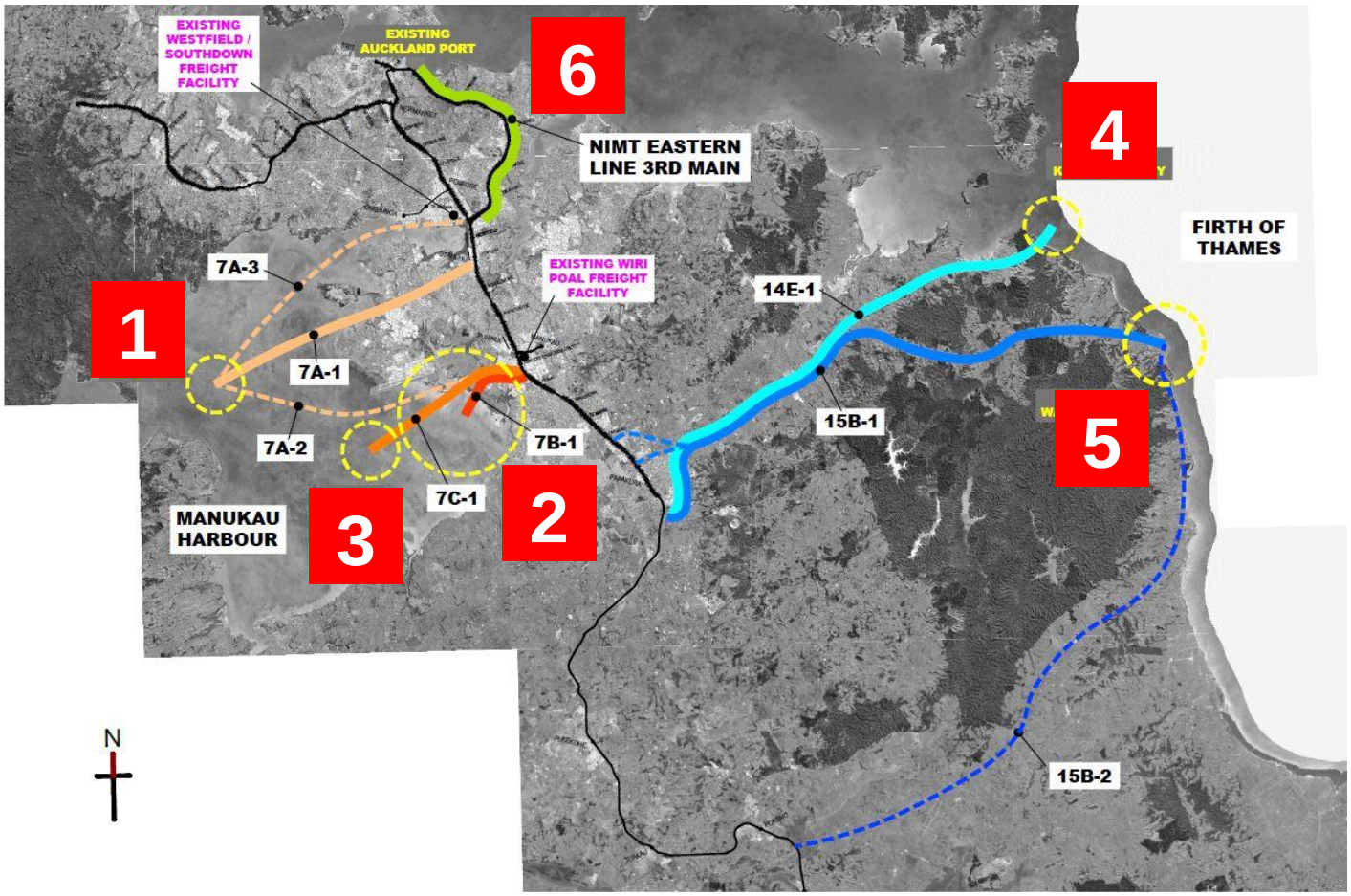
1. Manukau: Central Manukau Harbour (site 7A)
2. Manukau: Puhinui (site 7B)
3. Manukau: Hikihiki (site 7C)
4. Firth of Thames: Kawakawa Bay (Site 14E), and
5. Firth of Thames: Waimango Point (site 15B).
6. In addition, to inform the consideration of a base case in their cost benefit analysis, Sapere also asked RIC NZ Ltd to assess the potential cost for a third track on the NIMT Eastern Line from Westfield Junction to the existing POAL location, if that should be required in the long term under a counterfactual scenario.

This advice note forms part of wider investigations, and is not in itself intended to infer a recommended option.

The indicative scope, costings and programme assessments provided are for macro **rail/civil and land only**, excludes the port facilities themselves, and is intended as relativity between options rather than direct budgeting purposes.

This advice note had been prepared in a very short timeframe, and as such cannot be considered a 'definitive' view or reviewed/endorsed by KiwiRail, Auckland Transport or other organisations.

The primary purpose of this report is to investigate the likely rail alignments required to connect the sites to the existing rail network, as indicated on the diagram below.



The approach to this study has been a desk top study based on publicly available material.

The likely connection points to the existing mainlines have been identified, cognizant of the future network operations plan, with each route then being assessed on an indicative 3D basis.

The resultant rail /civil scope and macro implications on land have then been priced using the NZTA Schedule of Elemental Prices (modified for this pre-feasibility level assessment).

Findings

The following summarizes the macro **rail/civil and land costs only** for each route in $bil.

Manukau			Firth of Thames			Existing Port
Central Manukau Harbour (site 7A)	Puhunui (site 7B)	Hikihiki (site 7C)	Kawakawa Bay (site 14E)	Waimango Point (site 15B)	Waimango Point via Mercer (site 15B)	Westfield to Quay Park - Third Main
7.1	2	5.1	8.6	12.1	15.5	1.3

Refer to Appendix 3 for additional detail and cost build up information.

2 Context

This report has been commissioned to inform an officials-led Upper North Island Supply Chain Strategy (UNISCS) Work Programme that is assessing the options for a full move of the Ports of Auckland freight operations. The options in scope are:

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

Sapere was engaged as the lead consultancy to prepare a cost benefit analysis of these options. Sapere commissioned RIC NZ Ltd to consider indicative rail alignments that would be required under some of the options and to prepare high-level costings of those alignments.

The rail alignments in scope for this report are those for a new port on the Manukau Harbour and the Firth of Thames, at sites identified in the 2016 Port Future Study. The locations are:

- Manukau: Central Manukau Harbour (site 7A)
- Manukau: Puhinui (site 7B)
- Manukau: Hikihiki (site 7C)
- Firth of Thames: Kawakawa Bay (Site 14E), and
- Firth of Thames: Waimango Point (site 15B).

In addition, to inform the consideration of a base case in their cost benefit analysis, Sapere also asked RIC NZ Ltd to assess the potential cost for a third track on the NIMT Eastern Line from Westfield Junction to the existing POAL location, if that should be required in the long term under a counterfactual scenario.

3 Document Purpose

The primary purpose in this report is to investigate the likely rail alignments required to connect the sites to the existing rail network, and to quantify the macro infrastructure elements and cost of each option.

A secondary purpose of this report is to capture relative issues and opportunities that are raised through the alignment investigation that are worth noting for future wider studies. These may be operational, rail network planning, or even other major Auckland infrastructure or land use influences that have taken shape since the last report studies were completed.

This advice note is to form part of wider investigations, and is not in itself intended to infer a recommended option.

The costings provided here are intended to inform relativity between port location options, rather than for budgetary purposes.

4 Disclaimer

This advice note had been prepared in a very short timeframe, and as such cannot be considered a 'definitive' view, however it has been based on historic knowledge of the Auckland Network through involvement with:

- *ARDP – 30yr plan including 3rd and 4th mains and Pukekohe electrification*
- *City Rail Link – Including wider network infrastructure and train planning*
- *Network level crossing grade separation investigations*
- *LRT*
- *SMART – Heavy Rail to the Airport Investigations*

The views and advice contained herein are from the RIC team, and should not be considered as reviewed or endorsed by KiwiRail, Auckland Transport or other organisations.

Given the above, we have attempted to consider a 'reasonably practical' alignment for each of the sites on which to generate an indicative costing on, however these alignments should in no way be considered as 'correct' or 'proposed'.

Every attempt has been made to bring historic decisions / implications / assumptions up to date with current influences, however these cannot be guaranteed without more in-depth evaluation outside of the remit of this study.

All rail alignments considered in this report are for the purpose of considering feasibility and cost at a high level. They do not represent government plans.

5 Assessment Approach

5.1 Network Operations

A significant influence on the rail routes are the connections to the existing mainlines.

Initially, these are more driven by anticipated network operations and train patterns than by physical geometrics and engineering.

This review considers these macro operations first by analysing the assumptions on train patterns from ARDP out to 2045 in terms of the post-CRL train plan and predicted network expansion, overlaid with the existing freight hubs, how they connect with the proposed port locations, and new connection options.

5.2 Rail Connection to NIMT Mainline

The likely locations for the physical connections are driven by major infrastructure constraints such as existing overbridges, streams, land use, rail connectivity (locations of crossovers etc), and alignment geometrics.

These have been assessed at a high level as part of this work, or based on historic work where there has been investigation already (ie SMART Heavy Rail to the Airport Puhinui Area optioneering)

This assessment has not delved into significant detail, other than to consider feasibility, conceptual connectivity, and a nominal cost for a 'grade separated junction'.

5.3 Rail Route

Assessment of the alignments and associated civil works for each option has been based on publicly available topography, district planning information, geological and hydrological maps.

The route selected to represent each option has been made by engineering judgement given the constraints and/or a conservative sub option.

This has included a high-level assessment / quantification of the infrastructure required for that option e.g. bridges, tunnels, causeways, earthworks volumes, and potentially possible property impacts if any.

An indicative 3D model of the alignments has been generated in Bentley Concept Station using this data, and this has been used to determine the complexity of the civil works and macro infrastructure required (ie tunnels/bridges), as well as indicative quantum of cut/fill used in the cost analysis.

5.4 Constructability

Constructability, and programme, have an impact on cost.

Constructability has been assessed based on the land form, the complexity of infrastructure required, and impact on live operations where applicable.

For each location an indicative alignment was decided by visually checking the available topographical and planning information. Once the likely route was defined, this alignment was then overlaid with an assessment of difficulty for the civil works (Easy, Medium or Hard) using knowledge of the land layout over the identified route.

A macro level programme assessment based on timeframe assumptions has been developed to assist an Multi Criteria Analysis (MCA) of the different routes (An MCA is not included within this report)

5.5 Scope and Cost

The level of scope certainty in high-level concept design carries cost risk and scope creep risks. The alignment design is 2D and although 3D Concept Station software has been used to assist with some civil scope estimation for the Firth of Thames routes, the civil scope is an

area of focus for refinement at the next stage of business case development, design and cost analysis.

The costs are based on the layout drawings and scope identified for each route.

To enable a build-up of cost and to allow comparison between the different options, the costs have been split up into categories, aligned where relevant to the NZTA Schedule of Elemental Prices.

Given the limited level of design development and accuracy of base data, a number of cost items have been simplified into 'number of' items and/or classified as 'easy-medium-hard' and assigned cost levels appropriately.

