ŌTAKI TO NORTH OF LEVIN
Project Objectives MCA Report

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1 Introduction

1.1 Purpose

This document was prepared as a summary of the background and multi-criteria analysis (MCA) scoring process for the Fit to Project Objectives criterion for the Ōtaki to North of Levin MCA process in May/June 2020. The Fit to Project Objectives criterion includes the assessment of the project objectives, which are:

- Enhance the safety of the State Highway network by delivering a four lane State Highway between Ōtaki and North of Levin.
- Improve the resilience of the State Highway network.
- Support intra and inter-regional economic growth and productivity through improved movement of people and freight.
- Provide integration between the State Highway network and the local road network, including supporting access to multi-modal connections and Levin.
- Enhance efficiency and journey time reliability along the State Highway network.

The draft project objectives have been updated through the Project Delivery Plan; the draft project objectives are not the same as the draft Resource Management Act (RMA) objectives.

During the Project's re-evaluation, the problem statements and the benefits and associated were revised. The investment objectives for the Project as they currently stand (without targets) are:

- Reduce deaths and serious injuries from XX to YY per annum.
- Reduce the number and duration of journeys affected by closures and delays by XX%.
- Provide appropriate connections to serve urban areas, including planned growth areas.
- Reduce the number of trucks in the main retail area of Levin from XX to YY.

The outcomes sought from the Project, as identified in the project Indicative Business Case (IBC) phase, are outlined below:

- Reduce deaths and serious injuries.
- Enhance the resilience of the State Highway network.
- Facilitate safe, efficient growth in Horowhenua.
- Aid the improvement of Levin's main retail area attractiveness.
- Reduce travel times on the State Highway network.

All of these project and investment objectives, as well as the outcomes sought, are linked as demonstrated in Figure 1-1.

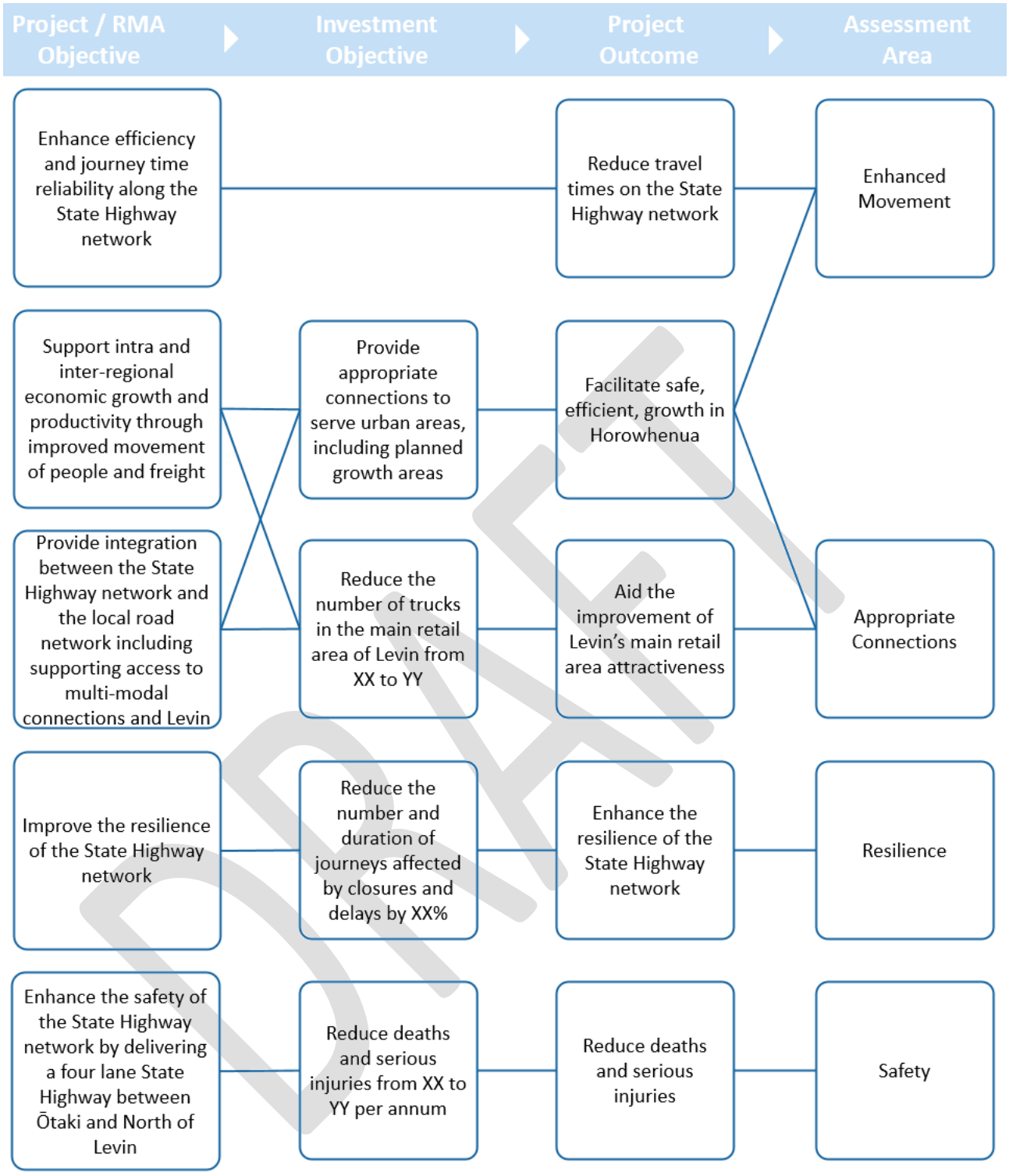

Figure 1-1: Relationships between project objectives, RMA objectives, investment objects and outcomes sought by O2NL

This is a high-level relationship map between areas and is not intended to identify all relationships. This map is also not directional(i.e. relationships work to the left and right).