5.6 Third Main from Westfield Junction to Quay Park

We have historically undertaken some investigations on a 3rd main on the NIMT eastern line (Westfield Junction to POAL) as part of ARDP, and have refreshed this with current knowledge and high-level costing.

The primary clarification of scope from the previous assessment is that the W2QP project has progress and confirmed a revised extent of works that the 3rd main would tie into at both the Westfield Junction and Quay Park ends.

6 Assumptions

The following assumptions have provided guidance to decisions adopted in this advice note:

6.1 Operational

- The 'existing' network is as per the ATAP 30yr plan, with a 4 main NIMT Pukekohe to Westfield, and 2 main NIMT eastern line to the existing POAL (**note -** The ATAP Report in 2016 allowed for a 3rd Main between Pukekohe and Papakura but the current update and work being undertaken by the Southern Growth Alliance is allowing for a 4th main between Pukekohe and Papakura)
- Any rail connection to mainline assumed to be fully, or at least partially, grade separated (any new connection to network must not create a legacy issue that hinders future timetabling, even if as expected we'd be running a 4 main corridor by that time)
- The 3rd main NIMT east assumes that the W2QP infrastructure has been completed
- It is assumed that there will be a period of transition between the existing site and any proposed site.
- For the Firth of Thames options, assumed single track construction with a 2km passing loop allowed approximately every 10km.

6.2 Design

- Climate change/sea level rise will affect the vertical alignment. Assumed design levels are min 4m above sea level.
- Above also applied through the flood prone areas of Clevedon Valley
- If route impacts on the known underlying peat areas in Papakura/Takanini area, assume greater complexity in the civil elements.
- Assumed that the Mill Rd arterial road has been completed and major road bridge structures are required, assumed to go over rail
- Assumed that all collector roads or higher classification will be grade separated (likely road over rail), with lesser roads nominated for level crossings.
- Rail Geometry:
  - Max Longitudinal Grade = 1 in 80 or 1.25%
  - Design Speed = Aspirational 120kph, Desirable Min 80km/h, Absolute Min 50kph.
- Civil:
  - Ballast = 0.5m depth x 3m width (Single Track), 6m width (Dual Track)
  - Formation = 0.2m depth x 8m width (Single Track), 12m width (Dual Track)

  - Earthworks Cut/Fill Batters = 2.5:1

- Tunnels:
  - Inserted where height above track exceeds ~10m.
  - Type = Circle
  - Diameter = 11.5m (to futureproof for potential double tracking / interim access)

- Bridges:
  - Inserted where height above ground level exceeds 4m approx.
  - Type = Box Girder
  - Width = 12m (to futureproof for potential double tracking including bridge barriers)
  - Deck = Concrete 1m Depth with 0.5m Ballast

6.3 Costing Assessment

A variety of estimation methods have been used to compile the base estimate for physical works for each of the options:

- Provisional sums (where more detailed workups are not practical based on the limited concept design information available)
- Current market rates from recent rail business case development
- Generalised rates from similar projects undertaken in the rail environment
- Bottom up desk-top analysis for some rail specific items

RIC have not engaged a quantity surveyor to validate rates or estimation techniques at this stage. The estimates provided here are intended to inform relativity between port location options, rather than for budgetary purposes.

6.4 Land Requirements

- Acquisition of 20m wide corridor of land will be required to allow for potential future double tracking (Manukau Harbour and Firth of Thames routes)
- An additional strip of land of up to 4m wide alongside the existing corridor will be required (NIMT 3rd Main)
- Acquisition of farmland may sever properties requiring alternate access or crossing to be constructed
- Tunnels under farmland will not require property purchase but half market rate for the land has been allowed to fund compensation to landowners
- Residential land will require full property purchase though only half may be required for the corridor
- Industrial / Commercial property may require full property purchase / business disruption compensation / building relocation etc.

- Seabed land for construction of marine bridges will have no cost but the planning and consent process to gain permission to construct will have programme implications.
- Iwi contributions or other charges to secure access to the marine area for construction are excluded from this assessment.
- Construction of road access to the Manukau Harbour options is excluded from this cost assessment.

7 Network Operations Assessment

As a baseline for this assessment, it is assumed that the ARDP/ATAP forecast post CRL 30yr train plan is in operation which results in the NIMT being 4 mains between Pukekohe to Westfield, with the NIMT Eastern line to the existing Port and the NAL remaining at 2 mains.

Although not set in stone, there is some logic behind the philosophy that where there is 4 mains that the western two mains are used for long distance/express (skip stop) metro as well as freight, and the eastern two mains are used for high frequency all stopping metro.

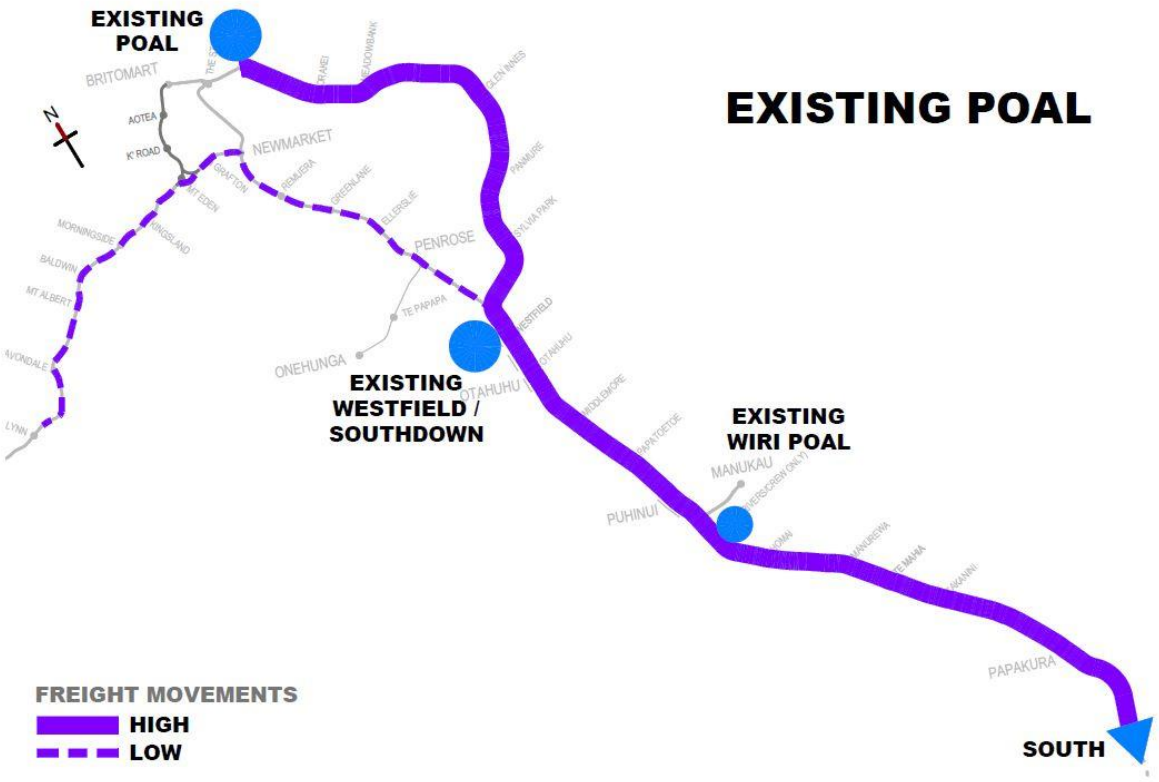
In the context of this assessment, this suggests that the Manukau Harbour options connect to the 'correct' side of the corridor operationally via a potentially less complicated grade separated rail junction, but make access in and out of the Wiri POAL more difficult/disruptive to the timetabling.

For the Firth of Thames options, a more complicated grade separated rail junction would be required to ensure connection across the eastern to the western set of mains. It also makes access in and out of the Wiri POAL potentially difficult/disruptive to the timetabling.

7.1 Existing POAL Location

Currently there is a heavy volume of freight traffic on the NIMT from the existing POAL to the South. This included movements in/out of Westfield/Southdown Hub, and the Wiri POAL hub.

There is limited volume on the NAL.



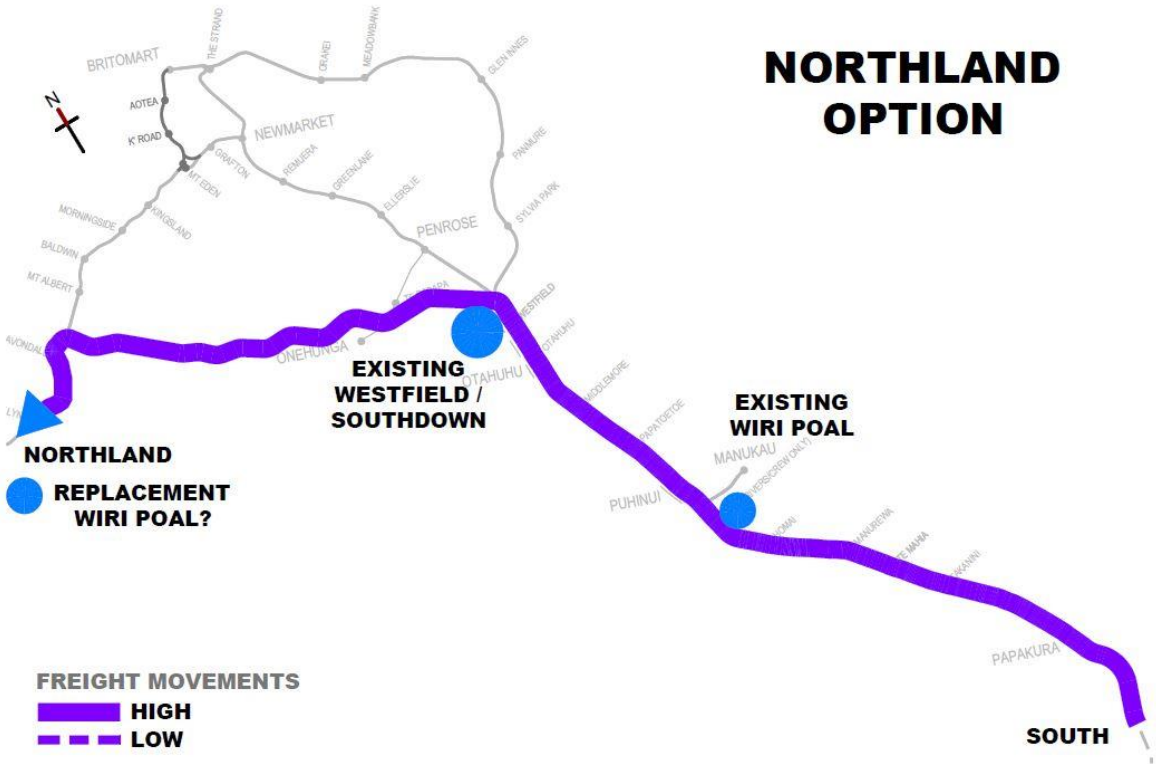
With the Post CRL timetable and growth expected over the next 30yrs and beyond, the metro volumes will increase on all lines. The result of this has driven the expected increase to 4 mainlines from Westfield south on the NIMT to Pukekohe.

Given the potential configuration of the 4 mains being two sets of two up and down mains, the Wiri POAL hub could be considered on the **'correct'** side of the railway to service to and from the existing POAL site.

7.2 Northland Option

With this option the freight movements on the NIMT Eastern line would drop significantly (or none at all).

The volume of freight is expected to exceed the capacity of the NAL (taking into account the expected post CRL metro train plan) to the point where the Avondale-Southdown connection is required.



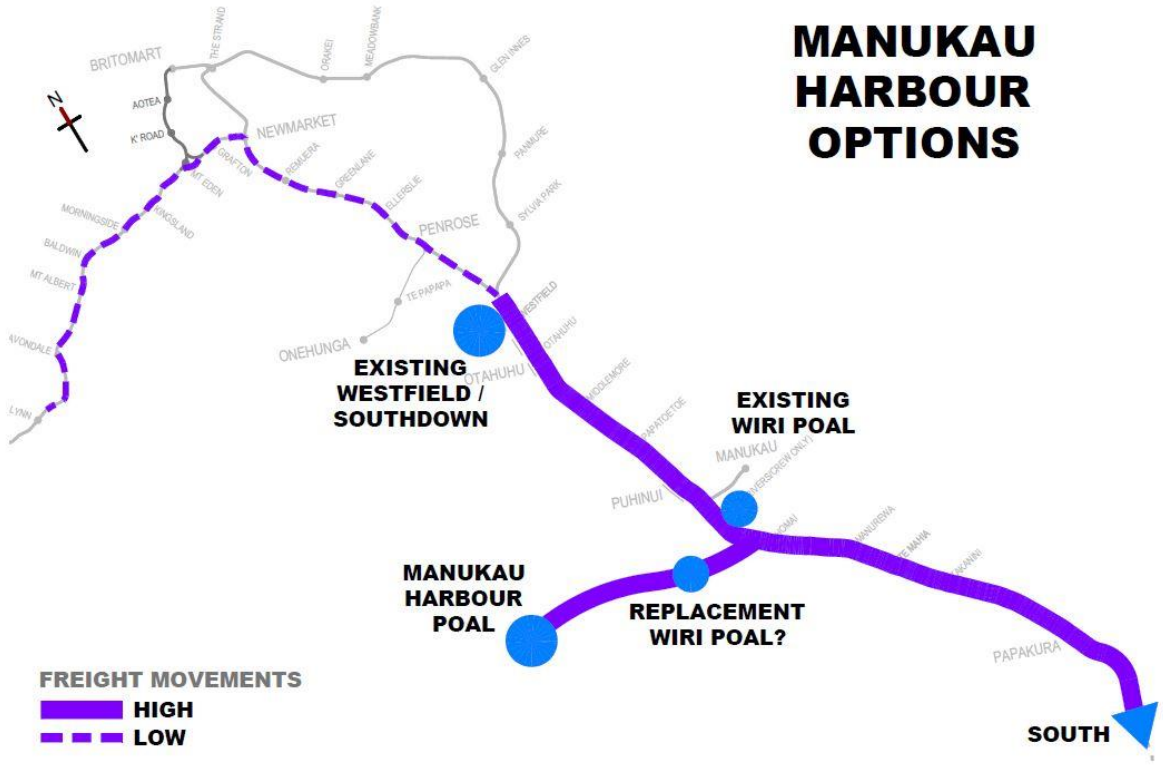
Again, the expected combined freight and metro growth would result 4 mainlines from Westfield south on the NIMT to Pukekohe.

Given the potential configuration of the 4 mains being two sets of two up and down mains, the Wiri POAL hub could be considered on the **'incorrect'** side of the railway to service the Northland site. Furthermore there could be consideration that this site is redundant in favour of a site to the West of Auckland (however this concept is yet to be proven viable).

7.3 Manukau Harbour Options

Again, with these options the freight movements on the NIMT Eastern line would drop significantly (or none at all).

There would be limited volume on the NAL.



Again, the expected combined freight and metro growth would result 4 mainlines from Westfield south on the NIMT to Pukekohe.

Given the potential configuration of the 4 mains being two sets of two up and down mains, the Wiri POAL hub could be considered on the **'incorrect'** side of the railway to service the Manukau Harbour sites.

Furthermore from a physical geometric and connectivity point of view, it would be practically difficult/potentially not feasible to connect from the suggested new junction over into the Wiri POAL site.

It is suggested that a replacement Wiri POAL facility be constructed where the route connects with the land. This would then place the facility to service both north and south directions.

Note that for the Central Manukau Harbour Site 7A, any connection at Otahuhu / Westfield will be complex due to the multiple demands for layout and connectivity within the available space for metro and freight operations / stakeholders / available space.

7.4 Firth of Thames Options

Again, with these options the freight movements on the NIMT Eastern line would drop significantly (or none at all).

There would be limited volume on the NAL.

Again, the combined freight and metro growth would result 4 mainlines from Westfield south on the NIMT to Pukekohe.

Given a grade separated rail junction would connect to the western side mains, the Wiri POAL hub could still be considered on the **'incorrect'** side of the railway to service the Firth of Thames sites.

It is therefore suggested that a replacement Wiri POAL facility be constructed either adjacent the Ardmore airport (if height/proximity constraints allow), or in the industrial area at Drury. This would then place the facility to service both north and south directions.

Note that for the Mercer alignment option any such facility would likely be located on the branch rather than the NIMT to allow connectivity to both north and south directions

7.5 Third Main from Westfield Junction to Quay Park

The operational purpose of this 3rd main is to separate the POAL freight traffic from the mainline network traffic via a single bi-directional track.

There is a risk that operational modelling shows that the single line to too long to provide the capacity, and an additional passing loop off the 3rd main may need to be provided, likely just south of the Purewa tunnel (or even through the tunnel as it would likely be bored to a diameter to allow a dual track irrespectively).

As the risk of requiring this loop is currently seen as low, any additional uplift cost for a passing loop has not specifically been allowed for in the cost.

As there is significant cost associated with the Purewa tunnel, and to a lesser degree the causeway widenings, there is a question as to whether there would be any benefit of constructing the 3rd main in part (either side of the tunnel).

This was considered originally by ARDP, and the operational advice at the time was:

- There is benefit to be gained operationally/capacity wise for the POAL operations from extending the 3rd track from the current W2QP Quay Park scoped arrival/departure project further south to just past the Boat Club. This would include multiple crossovers to create additional functionality for trains arriving / departing simultaneously.

- However there is little cost / benefit in creating a discontinuous 3rd track, as the freight traffic would need to utilise a freight path within the metro timetable irrespective where it connects to a two track railway. Put another way, once the freight has found its path from the POAL, there is little benefit in getting offline to go back online due to 'passing' manoeuvres taking time and the relatively short distance from the POAL to Westfield Yard.

It was concluded at the time that investment was better spent on streamlining the connection points at the POAL and Westfield Junction ends.

This suggests that if a 3rd main line from Westfield Junction to Quay Park were to be built, it would need to be continuous.

8 Rail Connections to the NIMT Mainline Assessment

As noted above, it is anticipated that the majority of the options would connect into a 4 main arrangement of the NIMT, with an assumed philosophy that the western two mains would carry the freight in terms of the report investigation.

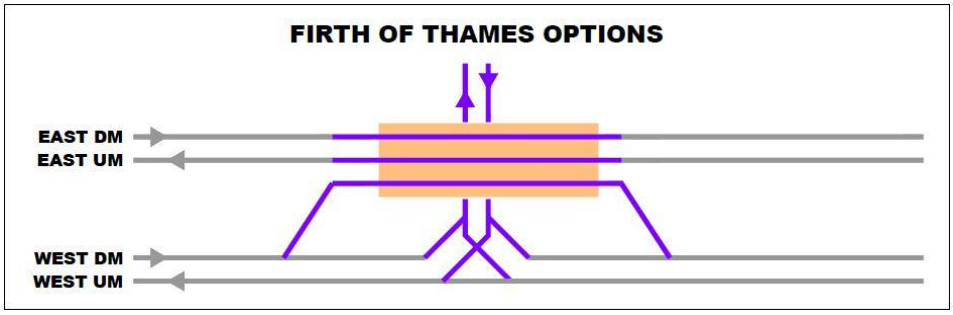
It is also assumed that the rail junctions should be at least partially grade separated. This is on the basis that the existing network has built up over decades from historic flat junctions, however these are now the major constrain on the ability to run the network as efficiently as possible.

As an example, CRL has worked hard to grade separate the Newton Junction, and both the Quay Park and Westfield Junctions have been investigated for grade separation to optimise the network.

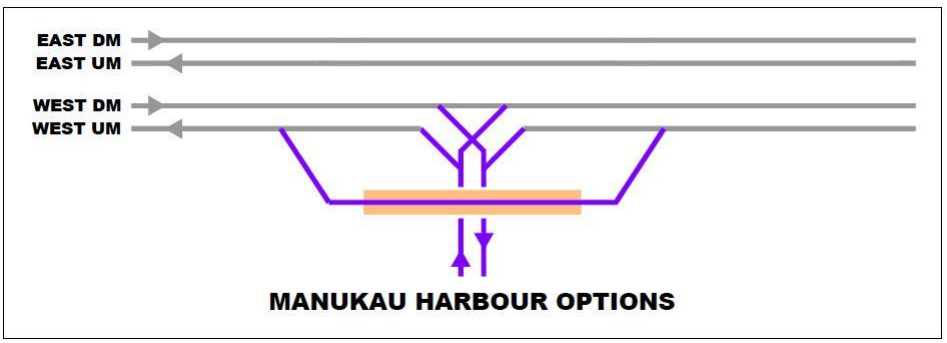
It is recommended that any potential additional junctions to the network should not create legacy issues to resolve in the future as flat junction timetables rely on trains hitting the junctions at exactly the right time to avoid other train paths.

Therefore the basic diagrams assumed for grade separation are as follows, albeit noting the footprint of each has only been considered at a very high level of feasibility at each site.

Mainline Connection Type A:



Mainline Connection Type B:



At this level of costing, we have just assumed a bulk cost of a ‘grade separated junction’.