As part of the investigation processes, the optioneering was split into the categories of alignments, interchanges/ intersections and local roads. These categories are in different stages of the long list to short list process. Three MCA processes were conducted, one for each category.

1.2 Assessment

Each of the assessment areas are discussed below.

1.2.1 Enhanced Movement

The enhanced movement objective has been assessed at a high level by looking at the travel time on key routes through the study area, focusing on those using the new highway. A first principles approach was adopted when assessing this objective. For the alignment assessment, travel times were calculated using measured distance for each segment/option and an estimated average speed. As this was done for comparative purposes, this is considered fit for purpose. For the interchange assessment, traffic modelling was used to inform travel times on key routes. These routes were kept the same as the IBC, being SH1 (south) to Levin, SH1 north and SH57 north. Local road connections were not assessed as part of this assessment due to it specifically noting the movement on the state highways.

This assessment area links directly to the project objectives of enhancing efficiency and journey time reliability along the State Highway network and supporting intra and inter-regional economic growth and productivity through improved movement of people and freight.

When assessing enhanced movement, the approach to focus on travel times was done in part to avoid double counting benefits in the MCA process. Whilst travel times are a good supporter of growth, other elements are important, too. However, as Horowhenua District Development was its own MCA criterion scored separately, counting the benefits from growth in Horowhenua in this project objective would result in those benefits being double counted in the MCA process and are therefore not included in this assessment. This does not preclude them being reported on in a project objective capacity in other reports. Inter-regional economic growth is governed by the travel time assessed above, as well as the reliability which is noted in the resilience objective.

1.2.2 Appropriate Connectivity

While this project objective includes the connections to the local road and impact on the community, these criteria are being evaluated separately as part of the MCA process. Consequently, in the alignment MCA, this project objective was not considered, as none of the alignment options have impacts on the connectivity possibilities.

For the interchanges MCA, only the appropriateness of the interchange form was assessed, with the local connectivity and community impacts assessed under other criteria. For the local roads assessment, the same approach was taken with the evaluation focusing on whether a journey could still be taken without too much disruption, with the impacts on the local road network and the communities served being assessed elsewhere in the MCA process. It is important to note that in this context, the absence of a direct connection to a current or growth area can be considered 'appropriate' if it fits with the wider One Network Road Classification system.

This assessment area links directly to the integration between State Highway and local road project objective, as well as supporting intra and inter-regional economic growth when reviewed in conjunction with enhanced movement. It facilitates the project outcome of facilitating safe, efficient growth in Horowhenua and aiding the improvement of Levin's main retail area attractiveness.

1.2.3 Resilience

The resilience assessment area is critical, as along the current SH1 there is no alternate north-south route. If a crash or closure occurs on the current highway, in many places traffic cannot be diverted to another route. All the expressway options create a new route while retaining the existing SH1 as an alternate route, which is a benefit to all options.

For the alignment assessment, the resilience evaluation assessed the potential of a natural hazard causing the new expressway to close. It did not factor in the engineering difficulty to prevent the closure, as this would be covered under the engineering degree of difficulty. For the interchange assessment, the resilience assessment looked at the impact of the interchange type on the road operation, as well as the length of any detours the absence of an interchange would create. For the local road assessment, the assessment considered the risk of the road being closed and the volume of traffic relying on it.

The project objective to reduce the number of journeys impacted by closures or delays relates to this assessment area. Like safety, it has a wider remit than the project objectives and is considered in the MCA process.

It links directly to the enhanced resilience of the State Highway network project outcome.

1.2.4 Safety

The safety assessment area relates to the number of fatal and serious crashes that are likely to be saved through implementation of the new highway. This objective was analysed using Waka Kotahi's crash estimation compendium for the alignment category. For the interchange MCA assessment, crash models were considered but did not meet the flow requirements for the models to be valid, therefore engineering judgement was used to determine the potential issues of each option. Traffic modelling outputs from the project's Saturn model were used to understand flows on the existing and new highways to qualitatively understand residual crash risk on the existing network. A first principles approach was undertaken for the local roads category to analyse the potential safety risk created by the expressway, looking at curves, sight distances and risks to active modes.

This assessment area links directly to the project objectives, investment objective and project outcomes, which all are about reducing deaths and serious injuries. The two objectives differ with respect to scope, with the project objective having a wider consideration. Both the project and investment objectives were considered in the MCA process.

This links directly to the project outcome of reducing deaths and serious injuries.

1.3 Scoring Systems

1.3.1 Alignment and Interchanges

The project objectives were scored based on performance. The alignment and interchange category scores ranged from 1 to 5, as well as an F rating, which are detailed in Table 1-1.