8.1 Manukau Harbour Options

8.1.1 Central Manukau Harbour (site 7A)

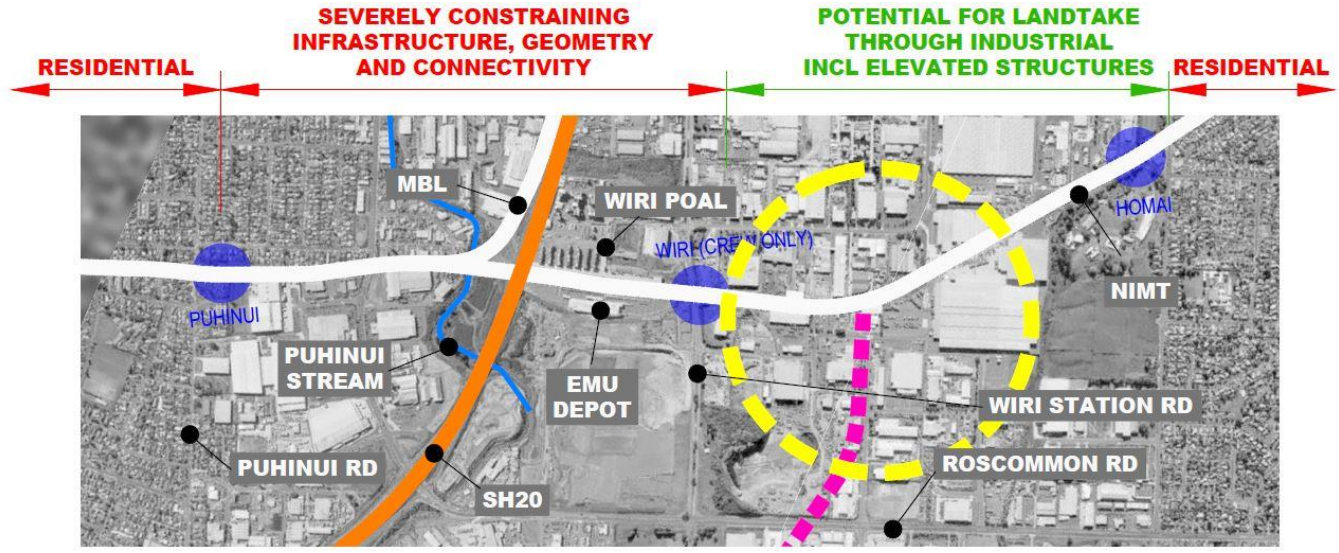
Route 7A-1: This connection is assumed to be just south of Otahuhu Station, or potentially through the back of Westfield Yard. The area is very complex geometrically and connectivity wise and the footprint would likely impact a number of existing industrial and freight properties. It would be similar to a 'Type B' above.

Route 7A-2: As per Route 7B-1.

Route 7A-3: This connection is assumed to be part of a wider grade separated Westfield Junction that included the NAL connection. The area is very complex geometrically and connectivity wise, however noting environmental issues in the area, there is a reasonable amount of space to design a workable junction.

8.1.2 Puhinui (site 7B)

Route 7B-1: This connection is assumed to be just south Wiri Station Rd. This is based on historic optioneering related to the SMART project investigating getting heavy rail to the airport. A number of connection options for this were looked at in 2013 with this being the only practical solution given the constraints indicated in the diagram below. This assessment has not re-challenged this conclusion.



The area is very complex geometrically and connectivity wise and the footprint would likely impact a number of existing industrial and freight properties. It would be similar to a 'Type B' above.

8.1.3 Hikihiki (site 7C)

Route 7A-2: As per Route 7B-1.

8.2 Firth of Thames Options

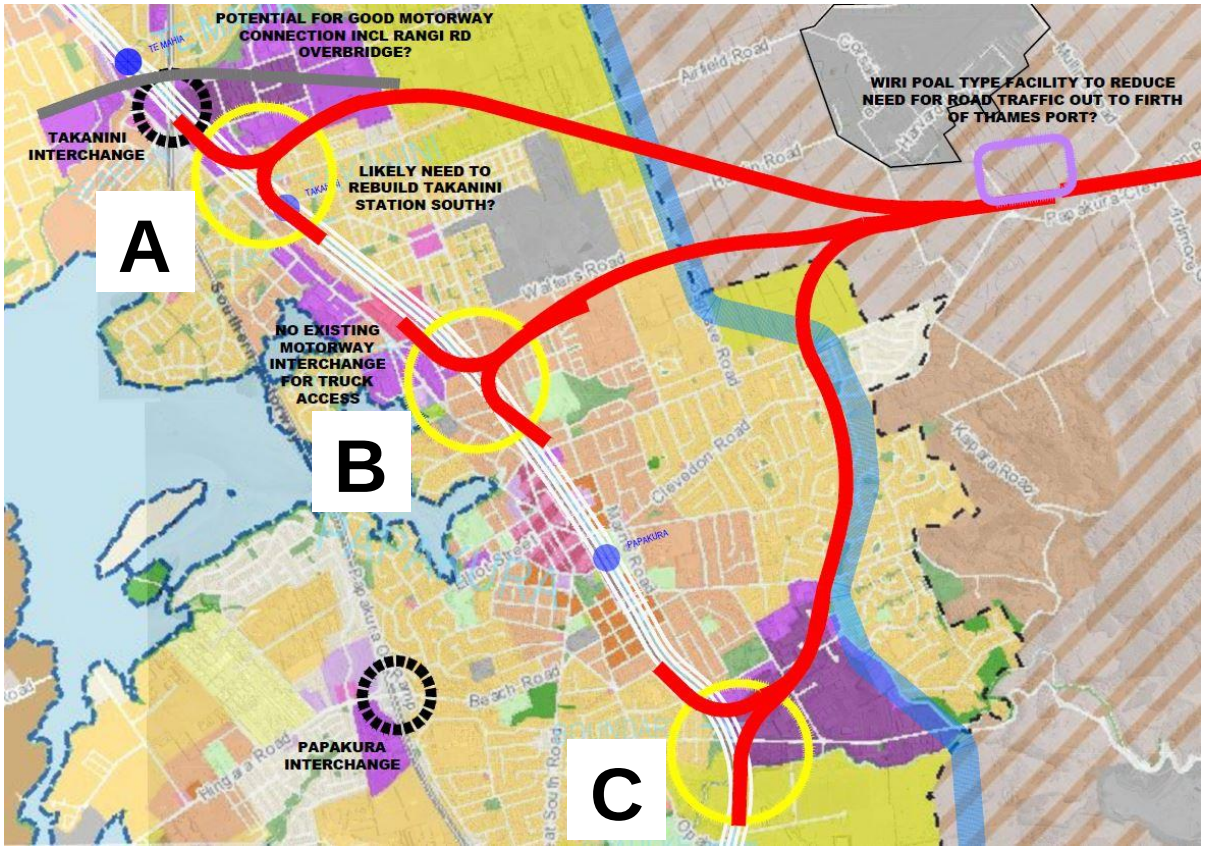
8.2.1 Kawakawa Bay (Site 14E)

Route 14E-1: With reference to below diagram, there was three primary options for connection into the mainline at Papakura.

- Option A - Potentially less disruptive to the 'existing' residential environment, good rail (and road) connectivity, difficult geometrics, complex SW/ geotech.
- Option B – Shortest route, disruptive to the 'existing' residential environment, good rail connectivity (but road would be via Takanini/Papakura or Drury interchange to SH1), easier rail geometrics, complex SW and geotech.
- Option C - Potentially less disruptive to the 'existing' residential environment IF combined with Mill Rd corridor, good for rail (and road) connectivity, difficult rail geometrics, complex SW and potentially easier geotech.

Option C has been chosen as it was considered giving the most conservative cost.

Note: Any rail alignments depicted below are for the purpose of considering feasibility and cost at a high level. They do not represent government plans.



8.2.2 Waimango Point (site 15B)

Route 15B-1: As per Route 14E-1.

Route 15B-2: The connection at Mercer is expected in the area of Kellyville Rd. This was a location that was earmarked for a rail connection many decades ago and apparently had some earthworks done in preparation. In terms of this assessment it is simple identified as a 'grade separated junction' in terms of a cost item noting that logic suggests the undeveloped nature of the area would lend itself to easier implementation than in the urban environment.

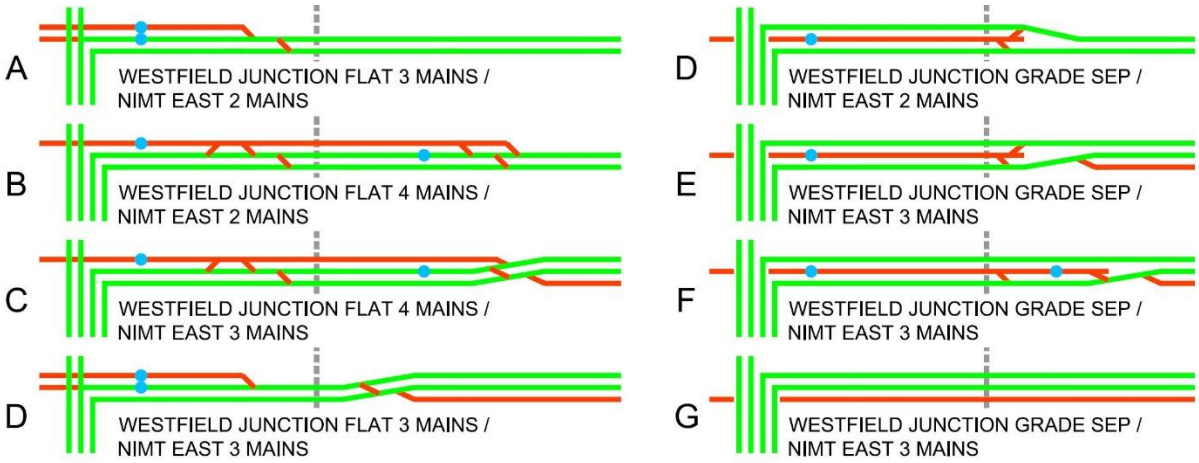
8.3 Third Main from Westfield Junction to Quay Park

The junction highlighted on the plans at Westfield Junction is complicated by the uncertainty over the form and function of the overall junction itself at the time of any 3rd main being constructed.

The current W2QP project will install a 3rd main on the Up main side to provide access across the current flat 2 main junction. This puts the 3rd main on the opposite side to the proposed 3rd main from the POAL, and would require a certain connectivity design solution to make it work operationally.

However, a different solution would be required if the junction was upgraded to a 4 main flat junction, or grade separated for example.

The following diagram represents a number of permutations.



For the purposes of this report and costing, we have assumed that the Grade Separated Westfield Junction would be included in future ARDP programmes (possibly Decade 4 - 2045 – 2055) and has not been allowed for within the cost estimate.

9 Rail Route Assessment

The following commentary references the drawings in Appendix 2 including the overall route options plan, plus the individual route plan sketches that show the simplified alignment and scope definition of major infrastructure features.

9.1 Manukau Harbour Options

9.1.1 Central Manukau Harbour (site 7A)

Route 7A-1: (sketch MOT-POA-GEN-RIC-DRG-000031)

This route has been inferred by the previous port studies on this option in that it has the shortest distance from the port facility to the existing land.

The key features of this alignment are:

- A long marine bridge (which at this stage has been allowed for rail only) directly to land just north of the airport. Noting the extent to which this land would actually be available given recent iwi issues around the Ihumatao land dispute is a significant risk. It is likely a causeway will be considered as an alternative to a bridge.
- The alignment would then run somewhere through the residential area of Mangere Bridge, cross SH20, through further residential area to Otahuhu, then connect through the industrial area at Otahuhu/Westfield. Previous high level transport corridor studies had identified a partial route through this area, however it is complicated by geotechnical/community/ and environmental issues.
- The route costed has assumed a ‘tunnel’ under SH20, as a conservative assessment for what would likely be an ‘open trench’ type configuration. This is on the basis of community push back on the SH20/Kirkbride grade separation project leading to a complex and costly trench being constructed, as opposed to an elevated structure.

Route 7A-2: (sketch MOT-POA-GEN-RIC-DRG-000001).

This route has been shown as an alternative to route 7A-1.

The key features of this alignment are:

- A marine bridge significantly longer than Route 7A-1. It is likely a causeway will be considered as an alternative to a bridge.
- The alignment would directly cross across the end of the airport runway(s), which may be of concern with this option.
- It would then connect to Puhinui as per Route 7A-1.

Route 7A-3: (sketch MOT-POA-GEN-RIC-DRG-000001).

This route has been shown as an alternative to route 7A-1.

The key features of this alignment are:

- A marine bridge significantly longer than Route 7A-1. It is likely a causeway will be considered as an alternative to a bridge.
- The alignment would follow up the Onehunga harbour and likely follow the potential 'East West' road corridor or the Avondale-Southdown rail corridor.
- It would then connect to the Southdown/Westfield area.

9.1.2 Puhinui (site 7B)

Route 7B-1: (sketch MOT-POA-GEN-RIC-DRG-000041)

This route has been a modification to that investigated on the historic SMART 'Heavy Rail to Airport' Study with a deviation adjacent the Wiri Oil Facility southwards towards the Papakura channel.

The key features of this alignment are:

- A marine bridge (which has been allowed for as rail only) directly to land just north of the Matukutreia – Area of Significance. This would cut through/require development of, the Puhinui Reserve.
- It is suggested that a replacement WPOAL rail facility may be constructed in this Puhinui Reserve area.
- The alignment then threads between the Wiri Oil Facility and Prison (s), over Roscommon Rd, and into the grade separated junction.
- A number of industrial properties would need to be removed.

9.1.3 Hikihiki (site 7C)

Route 7C-1: (sketch MOT-POA-GEN-RIC-DRG-000041)

As per 7B-1, but with a longer marine bridge (potential causeway).

9.2 Firth of Thames Options

9.2.1 Kawakawa Bay (Site 14E)

Route 14E-1: (sketch MOT-POA-GEN-RIC-DRG-000051 to 53)

This route costed adopts the connection option to the south of Papakura.

The key features of this alignment are:

- A grade separated junction and alignment through the existing industrial area in south Papakura, and then flows the proposed Mill Rd corridor. This will require additional land and grade separating of road connections with Mill Rd.
- The route then generally follows the Papakura-Clevedon Rd at the existing ground level out towards Kawakawa Bay.
- Around the junction at Ness Valley, the geometry and civil scope starts to get more complex, and as the route winds around Kawakawa Bay it triggers three tunnels due to the topography. This assessment has assumed these tunnels to be straight for simplicity.
- There would be relatively short marine bridge / causeway required to get out to the port operational area, which has been located based on ~12m depth off the hydrological chart (as per the existing POAL).

9.2.2 Waimango Point (site 15B)

Route 15B-1: (sketch MOT-POA-GEN-RIC-DRG-000054 to 55)

This route is identical to route 14E-1 from Papakura out to approximately 17km, then deviates up the Ness Valley towards Waimango Pt.

The key additional features of this alignment are:

- A long tunnel and then two smaller tunnels through the steep topography.
- Generally complex civil and geology out to the coastline where again there would be relatively short marine bridge / causeway required to get out to the port operational area. Located based on ~12m depth off the hydrological chart (as per the existing POAL).

9.2.3 Waimango Point (site 15B) via Mercer

Route 15B-2: (sketch MOT-POA-GEN-RIC-DRG-000001)

This route has been assessed purely as a sanity check against the 15B-1. It has been roughly assessed using the 3D terrain model to get a quantum of earthworks complexity and bridge/tunnel extents however has not been drawing up in detail.

The key features of this alignment are:

- Reasonably accessible rural land.

- A large number of short tunnels (up to 9, but potential refinement available).
- Less road crossing infrastructure needed, but a longer route.

9.3 Third Main from Westfield Junction to Quay Park

The alignment used for this assessment was as per the assumed configuration in the 2016 assessment for ARDP.

The key features of this alignment (sketch MOT-POA-GEN-RIC-DRG-000061) are:

- Additional crossovers and connectivity required just south of Mt Wellington Hwy road overbridge. (Bridge was rebuilt for 3 tracks during AEP)
- The alignment is assumed to be on the Up main side with significant implications of land, access road reconfigurations to the Sylvia Park Mall, and additional lateral platform required. However, this was on the basis at the time that the Coca-Cola siding remained in operation, and more recent network planning has determined that this siding would likely be closed in these timeframes. For the purposes of this assessment, the original identified scope remains but that this represents an opportunity to reduce complexity with the 3rd track on the Down main side.
- There is generally enough rail corroder width to accommodate the 3rd track between Sylvia Park and Panmure with civils/walls, noting that Waipuna Road Bridge needs rebuilding to accommodate the additional track.
- William Harvey Plc Footbridge, Ellerslie Panmure Highway, Mountain Rd, and Morrin Rd bridges have provision for the 3rd track.
- The Panmure station precinct has been designed cognizant of a 3rd track (and platform face) on the Down main side. This was allowed for with the adjacent road bridge rebuilds, and land provisions have been communicated through AT.
- An additional rail bridge is required at Glen Innes, with the additional track and lateral platform (if required) on the Down main side.
- The alignment will need to ‘splay out’ on the approaches to the Purewa tunnel to give enough separation to practically and safety bore a new (dual track diameter) tunnel adjacent the existing tunnel. This will require significant earthworks/civils to achieve.
- North of the Purewa tunnel to Meadowbank the 3rd track is on the Down main side with a large level difference dropping off a bank down to the marine estuary which will need building up.
- Causeway widening and additional rail bridges will be required between Meadowbank and Quay Park.
- There are challenging land and civil/structural/environmental issues for the 3rd main past the boat club / Tamaki Dr just before it joins into the Port Arrival Track.

10 Constructability Assessment

10.1 Overview

A high-level constructability assessment has been undertaken for each route assessing the main construction issues associated with each alignment.

10.2 Manukau Harbour Options

10.2.1 Manukau: Central Manukau Harbour (site 7A)

The Manukau 7A Option (1, 2 and 3) is the most complex of the three Manukau Options. This option has the longest marine bridge structure required to be built out into the harbour.

The work to construct the bridge in the Marine Environment will have specific construction risks associated with building in the marine area and working over the water.

The Manukau harbour has large tidal flows and strong currents and inclement weather would be more of an issue during construction for Option 7A and rough seas would make this option exposed to additional weather delays and risks.

The alignment passes through a heavily populated area at Mangere Bridge and construction in the residential area would cause disruption to the local residents. The most challenging construction component of this route is where the rail alignment crosses the SH20 Motorway.

The high-level design assessment has allowed for a cut and cover trench to pass under SH20 north of the SH20 SH20A Interchange. These works would be complex civil works to achieve this arrangement and the traffic disruption to the area could impact on Airport Traffic.

As well as the major cut and cover works there are a number of major arterial roads that the alignment crosses that would require Grade Separation. Each of these Grade Separations would be major civil activities to construct a bridge over the rail alignment and construction would impact on the surrounding area – noise and traffic disruption.

An option to consider in future assessments could be to continue the cut and cover trench arrangement through the residential area and the rail would pass under the roads which would remain in their existing arrangement, similar to the New Lynn Trench.

The alignment has good connectivity onto the mainline at Otahuhu and connects close to the main KiwiRail Westfield Yard so the possible requirement of additional marshalling yards could be solved by using existing rail infrastructure at Otahuhu.

Two alternate routes 7A2 and 7A3 have been identified as possible alternate alignments. Both of these options would reduce the construction in the residential areas and would not require as many grade separations. 7A2 avoids crossing SH20 but follows a longer marine route but would have the added complexity of passing under the SH20 bridge crossing the Manukau Harbour south of Onehunga. 7A3 follows the path of 7B and 7C options on the land and then uses a longer marine bridge to connect onto the port area.

10.2.2 Manukau: Puhinui (site 7B)

Manukau Option 7B and 7C follow the same land alignment to connect from the mainline to the Manukau Harbour. Both 7B and 7C options are considerably less complex in terms of the civil works required to connect from the Mainline to the harbour.

The alignment passes through a heavy industrial area to connect to the mainline south of the Wiri Junction. The alignment passes adjacent to the Wiri Prison complex (Impacts on this would require further validation). The area where the alignment connects onto the mainline is a heavy industrial area and the grade separated junction would impact on existing industrial and commercial businesses.

The alignment also passes close to an area of cultural significance - volcanic cone Matukutereia. The route crosses two major arterial roads which require grade separations but the number is considerably less than Optrion 7A. Route 7B and 7C once they get to the open farmland area on the edge of the Manukau they diverge, 7C to the north and 7B to the south to align to the proposed port sites in the Manukau Harbour.

The risks of constructing in the marine environment would be greater for alignment 7C as this is a longer bridge to connect to the proposed port site, but the 7C alignment is still less than option 7A. For both 7B and 7C an area for a marshalling yard adjacent to the rail alignment in the farmland area adjacent to the Manukau has been identified for further assessment.

Manukau: Hikihiki (site 7C)

This option has been covered above with the primary difference between Option 7B being the length of marine bridge required to connect to the proposed port site in the Manukau

Note – an alternative option for both 7B and 7C routes would be a marine causeway instead of a marine bridge. This would have pros and cons associated with this as an alternative but could be cheaper than the bridge. Further assessment would be required at the next stage if these routes were considered further.

10.3 Firth of Thames Options

10.3.1 Firth of Thames: Kawakawa Bay (site 14E)

The two alignments 14E and 15B connect onto the mainline at the same point and follow the same alignment until the 10km point where 14E and 15B split and head in different alignments to reach Kawakawa Bay. The connection to the mainline assessment has identified three locations where the mainline connection occurs. The three options North (around Takanini), Central (north of Papakura Junction) and South (south of Papakura Junction) have different complexities and impacts on existing land and buildings.

The preferred alignment chosen at this stage is the alignment that connects to the south of Papakura Junction. This proposed alignment follows the Mill Rd corridor but the work to cross Mill Rd needs further assessment as this would need to be grade separated. Where the proposed new mainline connection is proposed for this route connects is in an industrial/commercial area which would reduce the impact on residential properties but have a higher land costs due to the industrial and commercial property impacts.

The alignment from the 4km point then follows along mainly farmland route along the Clevedon Valley. The works associated through this area will be civil activities to construct the new rail alignment which consists of earthworks, drainage and civil structures (bridges) to create the new rail alignment. The alignment crosses multiple roads which will need to be either:

- grade separated where the road is deemed to be at a traffic level that requires the grade separation approach or
- an at Grade Level Crossing with a standard arrangement barrier and safety system including provisions for pedestrian safety.

Provisions for these option have been include in the cost estimate for the route. The 10km point the 14E option route travels north around the base of the Hunua Ranges but the topography at the Kawakawa bay end is steep hilly terrain. To reach the required Kawakawa Bay site a tunnel will be required to connect to the port location. The tunnel construction will be the most complex construction component of the route and will be undertaken using a Tunnel Boring Machine (TBM). For any major tunnelling activities of this nature the TBM would be specially manufactured for the work to be undertaken and size of the bore required for the rail alignment.

From the 25km to the 30km point the alignment follows the edge of the foreshore and impacts on pockets of existing residential areas.