Table 1-1: Alignment and interchange score details

Score	Description
1	The option presents few difficulties on the basis of the criterion being evaluated and may provide significant benefits in terms of the attribute
2	The option presents only minor aspects of difficulty on the basis of the criterion being evaluated, and may provide some benefits in terms of the criterion
3	The option presents some aspects of reasonable difficulty in terms of the criterion being evaluated and problems cannot be completely avoided. There are few apparent benefits in terms of the criterion
4	The option includes clear aspects of difficulty in terms of the criterion being evaluated, and very limited perceived benefits
5	The option includes significant difficulties or problems in terms of the criterion being evaluated and no apparent benefits
F	The option will result in completely unacceptable adverse effects that cannot be appropriately avoided, remedied or mitigated (including offsetting)

1.3.2 Local Connectivity

The Local Connectivity project objectives scores were also based on performance. Due to the local road options being less developed than the alignment and interchanges, a simpler system was used to identify options worth looking at in more detail opposed to highlighting the emerging preferred alignment. The local roads scores ranged from 1 to 3 and detailed in Table 1-2.

Table 1-2: Local connectivity score details

Score	Description
1 (Green)	The option is likely to have only minor impacts or issues
2 (Orange)	The option is likely to have moderate impacts or issues
3 (Red)	The option is likely to have serious or significant negative impacts or issues

The local connectivity assessment was deliberately high level and focused on identifying issues that will prevent an option from being considered further opposed to the selection of an option to be put forward.

1.4 Supporting Information

To support the assessors in scoring the options, the updated project model ran five interchange scenarios to help assess the impacts of interchange locations and types. The type of interchange at each location is outlined in Table 1-3

Table 1-3: Initial modelling scenarios

Interchange	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
SH1	Grade Separated	Roundabout	Roundabout	Roundabout	Roundabout
SH1/57	Grade Separated	Roundabout	Roundabout	Roundabout	Roundabout
Tararua	Grade Separated	Roundabout	Roundabout	Grade Separated	No Interchange
Kimberley	No Interchange	No Interchange	No Interchange	No Interchange	Grade Separated
Kuku South	Grade Separated	Roundabout	No Interchange	No Interchange	No Interchange
South Manakau	No Interchange	No Interchange	Roundabout	No Interchange	No Interchange

These scenarios were developed to allow understanding of the key differences between interchange types and locations.

- Comparing scenarios 1 and 2 allows a direct comparison between roundabouts and grade separated interchanges.
- Comparing scenarios 2 and 3 allows a direct comparison between having an interchange at South Manakau or South Kuku.
- Comparing scenarios 4 and 5 allows a direct comparison between having an interchange at Kimberley or Tararua.
- While being aware of the implications of roundabouts and grade separated, scenarios 2 and 3 compared to scenario 4 allow for the understanding of the implication of removing an interchange at Manakau/Kuku.

A bifurcation was not specifically modelled.

2 Alignment

During the IBC phase of the O2NL, a 300m wide preferred corridor was identified (S6N4). During the Detailed Business Case (DBC) phase, various alignments within this corridor have been developed. These have already been through a long list to short list process. The short-listed alignment options are being subjected to an MCA process to determine the emerging preferred alignment within the corridor.

The design team split the corridor into different zones and presented different options within each zone. Each zone has already been through a long list to short list process with the MCA seeking to identify the emerging preferred alignment.

2.1 Enhanced Movement

As previously mentioned, the key metric for this is travel times, which was calculated using measured distance for each option (within a zone) and a speed of 110 km/h. The same travel speed was assumed for all options, as they are all designed to a 110 km/h standard. Traffic volumes were not considered to be significant for this assessment due to the high capacity of the new highway; it is assumed that traffic will travel at free flow conditions and will therefore have minimal effect on travel times.

The alignment was divided into multiple zones (A to L) and assessed independently of each other. This is considered reasonable, as each option within a zone is assumed to be able to connect to all options in adjacent zones. Table 2-1 shows the length of each segment within a zone, as well as a comparision of travel times. The assessment revealed that the travel times for each segment will be very similar: within 5 seconds of each other.

Table 2-1: Travel times for each alignment option

Zone	Alignment	Length (km)	Travel Time (s)	Ratio to Shortest in Zone
A	Green	2.25	74	1.024
A	White	2.2	72	1.000
B	Green	3.25	106	1.029
B	White	3.23	106	1.023
B	Cyan	3.16	103	1.000
C	Green	2.28	75	1.000
C	Purple	2.3	75	1.006
C	White	2.31	76	1.012
D	Dark Blue	4.2	137	1.011
D	Cyan	4.15	136	1.000
E	Green	1.87	61	1.000
E	Cyan	1.88	61	1.006
F	Purple	2.29	75	1.008
F	White	2.29	75	1.009
F	Orange	2.27	74	1.000
G	Purple	2.07	68	1.001
G	White	2.07	68	1.000
G	Cyan	2.18	71	1.056
H	Purple	1.38	45	1.000
H	Cyan	1.39	45	1.004
K	Yellow	2.27	74	1.000
K	Dark Blue	2.35	77	1.037
K	Cyan	2.42	79	1.067
L	Purple	3	98	1.000
L	Green	3.01	98	1.002
L	Orange	3.08	101	1.025
L	Black	3.11	102	1.035

In addition, a corridor-wide comparison was done for the shortest and longest possible routes, showing a difference in travel time of less than 20 seconds.

Table 2-2: Travel times for longest and shortest route

Route	Seconds	Minutes
Longest	827	13:47
Shortest	807	13:27

Based on the marginal differences in travel times, all alignment options scored a 1.

It must be noted that the purpose of this exercise was to compare travel times for alignment options within the corridor and not to the existing travel times.