10.3.2 Firth of Thames: Waimango Point (site 15B-1)

The route for the 15B-1 option as described above for the first 10km follows the same alignment as 14E described above. From the 10km point the alignment splits to head towards Waimango Point. The alignment generally follows an alignment over farmland and forest areas. The works from the 10km to the 23km involve major cut and fill earthworks, drainage and bridge structures. At the 23km point the vertical alignment and topography has identified the need for approximately 8.3km of tunnels to connect to the proposed Waimango Point port location.

As described in Option 14E this would be the most complex construction component of the route and a TBM would be used to construct the tunnels. As per Option 14E the alignment crosses multiple roads and the requirement of either grade separation or level crossing has been allowed for each. The civil works to create a grade separated road bridge over the rail involves complex civil works for each. The installation of the at grade level crossing is undertaken as part of the rail systems activities and involve civil and rail systems activities.

10.3.3 Firth of Thames: Waimango Point via Mercer (site 15B-2)

The route 15B-2 option takes a completely different route to reach the Waimango Point port location. The mainline connection has been identified south of Pokeno. The mainline

connection at this location would be simpler than the other options considered as the train frequency at this location is less than the other connections that are located within the Auckland Metro Area.

The route follows open farmland for the majority of the first section of the route and involve civil activities - earthworks, drainage, bridges and embankments. Geological assessment through this area would need further consideration as the area could be prone to flooding. The route then follows the foreshore around to Waimango Point. This section has challenging vertical topography and the assessment has identified 11.2km of tunnel to achieve the alignment through to the Port.

As per the previous options this would be the most complex construction component of the works. Consistent with the other routes that require tunnelling a TBM would be used and specially manufactured for the activities. This route has less road interfaces than the other assessed two options but there are still roads that would need to be either Grade Separated or at Grade Level crossings installed. But in general the roads along this route would most likely be a lower traffic frequency. This option as well as option 15B-1 have a high number of bridges required to facilitate the rail alignment. These structures are generally more complex in nature to design and construct.

10.4 Third Main from Westfield Junction to Quay Park

The route to create the third main between Westfield Junction and Quay Park has different complexity levels for construction than the other assessed routes in that the works would be undertaken in a live rail environment. The planning of the construction activities would need to be assessed for work that can be safely undertaken while trains are operating “Normal Access” and the works which cannot. Works that are not able to be safely undertaken as normal access are further assessed as below:

- **Restricted Access** – Works that can be safely carried out while trains are operating but require rail protection and/or Electrical Safety Observers

- **Isolation Hours** – work cannot be undertaken while trains are operating but can be undertaken in a short time frame at night.

- **Block of Line** – works that cannot be carried out while trains are operating and require a longer duration to complete. Blocks of Line are required to be planned at least 12 months in advance of the work being undertaken and must follow the BOL Planning process1

For the majority of the construction activities associated with the 3rd main the works would be carried out under a restricted access regime that requires rail protection and is covered by the additional applied costs allocated for these activities. The works would also be undertaken adjacent to the live Overhead Line Equipment 25kV system and this requires additional protection resources to ensure that works are undertaken safely. Where works need to be undertaken within 4.0m of the live OHLE system then these works would be undertaken using

isolations hours or additional protection resources. For major works associated with work that affects the existing tracks signalling and OLE Blocks of Line would be required. At this stage of design and planning these additional factors have been allowed for as % uplifts covered in the Scope and Cost Assessment - Section 11.

The other construction factor associated with the Third Main is that the works would interface at the operational passenger platforms at Sylvia Park, Panmure, Glen Innes, Meadowbank, and Orakei. The 3rd main design does allow for the new track to pass by the stations and in current activities but the cost of any platform construction is deemed to not be included in the costs but would be funded separately by additional funding streams. The works would need to allow for passenger access to be maintained (BoL's would shut the stations to passenger operations) at the stations and would add complexity to the way the works are planned and temporary works to maintain access would be required. The Purewa Tunnel as per the other routes assessed would require a TBM to be manufactured to undertake the tunnelling works.

At the Meadowbank end of the proposed new tunnel considerable civil works would be required to provide the new alignment as the two tracks at this location are in a steep cutting. There are existing road over rail bridges along the route that would need to widened to allow for the additional track and in the current works being undertaken in Auckland all new infrastructure being constructed allows for future expansion , thus these bridges would be widened to allow for a 3rd and 4th main.

The work to cross the Orakei Basin is deemed to be 'hard' civil activities as constructing in this environment would be more challenging to access the works, and consideration to bridge structures across the basin would need to be given in the next phase of design and costing.

The assessment of the route has considered the proposed works being undertaken as part of the Auckland Rail Development Programme which includes works at the Westfield Junction and Quay Park ends of the route. For the assessment of the third main it is assumed that the new 3rd Main would be electrified as the track sections are in the shared Passenger and Freight network and the current ARDP works to create the new third main allow for this track to be electrified. These activities along with the signalling and track activities are specialist activities and there are a limited number of specialist resources that can undertake specialist rail construction - track, signalling and OHLE.

10.5 Programme

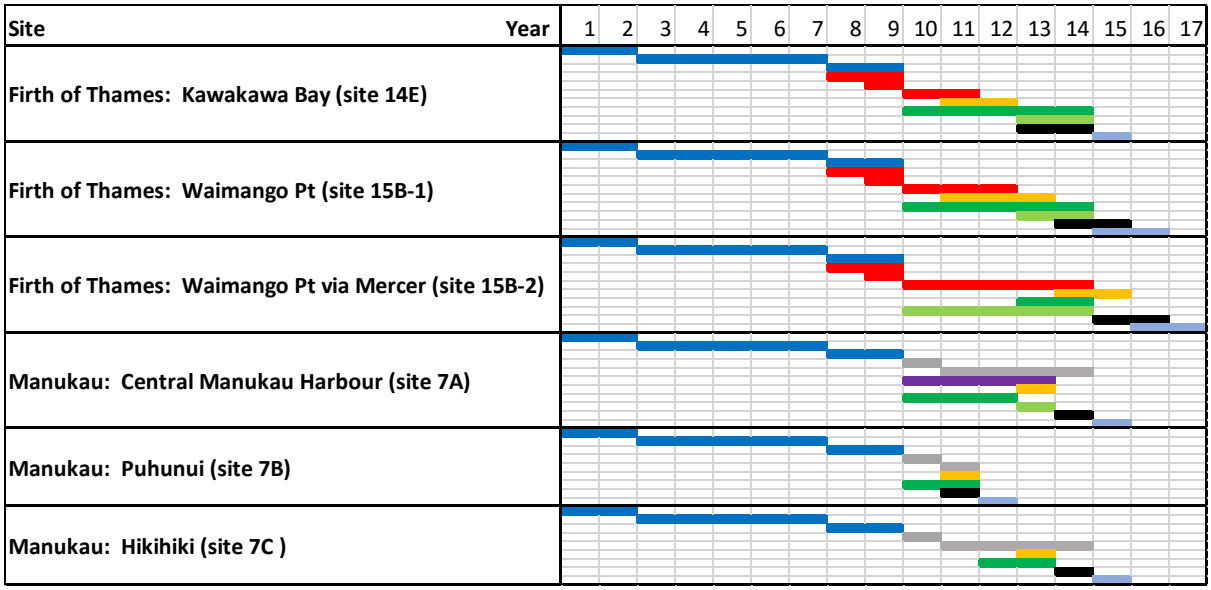
The assessment of the programme durations for each of the routes at this stage is a very high-level approach that gives some possible indication of timeframes that could be used to assess each of the routes for an MCA analysis. These assessments are a guide only as there are a lot of variables that could affect the programme on any of the routes that have not been adequately assessed at this level of feasibility design.

ACTIVITY	APPROXIMATE DURATION	NOTES
Project Development	2 Years	
Pre-Implementation	5-7 Years	Would include reference design and consenting and application of the NOR.
Property Purchase	Min 2 Years	Minimum timeframe based on Public Works Act acquisition. Can only commence once full funding approvals has been granted – at the end of Pre-Implementation Phase.
TBM Procurement and Manufacture	18mnths – 24mnths	
Tunnelling Set Up	1Year	Tunnelling staging and laydown areas and manufacturing plants for precast sections.
Tunnelling	Kawakawa Bay =2years Waimango Point = 3years Mercer = 4.5years 3rd Main = 6months	Assessment based on 10m/day 5days a week operation (2days/week contingency and maintenance) and rounded up to half a year.
Earthworks and Drainage	Kawakawa = 2years Waimango Point = 2.5years Mercer = 2years Manukau Options = 6months Note – The Manukau Routes are low volumes compared with the Hauraki Options, so all have been assessed as a 6month duration	Volume Based Assessment based on being able to undertake 2,500m3/working day. Assessment is based on work to cut, load, place and manage fill and truck turnaround times. Earthworks season is from 1st October – 30 April = 7months
Cut and Cover Trench	Manukau Option 7A 1500m long cut and cover trench These works would be in the vicinity of 3-3.5 years to construct.	New Lynn Trench took 2.5years and was 1km long.

ACTIVITY	APPROXIMATE DURATION	NOTES
Grade Separations	Kawakawa = 4.5years Waimango = 4.5years Mercer = 1.5years Manukau 7A = 3years Manukau 7B = 1.5years Manukau 7C = 1.5years	Assume 18months each – sites would run concurrently based on multiple worksites – Assumed that there would be 4Xsites operating at a time.
Bridges	Kawakawa = 2years Waimango = 2years Mercer = 4.5years Manukau 7A = 1year Manukau 7B = N/A Manukau 7C = N/A	Assume 1 Year per bridge – sites would run concurrently based on multiple worksites – Assumed there would be 4Xsites operating at a time.
Marine Bridge Set Up	6months	Laydown areas Piling Equipment Piling Materials Pre-Cast Manufacture
Marine Bridges	Manukau 7A = 4years Manukau 7B = 1year Manukau 7C = 3.5years	Assume 6 months per km. Note - Sites rounded up to nearest 6months
Track Laying	Manukau 7A = 9months Manukau 7B = 3months Manukau 7C = 5months Kawakawa = 16months Waimango = 18months Mercer = 21months 3rd Main = 5months	Allow for 2km/month Allows for different track forms and laying through tunnels. Note – rounded up to nearest month
Signalling	Allow 6months at the end of each programme for install and commissioning.	Includes installation of level crossing equipment.

ACTIVITY	APPROXIMATE DURATION	NOTES
		Note – Signalling would be installed concurrently with Track Laying activities but would be the final activity to be completed on each site.
OHLE	3rd Main	Undertaken in conjunction with signalling activities.

An indicative high-level indicative programme is given in Appendix 4 and is summarised below.



11 Scope and Cost Assessment

11.1 Physical works

The alignment designs are high-level concept designs and the costs are based on the layout drawings and scope identified for each route.

Because the designs are high-level concept design the level of scope certainty carries cost risk and scope creep risks. The current design is 2D and although 3D Concept Station software has been used to assist with civil scope estimation on the Firth of Thames routes, this has been based on very indicative alignments and limited accuracy ground surface data.