2.2 Safety

The new highway will be built to a high standard, therefore all alignment options are expected to perform similarly in terms of safety. Each alignment was assessed using Waka Kotahi's crash model for multi-lane divided carriageways, as shown below. This utilises the measured distances from above and traffic volumes of 150000[1] vpd from the previous strategic modelling.

$$A_T = b_0 \times Q_T^{b_1} \times L$$

where: Q_T is the daily two-way traffic volume (AADT) on the link

L is the length of the motorway link

b_0 and b_1 are given in Table 11

The results show that all segments within a zone were within 10 percent of each other and will perform simiarily. Based on this, all options scored a 1.

Table 2-3: Safety for alignment options

Zone	Alignment	Length (km)	Predicted Injury Crashes / Year	Ratio to Worst in Zone
A	Green	2.25	0.66	1.024
A	White	2.2	0.64	1.000
B	Green	3.25	0.95	1.029
B	White	3.23	0.94	1.023
B	Cyan	3.16	0.92	1.000
C	Green	2.28	0.66	1.000
C	Purple	2.3	0.67	1.006
C	White	2.31	0.67	1.012
D	Dark Blue	4.2	1.22	1.011
D	Cyan	4.15	1.21	1.000
E	Green	1.87	0.54	1.000
E	Cyan	1.88	0.55	1.006
F	Purple	2.29	0.66	1.008
F	White	2.29	0.67	1.009
F	Orange	2.27	0.66	1.000
G	Purple	2.07	0.60	1.001
G	White	2.07	0.60	1.000
G	Cyan	2.18	0.63	1.056
H	Purple	1.38	0.40	1.000
H	Cyan	1.39	0.40	1.004
K	Yellow	2.27	0.66	1.000
K	Dark Blue	2.35	0.68	1.037
K	Cyan	2.42	0.70	1.067
L	Purple	3	0.87	1.000
L	Green	3.005	0.87	1.002
L	Orange	3.075	0.89	1.025
L	Black	3.106	0.90	1.035

The impact of improved safety on the State Highway by redistributing traffic to the expressway was assessed in the interchange MCA.

2.3 Resilience

The new alignment will improve the resilience of the highway network by the provision of a second corridor. This MCA focused on the likelihood of the new route closure. Each zone option was assessed against the following potential hazards:

- Faultlines
- Flood zones

[1] The updated modelling showed traffic volumes between 17000 –18500 vpd; the crash models were not changed, since this is a comparative excerise and the traffic volumes remain constant for each alignment option.

- Landslide/slip hazards
- Liquefaction potential

Faultlines were assessed based on the proximity of an alignment option to a faultline. The analysis showed that all options will lie between 1.2km to 5.3km away from the closest faultline. The expressway will be designed to meet all earthquake standards. The risk of closure due to an earthquake is considered minimal.

The risk of the expressway closing due to flooding was assessed using a floodplain map considering the zones. Zones that lie within a floodplain area scored marginally worse than those outside a floodplain. Therefore, the relative exposure of alignment options within a zone were consistent. The expressway will be designed with adequate drainage. Therefore, the risk of closure due to flood is considered minimal.

A few zones will lie in areas that have large cut slopes. Portions of the alignment, within said zone, will lie closer to large cut slopes than others and have therefore been noted as more at risk than other options in that zone. The expressway will be designed to ensure slipping hazards are mitigated. Therefore, the risk of closure due to slipping is considered minor.

A liquefaction map was used to determine the proximity of liquefaction areas to the alignment options. The map showed that none of the alignment options will lie in a High Liquefaction Zone. There will be zones that lie in the Moderate Liquefaction Zone. These zones are more at risk of closure than other zones and were rated as such.

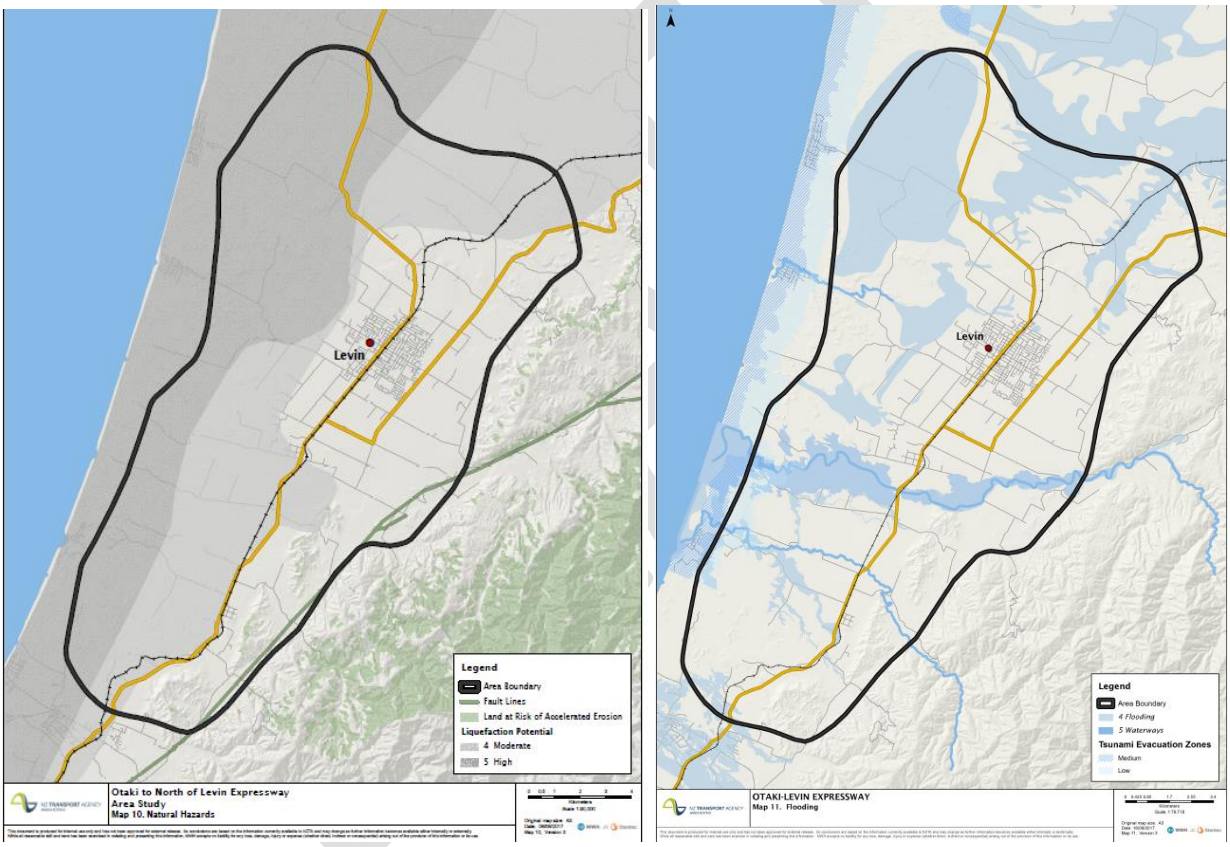

Figure 2-1: Hazard maps

Based on the above, a risk assessment was undertaken for each of the resilience hazards. The probability and consequence of each hazard is shown below. Table 2-5 shows that none of the hazards ranked high. Zone A, B, D and E all have options that ranked moderately risky.

Overall, the alignment options will provide adequate resilience to the existing road network, with a nominal likelihood of closure due to a hazard, as this is a new build and will be designed to a high standard. Therefore, the project objective scored either a 1 or 2.

Table 2-4: Consequence and probability

Hazard	Consequence	Probability
Faultline	1-3 month	Unlikely
Flood	1-5 days	Unlikely
Landslide/slip hazards	1 - 4 weeks	Varies
Liquefaction	1 - 4 weeks	Varies

Table 2-5: Resilience risk assessment

Zone	Alignment	Faultline	Flood	Slope	Liquefaction	Total
A	Green	M	L	L	M	2
A	White	M	L	M	M	2
B	Green	M	L	L	L	1
B	White	M	L	L	L	1
B	Cyan	M	L	M	L	2
C	Green	M	L	L	L	1
C	Purple	M	L	L	L	1
C	White	M	L	M	L	2
D	Dark Blue	M	L	M	M	2
D	Cyan	M	L	L	M	2
E	Green	M	L	L	M	2
E	Cyan	M	L	L	M	2
F	Purple	M	L	L	L	1
F	White	M	L	L	L	1
F	Orange	M	L	L	L	1
G	Purple	M	L	L	L	1
G	White	M	L	L	L	1
G	Cyan	M	L	L	L	1
H	Purple	M	L	L	L	1
H	Cyan	M	L	L	L	1
K	Yellow	M	L	L	L	1
K	Dark Blue	M	L	L	L	1
K	Cyan	M	L	L	L	1
L	Purple	M	L	L	L	1
L	Green	M	L	L	L	1
L	Orange	M	L	L	L	1
L	Black	M	L	L	L	1

2.4 Local Connectivity

This project objective was not considered to be a differentiator for the alignments, as any option within the corridor should have the same impact on local connectivity. This project objective was assessed in the MCA processes of interchanges and local roads categories. Subsequently, all options were given the same score of 1.

2.5 Overall

Table 2-6 shows overall scores of 1 and 2 for the alignment catergory, revealing these options have few or minor difficulties and closely Fit to Project Objectives.

The scores indicate:

- Enhanced movement is consistent for each option.
- Safety is consistent for each option.
- Resilience has slight differences per option based on proximity to hazards.
- Connectivity was not assessed for the alignment catergory, but was given a score of 1 for each option and is therefore consistent.

Table 2-6: Overall scores for Alignments

Zone	Option	Enhanced Movement	Safety	Resilience	Connectivity
A	Green	1	1	2	1
A	White	1	1	2	1

Zone	Option	Enhanced Movement	Safety	Resilience	Connectivity
B	Cyan	1	1	1	1
B	Green	1	1	1	1
B	White	1	1	2	1
C	Green	1	1	1	1
C	Purple	1	1	1	1
C	White	1	1	2	1
D	Cyan	1	1	2	1
D	Dark Blue	1	1	2	1
E	Cyan	1	1	2	1
E	Green	1	1	2	1
F	Orange	1	1	1	1
F	Purple	1	1	1	1
F	White	1	1	1	1
G	Cyan	1	1	1	1
G	Purple	1	1	1	1
G	White	1	1	1	1
H	Cyan	1	1	1	1
H	Purple	1	1	1	1
K	Cyan	1	1	1	1
K	Dark Blue	1	1	1	1
K	Yellow	1	1	1	1
L	Black	1	1	1	1
L	Green	1	1	1	1
L	Orange	1	1	1	1
L	Purple	1	1	1	1

3 Interchanges

During the IBC phase of the Project, the interchange strategy was deliberately left to the next phase, as the impact of interchanges was determined to not be a significant determinant of the preferred corridor.

Prior to the MCA workshop, an Interchange Options Report was developed to assess the long list to short list of interchange options.

Interchange Options:

A summary of the conclusions from the Ōtaki to North of Levin Interchange Options Report is presented in Table 3-1.