To enable a build-up of cost and to ensure comparative costing between the different options, the costs have been split up into categories, aligned where relevant to the NZTA Schedule of Elemental Prices. **It is important to note that none of the estimates include Contingency, Funding Risk Contingency, Escalation or GST.**

The table below shows the components that are included, and the estimating technique used for each element of the construction cost given in the Elemental Breakdown for Physical Works.

COST ELEMENT	INCLUSIONS	ESTIMATING TECHNIQUE
Environmental Compliance	Preparation and management of plans, erosion and sediment control measures,	Provisional sum/kilometre of new track applied for budget purposes

COST ELEMENT	INCLUSIONS	ESTIMATING TECHNIQUE
	noise attenuation and stormwater treatment	
Earthworks	Civil works (cut, fill, cut to waste, import fill)	$/cubic metre of material (sourced from current market rates used in recent rail business case development)
	Allowance for easy, medium, and hard civil work based on retaining / benching required and ground conditions (coastal, floodplains)	$/lineal metre of new track (generalised from more detailed cost assessments of retaining etc on other rail projects)
	Easy – assumed at grade, (0-2m)	
	Medium – coastal / floodplain area, (±2-4m)	
	Hard – retaining structures / benching required, (+4 to +6m, -4 to -10m)	
	Site clearance, temporary fencing	$/cubic metre of material (sourced from current market rates used in recent rail business case development)
Drainage	Longitudinal corridor drainage including catchment and connection to existing drainage network and /or waterways	Provisional sum/kilometre of new track applied for budget purposes
	Treatment devices	Provisional sum/kilometre of new track applied for budget purposes
Bridges	Land area bridges	$/square metre of bridge deck (sourced from current market rates used in recent rail business case development)
	Marine area bridges	As above with 25% uplift to allow for working within the marine environment
Tunnels	Bored tunnel including all associated works (NO slab track allowance in estimate as freight would run on ballasted tunnels. If dual passenger-freight line, slab track to be included in the passenger feasibility costing)	$/lineal metre of new ballasted track within the tunnel (invalidated estimate based on recent Auckland tunnelling projects)
	Cut and cover tunned including all associated works	$/lineal metre of new ballasted track within the tunnel

COST ELEMENT	INCLUSIONS	ESTIMATING TECHNIQUE
Services	Potential service relocations and impacts and provision for new connections - stations	$/standard kilometre of new track based on similar works undertaken in the rail environment
Landscaping & Urban design	Landscaping Fencing	$/standard kilometre of new track based on similar works undertaken in the rail environment
Traffic Management and Temporary Works	Temporary traffic diversions (All routes) Work in electrified area (NIMT only) Protection costs (NIMT only)	% uplifts on construction costs (sourced from current market rates used in recent rail business case development)
Rail Specific Construction Costs – Rail Systems	Lay formation Lay track, ballast and sleepers	$/standard kilometre of new track (sourced from current market rates used in recent rail business case development)
	Signalling – design, installation and commissioning	Bottom up based on desktop analysis and track components – track length, turnouts.
	Passing Loops based on 4 turnouts and 2km of track	$/passing loop using consistent track and turnout costing
Rail Specific Construction Costs - Turnouts	Track Signalling	$/turnout installation (sourced from current market rates used in recent rail business case development)
Rail Specific Construction Costs – Mainline connection	Connection to mainline / NIMT – Grade Separate Junction including Protection, OLE uplift and all associated works	$/connection (estimated provisional sum – further validation required once design is available)
Rail / Road interfaces	Level Crossing – barriers, controls and pedestrian mazes	$/level crossing (comparative estimate based on current pricing for upgrades)
	Grade Separation	$/grade separation (based on previous grade separation assessment)
	Permanent Road Closure	$/permanent road closure

Each of the designs has been costed for the scope areas covered in table 12 above. The cost estimate allows additional cost % mark ups to the base construction estimate for Project Development, Pre-implementation and Implementation Phase fees.

Additionally cost % mark ups have been added for operational rail corridor costs (apply only to the NIMT Third Main option) and contractor costs.

Project Development Phase Fees
Consultancy fees at 1% of the Construction Base cost has been allocated for design and first stage of Business Case development

Pre-Implementation Phase Fees
An allocation of costs has been allowed for as a % of the base construction costs to further develop the preferred options from Feasibility level through to a Rail Systems Reference design level to inform the next stages of the Business Case process.

Implementation Phase fees

An allowance of 10% has been made for design, project management and construction management costs. This includes planning and resource consent submissions.

Operational Rail Corridor Costs

Operational rail corridor allowances are based on a % mark-up of other construction costs

An allowance of 10% has been made for providing train protection while working in the rail corridor. This includes an allowance for block of line costs.

An allowance of 10% has been made for working in the electrified corridor.

Contractor Costs

An allowance of 20% has been made for contractor P&G and profit.

11.2 Land Requirements

Rail Infrastructure Consultants (RIC) are not registered property valuers and analysis has been based on total property cost data using Auckland Council GIS system and should therefore be considered indicative only.

Land requirements have been identified from the indicative alignment for each route shown on the drawings (Appendix X).

A provisional sum has been allocated within the NIMT estimate for land requirements. This figure is a high-level estimate based on acquisition of an additional strip of land up to 4m wide alongside the existing corridor.

Land acquisition requirements for the Firth of Thames & Manukau Harbour routes have been estimated by assessing the length of corridor within different types of land category and applying an estimated rate based on market rate for the land plus an uplift to reflect additional works required or the extent of land requiring purchase.

COST ELEMENT	INCLUSIONS	ESTIMATING TECHNIQUE
Land costs	Acquisition of land for 20m wide rail corridor with rates dependent on planning designation. Seabed land for marine bridge construction is assumed to be free.	$/m2 of land to be acquired Rates based on a high-level assessment of LINZ data for applicable areas

COST ELEMENT	INCLUSIONS	ESTIMATING TECHNIQUE
	Iwi contributions or other charges are excluded from this assessment. Easy – farmland rate + 25% uplift to cover alternative access construction or purchase of severed land Medium – residential rate x 200% to cover whole property purchase of effected properties Hard – commercial / industrial rate x 300% to cover whole property purchase of larger commercial properties, building relocation, business operations compensation etc	

Building a causeway in the marine environment has not been included as an option at this stage due to significant environmental impacts. If this was to be considered as an option, the costing would need to be developed to include road access on the same causeway. The current cost estimates do not include any road access alongside the marine rail access. This could be achieved by increasing bridge capacity or by building a separate access bridge but the cost of either of these options is not included in the estimates given in this report.

11.3 High-level Cost and Civil Metrics for each option

Table 1 on the following page gives construction cost estimates for each cost element for each route option. These figures are not to be compared in isolation as it is the intention that these estimates are to form part of wider investigations and as such are not intended to infer a recommended option.

The costings provided here are intended to inform relativity between port location options, rather than for budgetary purposes.

Further detail of the build up of costings is given in Appendix 3 Elemental Breakdown for Physical works – detailed costings.

Table 1 Elemental Breakdown for Physical Works

Elemental Breakdown for Physical Works ($M)									
Port Rail Connection Assessment Elemental Breakdown for Physical Works		Manukau			Firth of Thames			Existing Port	
		Central Manukau Harbour (site 7A)	Puhunui (site 7B)	Hikihiki (site 7C)	Kawakawa Bay (site 14E)	Waimango Point (site 15B-1)	Waimango Pt via Mercer (site 15B-2)	Westfield to Quay Park - Third Main	
Item	Description								
	Project Development Phase Fees	$ 45.1	$ 11.8	$ 33.7	$ 53.4	$ 78.2	$ 101.4	$ 7.2	
	Pre-implementation Phase Fees	$ 90.2	$ 23.6	$ 67.4	$ 106.8	$ 156.3	$ 202.8	$ 14.3	
	Implementation Phase fees	$ 450.8	$ 117.8	$ 336.8	$ 533.9	$ 781.1	$ 1,013.9	$ 71.3	
	Physical Works								
1	Environmental Compliance	$ 3.4	$ 1.1	$ 2.1	$ 6.6	$ 7.6	$ 8.6	$ 2.0	
2	Earthworks	$ 39.4	$ 17.5	$ 17.5	$ 245.2	$ 319.4	$ 242.0	$ 164.2	
3	Drainage	$ 9.6	$ 4.1	$ 4.1	$ 22.0	$ 29.7	$ 12.7	$ 18.0	
4	Bridges	$ 3,369.3	$ 831.8	$ 3,018.8	$ 1,261.5	$ 592.1	$ 1,043.1	$ 40.0	
5	Tunnels	$ 525.0	$ -	$ -	$ 3,114.8	$ 6,153.7	$ 8,399.6	$ 450.0	
6	Service Relocations	$ 6.3	$ 2.7	$ 2.7	$ 14.2	$ 19.1	$ 8.2	$ 8.0	
7	Landscaping & Urban design	$ 6.7	$ 2.8	$ 2.9	$ 15.1	$ 20.3	$ 8.7	$ 8.5	
8	Traffic Management and Temporary Works	$ 225.4	$ 58.9	$ 168.4	$ 267.0	$ 390.6	$ 507.0	$ 178.1	
9	Preliminary and General	$ 1,063.9	$ 278.0	$ 794.8	$ 1,260.0	$ 1,843.4	$ 2,392.7	$ 196.6	
10	Rail Specific Construction Costs	$ 548.6	$ 318.1	$ 319.9	$ 659.8	$ 669.2	$ 415.7	$ 21.5	
	Land Costs	$ 618.0	$ 276.0	$ 276.0	$ 975.2	$ 975.2	$ 1,124.7	$ 40.0	
	Conctruction Costs Sub-total	$ 4,508.0	$ 1,177.8	$ 3,367.7	$ 5,338.8	$ 7,810.9	$ 10,138.2	$ 712.1	
	Construction Costs Sub-total plus % uplifts (excl P&G)	$ 5,319.4	$ 1,389.8	$ 3,973.8	$ 6,299.8	$ 9,216.8	$ 11,963.1	$ 982.7	
Base Estimate		$ 7,001	$ 1,944	$ 5,045	$ 8,535	$ 12,035	$ 15,480	$ 1,219	
Note: These estimates are exclusive of Contingency, Funding Risk Contingency, Escalation and GST.									

The table below gives a summary of the key civil metrics for each of the options.

KEY CIVIL METRICS	CENTRAL MANUKAU HARBOUR (7A)	PUHUNUI (7B)	HIKIHIKI (7C)	KAWAKAWA BAY (14E)	WAIMANGO POINT (15B-1)	WAIMANGO PT VIA MERCER (15B-2)	THIRD MAIN NIMT
Overall track length (km)	17.0	5.2	10.2	33.0	38.0	42.6	10.2
Civils Volume (m3)	23,300	9,900	9,000	527,000	785,000	680,000	n/a
Easy Civils	2	1.3	1.3	7.9	6.3	12.8	
Med. Civils	5	0.7	0.7	8.3	15.1	12.8	
Hard Civils (stkm)	0.8	1.3	1.3	11.3	10.7	6.0	
Land bridges (m)	20	0	0	12800	12800	30800	
Marine bridges (m)	770	1900	6900	2150	620	620	
Widen road bridge							2
Platform overbridge							4
Bored tunnels	0	0	0	4150	8200	11200	600
Cut & Cover tunnels (m)	1500	0	0	0	0	0	0
Grade separations	9	2	2	12	12	4	0
Level crossings	0	0	0	10	10	10	0

12 Risk and Opportunities

12.1.1 Land (Risk):

Specifically for Route 7A-1, the extent to which this land just north of the airport would actually be available given recent Iwi issues around the Ihumatao land development dispute is a significant risk.