Table 3-1: Interchange Options Report conclusions

Location	Service Interchange	System Interchange	At Grade Roundabout
Manakau South	Consider further	Not required as there is no need for a high-speed standard connection at this location	Consider further
Kuku South	Consider further	Not required as there is no need for a high-speed standard connection at this location	Consider further
Kimberley	Consider further	Not required as there is no need for a high-speed standard connection at this location	Consider further
Tararua	Consider further	Not required as there is no need for a high-speed standard connection at this location	Consider further
SH1 / 57 Split	Consider further	Consider further	Consider further
North Levin	Consider further	Not required as there is no need for a high-speed standard connection at this location	Consider further

For this assessment, while there are six locations identified, it is known there would be a maximum of four interchanges along the alignment. This leads to the following four scenarios to be considered:

- Choosing between having no interchange or the form of interchange at Manakau or Kuku (four interchange options or having no interchange).
- Choosing the form and location of interchange between Kimberley and Tararua (four interchange options).
- Choosing the form of interchange at the expressway and SH57 split (three interchange options).
- Choosing the form of interchange north of interchange (two interchange options).

Unlike the alignment MCA where each section could be treated independent of the downstream alignments, this is not possible for the interchange MCA process.

3.1 Enhanced Movement

This project objective related to the enhanced movement of people and freight on the State Highway network. This work was informed by the traffic modelling. See section 1.4 above for a description of the modelled scenarios.

The consideration for this is the travel times for key journeys. Like the IBC phase, journeys to Central Levin, SH1 north and SH57 from Ōtaki were considered. The modelling results highlighted the following:

- Roundabouts performed worse than grade separation due to forcing all traffic to slow down on the highway.
- The Kimberley interchange performed worse than the Tararua interchange for accessing Central Levin, however this was a small difference.

Table 3-2: Enhanced movement results

Option	Route 1: SH1 Ōtaki to SH1 North of Levin						Route 2: SH1 Ōtaki to Central Levin						Route 3: SH1 Ōtaki to SH57 North of Levin					
	Time	Dist	T Diff	%T.Diff	D Diff	%D.Diff	Time	Dist	T Diff	%T.Diff	D Diff	%D.Diff	Time	Dist	T Diff	%T.Diff	D Diff	%D.Diff
Base 2018	26.7	30.5					18.0	20.0					21.9	27.4				
Do Min	27.0	30.4	0.3	1%	-0.09	0%	18.2	19.9	0.2	1%	-0.09	0%	22.1	27.3	0.3	1%	-0.09	0%
A01a	20.3	32.4	-6.7	-25%	1.96	6%	15.9	22.0	-2.3	-13%	2.00	10%	16.2	25.5	-5.9	-27%	-1.99	-7%
A02a	21.1	32.4	-5.9	-22%	1.96	6%	16.2	22.1	-2.1	-11%	2.10	11%	16.4	25.4	-5.8	-26%	-2.04	-7%
A03a	21.1	32.4	-5.9	-22%	1.96	6%	16.2	22.1	-2.1	-11%	2.10	11%	16.4	25.4	-5.8	-26%	-2.04	-7%
A04a	20.7	32.4	-6.3	-23%	1.96	6%	16.0	22.0	-2.3	-12%	2.00	10%	16.0	25.4	-6.2	-28%	-2.04	-7%
A05a	20.7	32.4	-6.3	-23%	1.96	6%	16.3	22.0	-1.9	-10%	2.04	10%	16.0	25.4	-6.2	-28%	-2.04	-7%

All differences were minor from the modelling which was for 2026. Other future years will be assessed, and any impacts will be considered before finalising the scores after public consultation.

All roundabouts therefore scored a 2 for this objective, and all grade separation (including bifurcation) scored 1. Having no Manakau or Kuku interchange also scored 1 due to the project objective being about the efficient movement on the highway. The results of 2046 modelling to assess the roundabout scores will be confirmed at a later point in the project development cycle.

3.2 Safety

Safety was assessed in a qualitative manner but relied on the modelling results from above to understand the impact on flows and taking traffic off the existing SH1. Crash models from the crash estimation compendium were considered as a method of assessment, however as the traffic volumes for which the models are valid and the expected flows on the new highway did not overlap, they were deemed to not be suitable for the assessment.

Consideration was given to the new highway in the context of the Wellington Northern Corridor. While each interchange option was considered from a standalone perspective, considerations to the wider interchange layout was given. For example, an at grade roundabout should not be located between two grade separated interchanges.

3.2.1 Manakau and Kuku Locations

As the southernmost potential interchange on the O2NL alignment of the Wellington Northern Corridor, much consideration was given to driver expectations.

At this location, a rural area on a high standard road, a roundabout scored poorly due to its location within the Wellington Northern Corridor. At the time of completing O2NL, a roundabout here would be the first at grade intersection from the Wellington Central Business District (CBD) for northbound travellers. Its location in a rural area would constitute a remarkable change from the expected interchange form.

The majority of local road traffic using these interchanges comes from the west and heads south on the expressway, which means southbound traffic would go from a 110 km/h environment to being expected to give way to traffic joining the highway. There is also the converse - that southbound traffic getting off the highway having priority over northbound traffic using the new highway.

The design of the roundabouts was also considered. As they would likely be dual lane roundabouts with low traffic volumes, this would enable users to ‘keep straight’ by using the left lane on the approach, and minimising the turning required to traverse the roundabout by using the right circulating lanes. This would result in drivers approaching the roundabout at higher speeds, which leads to a more severe outcome if there is a crash.