12.1.2 Route resilience (Risk):

All of the 5 options considered here offer 'single' route access to the Port facilities. If an incident (or BOL for maintenance) were to occur, then the line would be blocked with no alternative rail access. This is different to the existing POAL location in that there is the option of running freight through Newmarket.

For the Firth of Thames options this is compounded by the proposed tunnels. It is recommended to consider additional risk apportioned to these routes due to the increased complexity in recovering from incidents such as fire, mechanical breakdown, and public incidents due to accessibility, safety and time

12.1.3 Wiri POAL site used for EMU Depot Expansion (Opportunity):

For some of the options, the current location of the Wiri POAL hub becomes difficult to access operationally (ie 'incorrect' side of 4 main network), the collective opportunity here is that it is moved to a new location and that the current site is used to create an expended EMU depot stabling area.

This appears an excellent location as it would have direct personnel access across from the existing Depot, and train access to/from the 'end of train pattern' at Manukau.

The cost/benefit of this opportunity has not been allowed for in the high level cost assessment in this report

12.1.4 Dual use of Rail Corridor through Clevedon Valley (Opportunity):

The route options that run through the Clevedon valley may offer the opportunity to be setup as a dual use corridor given the potential for long term urban development along the route.

It would make sense to consider this if a rail designation was put in place, even if only a single line freight connection was made initially.

Alternatively the economic calculations may be improved if the benefits from an additional metro service with stations acting as catalysts for development.

The route chosen for this assessment (discussed further below) has connected south of Papakura. This in part was chosen as it would offer a potentially logical location operationally to connect as it would be able to use Papakura as the interchange station.

The long term post CRL train plan makes allowance for the additional 6 trains per hour pattern starting ‘somewhere’ on the western line, to ‘somewhere’ on the southern line. This could be the pattern that travels up the Clevedon Valley.

The cost/benefit of this opportunity has not been allowed for in the high level cost assessment in this report

12.1.5 Autonomous Trains (Opportunity):

By the time a new Port facility is implementation, there may be the ability to directly design for the use of autonomous trains to shuttle back and forth from an offshore facility.

This philosophy may potentially change the design of the longer routes (specifically the Firth of Thames) to have less facilities at the Marine end where land/environmental issues are at a premium, in favour of a larger facility in the designated industrial areas inland closer to the State Highway connections.

12.1.6 Potential for a new Metro Station at Quay Park (Risk and Opportunity):

This has been listed as both a risk and an opportunity.

The former as there is a cost risk that for any scenario where the POAL freight operations have been moved and the waterfront land redeveloped for alternative uses (including a mix of residential and commercial purposes), that this uplift on population density would trigger the need for improved public transport facilities.

Conversely the opportunity exists to increase the value of any waterfront development (and surrounding area) by providing this facility for convenient access, plus potentially reduce the need for road/carparking infrastructure.

Due to experience for a number of years working on the master plan in this area, it would be advisable not to use a ‘standard station cost’ allowance for this item. There are significant geometric and operational constraints in this area that would likely mean ‘providing for a metro station’ could be far greater in this location (circa $150mil to $200mil).

13 Summary of Findings

The following summarizes the macro **rail/civil and land costs only** for each route in $bil.

Manukau			Firth of Thames			Existing Port
Central Manukau Harbour (site 7A)	Puhunui (site 7B)	Hikihiki (site 7C)	Kawakawa Bay (site 14E)	Waimango Point (site 15B)	Waimango Point via Mercer (site 15B)	Westfield to Quay Park - Third Main
7.1	2	5.1	8.6	12.1	15.5	1.3

Refer to Appendix 3 for additional detail and cost build up information

There are a number of macro risks and opportunities identified that may impact the feasibility and/or cost of each option. These should be considered within an overarching assessment.

Appendix 1 Glossary

REF	DEFINITION
2D	Two Dimensional
3D	Three Dimensional
AEP	Auckland Electrification Project
ARDP	Auckland Rail Development Programme
AT	Auckland Transport
ATAP	Auckland Transport Alignment Project
CRL	City Rail Link (project)
CV	Capital Value
EMU	Electric multiple unit
MBL	Manukau Branch Line
NIMT	North Island Main Trunk (railway line)
NZTA	New Zealand Transport Agency
P2P	Papakura to Pukekohe Electrification
POAL	Ports of Auckland Ltd
W2QP	Wiri to Quay Park (project)

Appendix 2 Route Alignment Option Sketches

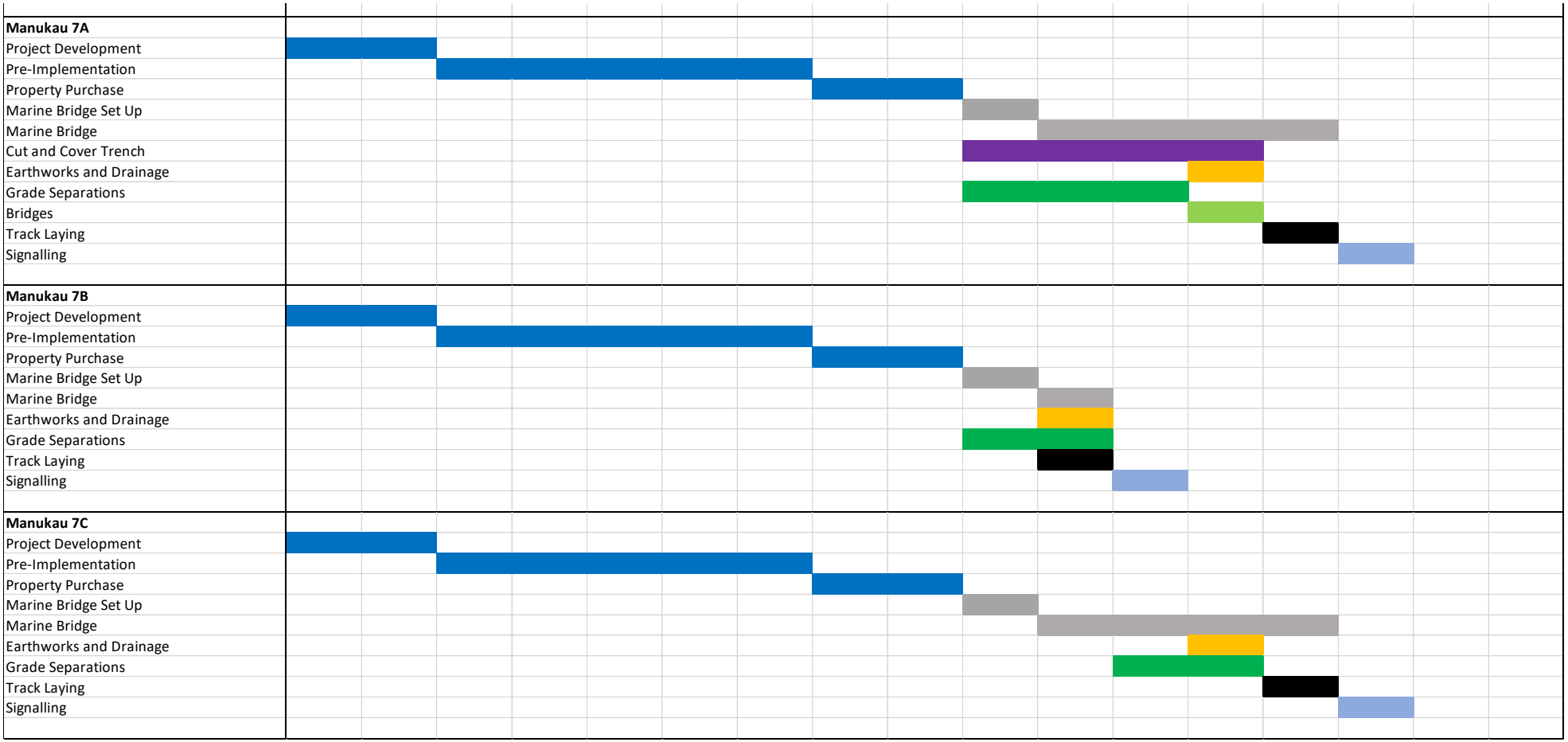
MOT-POA-GEN-RIC-DRG-000001	Primary Route Options (Index Plan)	
MOT-POA-GEN-RIC-DRG-000031	Manukau Harbour – Otahuhu	
MOT-POA-GEN-RIC-DRG-000041	Manukau Harbour – Puhinui	
MOT-POA-GEN-RIC-DRG-000051	Firth of Thames - Papakura - Sht 1 of 5 (Kawakawa Bay & Waimango Pt)	
MOT-POA-GEN-RIC-DRG-000052	Firth of Thames - Papakura - Sht 2 of 5 (Kawakawa Bay & Waimango Pt)	
MOT-POA-GEN-RIC-DRG-000053	Firth of Thames - Papakura - Sht 3 of 5 (Kawakawa Bay)	
MOT-POA-GEN-RIC-DRG-000054	Firth of Thames - Papakura - Sht 4 of 5 (Waimango Pt)	
MOT-POA-GEN-RIC-DRG-000055	Firth of Thames - Papakura - Sht 5 of 5 (Waimango Pt)	
MOT-POA-GEN-RIC-DRG-000061	NIMT Eastern 3rd Main	

Appendix 3 Elemental Breakdown for Physical Works – detailed costings

NZTA Cost Estimate Sheet RevA 2020-03-23

Appendix 4 High Level Programme

Site	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17
Kawakawa Bay																	
Project Development																	
Pre-Implementation																	
Property Purchase																	
TBM Procurement and Manufacture																	
TBM Set Up																	
Tunnelling																	
Earthworks and Drainage																	
Grade Separations																	
Bridges																	
Track Laying																	
Signalling																	
Waimango Point																	
Project Development																	
Pre-Implementation																	
Property Purchase																	
TBM Procurement and Manufacture																	
TBM Set Up																	
Tunnelling																	
Earthworks and Drainage																	
Grade Separations																	
Bridges																	
Track Laying																	
Signalling																	
Mercer																	
Project Development																	
Pre-Implementation																	
Property Purchase																	
TBM Procurement and Manufacture																	
TBM Set Up																	
Tunnelling																	
Earthworks and Drainage																	
Grade Separations																	
Bridges																	
Track Laying																	
Signalling																	


Manukau 7A
Project Development
Pre-Implementation
Property Purchase
Marine Bridge Set Up
Marine Bridge
Cut and Cover Trench
Earthworks and Drainage
Grade Separations
Bridges
Track Laying
Signalling
Manukau 7B
Project Development
Pre-Implementation
Property Purchase
Marine Bridge Set Up
Marine Bridge
Earthworks and Drainage
Grade Separations
Track Laying
Signalling
Manukau 7C
Project Development
Pre-Implementation
Property Purchase
Marine Bridge Set Up
Marine Bridge
Earthworks and Drainage
Grade Separations
Track Laying
Signalling