Due to these issues, a score of 3 was determined to be appropriate. This was noting that roundabouts on expressway environments have been carried out previously (eastern end of the Tauranga Eastern Link), however would not be as safe as grade separation.

The grade separated interchanges do not have these issues, as they separate out the traffic on the highway from those accessing or exiting it. While for a rural interchange, it is assumed that they will have two roundabouts in a similar manner to the interchange between Transmission Gully and SH58. The scores would not change should it be a priority or signal controlled interchange, as grade separation still provides significant safety benefits.

Traffic modelling indicated that the presence of any form of interchange at Manakau/Kuku resulted in a significant amount of traffic diverting onto the current SH1 to access Ohau and South Levin instead of using the Kimberley or Tararua interchange. This is shown in Figure 3-1.

Figure 3-1: A comparison between traffic flows for scenario 2 and scenario 4 (with and without South Kuku interchange)

Grade separated interchanges was scored a 2, with the biggest factor being enabling the use of the current State Highway to access Ohau and South Levin resulting in lower safety outcomes than remaining on the new highway.

No interchange at Manakau/Kuku was scored a 1 due to it not having the safety issues of having an interchange and preventing the use of the current SH1 to access South Levin.

3.2.2 Kimberley and Tararua

As with the Manakau/Kuku interchange, this could also be the southernmost interchange on the O2NL alignment. This resulted in many of the key concerns from above being replicated here.

The difference here is that if there is an at grade interchange to the south of the Kimberley/Tararua interchange, the driver expectation would be different than if the adjacent interchanges were also at grade compared to a grade separated interchange.

Consequently, the final scoring for roundabouts was 3 if it was the southernmost at grade solution, which would be improved to a 2 if there was a roundabout at Manakau/Kuku due to the change in driver expectations.

3.2.3 Expressway and SH57 Split

The split with SH57 presented three options, being an at grade roundabout: a grade separated interchange and a system (bifurcation) interchange.

The system interchange would result in a high speed to high speed connection onto SH57. This would enable motorists from the south on the expressway to connect onto SH57 seamlessly. From a safety perspective, this was viewed quite negatively, especially if the southern interchanges were grade separated. SH57 is posted at 100 km/h, but has a safe and appropriate speed of 80 km/h. In addition to this, there are several at grade intersections, as well as access points to property. Having a seamless transition from the 110 km/h design philosophy of the Wellington Northern Corridor would mismatch driver expectations. This is not present in the other interchange types, which require drivers accessing SH57 to slow down during the intersection to access the highway. It is noted that the safety concerns from this intersection type are not with the intersection itself, but the surrounding environment. The system interchange received a score of 3.

A roundabout at this location scored a 1 on the assumption that the approach from the south contains some softer measures to prepare drivers for the changing environment. Compared to the southern interchanges, a score of 1 here is suitable due to the semi-urban nature of the alignment at this point, which would promote the changing environment of the road compared to the southern options. It also more appropriately caters for the more balanced traffic flows between SH1 and SH57. The roundabout option also has benefits for drivers transitioning to SH57, as they will be forced to transfer from the new highway to the existing highway through a slower route allowing them to ‘reset’ their expectations of the road. There is potential for this to score a 2 should the road environment to the south of the roundabout not adequately convey the changing environment of the corridor. The score of 1 is also conditional on the new section of highway connecting to SH1 being two lanes instead of four (which is yet to be determined). This would then mark the difference between the two environments.

A grade separated interchange has the benefit of the bifurcation with the added advantage of requiring motorists heading north on SH57 to slow down. It also scored 1, as it combined the best safety aspects of each of the two above options.

3.2.4 North of Levin

North of Levin provides the gateway to the new highway when travelling south. A roundabout scored well here, as it marks the change in the design and feel between the new and old highway. This resulted in a score of 1.

A grade separated interchange also received a score of 1 on the assumption that the link from the split with SH57 and the SH1 interchange is a two-lane road. Should this be a four-lane road, it would score a 2 in a similar manner to the bifurcation at the SH57 split; however, as SH1 has a lower collective risk, the risk is lower than the bifurcation.

While both options scored 1, a roundabout is preferred from a safety perspective.

3.3 Resilience

This criterion evaluates the accessibility of the new highway or old route in the event that either route is closed for any reason. This will be given particular weighting south of the Ohau River, which currently does not have an alternative route.

This criterion included two elements:

- The ability of the interchange to facilitate travel on the alternative route (the current SH1 and the new highway).
- The impacts to the network if there is a crash at the interchange.

There was no notable difference between the connectivity offered by a grade separated interchange or a roundabout. However, the consequence of a crash at a roundabout is more severe than a grade separated interchange, as traffic exiting or entering the roundabout could impact an entire direction of travel or both directions of travel. This is much more mitigated with a grade separated interchange that has a lower crash risk and more separated movements.

The absence of an interchange at Manakau/Kuku scored a 2, while having a second route has improved the resilience significantly, the absence of connectivity here could result in over 10 km of additional travel to access the alternative route depending on the closure location.

3.4 Connectivity

The assessment for the connectivity project objective was narrow. While this would normally be a broader objective, factoring in links to the local road network and impacts on the community, these impacts are being assessed separately in the MCA under the 'fit with local roads' and 'social, community and recreation' assessments. To prevent double counting of these impacts, they were excluded from the project objectives assessment. This does not impact how they would be reported in any wider reporting for the Project.

The primary focus was whether the interchange location and form would be considered appropriate. The guide for this is the One Network Road Classification and corresponding Customer Levels of Service[2] document.

Currently, SH1 is classified as a National High-Volume Road from the southernmost point of the project area to the SH1-SH57 intersection. From here, both SH1 and SH57 are considered National Roads. For the new highway, the same junction points have been assumed (i.e. the split between SH1 and SH57), however some mitigation has been applied at the Kimberley/Tararua interchanges in case the future change in classification is located there.

The Customer Level of Service for a National High-Volume Road when evaluating access points is described as follows:

> *Landuse access for road users rare and highly engineered, usually only to highway service centres. Strategic network connectivity for road users due to infrequent connections, generally only to National high volume roads. High volume traffic will be unimpeded by other traffic at junctions.*

The Customer Level of Service for a National Road when evaluating access points is described as follows:

> *Landuse access for road users infrequent and highly restricted in rural areas, and often restricted in urban areas. Mainly strategic network connectivity for road users due to infrequent connections, generally only to other equal and higher category roads. Easy navigation at intersections, with National road traffic given priority, unless joining with equal or higher category roads.*

At Manakau/Kuku, the highway is expected to be a National High-Volume Road. This would mean an at grade solution would be at odds with the customer expectation. Furthermore, there is no ability to ensure the highway has priority at an at grade roundabout, also at odds with the customer expectation. This resulted in a score of 4. While a score of 3 is considered neutral, the provision of an expressway standard road with a mid-block roundabout is considered worse from a Customer Level of Service point of view than the existing highway, which drivers are used to.

[2] https://www.nzta.govt.nz/assets/Road-Efficiency-Group-2/docs/customer-levels-of-service.pdf

Grade separation scored a 1, as it provides the expected level of service for a National High-Volume Road. No interchange also scored a 1, as for a National High-Volume Road, there is no expectation for connections to a rural area. The provision of a grade separated interchange or no interchange scored favourably when compared to the current scenario, which has at grade and private access onto a National High-Volume Road.

Many of the issues with roundabouts noted above apply at Kimberley/Tararua. This is partially mitigated by the fact that this interchange could potentially be the end of the National High-Volume classification. This means that while still not ideal, it is more acceptable than earlier. Roundabouts at this location scored a 3.

At the SH57 split, both grade separation and roundabouts scored 1. At this point, both roads are expected to be a National Road. A roundabout is considered more equal between the two roads; however, grade separation is still acceptable for the user experience.

A system interchange by means of bifurcation scored a 2, as it was considered to be inappropriate to provide a high-speed motorway to motorway styled connection to SH57, where both roads are not built to an expressway standard. This still scores well due to the expectation from drivers from the south being met.

At the reconnection of the new highway to SH1 north of Levin, both grade separation and roundabout were determined to be appropriate based on the ONRC descriptions.

3.5 Overall

The overall scoring for the interchanges is presented in Table 3-2.

Table 3-2: Interchange scores for project objectives

Option	Enhanced Movement	Safety	Resilience	Connections
Manakau - Roundabout at South	2	3	2	4
Manakau - Grade Separation at South	1	2	1	1
Manakau - Roundabout at Kuku	2	3	2	4
Manakau - Grade Separation at Kuku	1	2	1	1
Manakau - No Connection	1	1	2	1
K/T - Roundabout at Kimberley	2	3	2	3
K/T - Grade Separation at Kimberley	1	1	1	1
K/T - Roundabout at Tararua	2	3	2	3
K/T - Grade Separation at Tararua	1	1	1	1
Split - Bifurcation	1	3	1	2
Split - Roundabout	2	1	2	1
Split - Grade Separation	1	1	1	1
North Levin - Roundabout	2	1	2	1
North Levin - Grade Separation	1	1	1	1

This assessment shows that for the project objectives, grade separated options are typically the most consistent with the project objectives.

4 Local Roads

At completion of the IBC, it was identified that further development and assessment of local road connections would be one of the first key activities needing to be undertaken when developing the DBC. Accordingly, the long list of options for reconnecting local roads and accesses potentially severed by the Ōtaki to North of Levin expressway has been completed. The MCA for this long list option was undertaken and is detailed hereafter.

All local road options will ensure adequate connectivity for private properties and severed road links to the surrounding network and the State Highway.

At this stage in the process, the MCA is seeking to shorten the list for further investigation by identifying options which have issues that would lead to adverse outcomes or require mitigation.

4.1 Enhanced Movement

This project objective refers to State Highway travel; it was therefore concluded none of the options will have travel time concerns relating to movement to and from the State Highway. A high-level analysis showed that there may be a few options that will experience increased travel times for commuters trying to access the State Highway, however these increases will not significantly impact overall travel times for the network.

This project objective scored a 1 for all options, as there were no concerns raised.

4.2 Safety

All local road connections are to be built to a high standard, with safety at the forefront, and are expected to perform similarly. There are options that require sharp bends and some with impacts on sight distance; it was assumed that these options would be marginally less safe than other options. In addition, there are options that improve pedestrian and cyclist facilities; these are considered marginally safer than other options.

Safety for each option was assessed using the criteria listed below.

- Impacts on cyclists/pedestrians
- Sight distance
- Sharp bends

An option with no/minor impacts scored a 1, with the adjudicated score increasing as the impacts increased. The results indicate that all options will be safe, therefore this project objective scored a 1 or 2.

Table 4-1: Safety assessment

Site Name	Cyc/Ped	Sight Distance	Sharp Bends	Point of Concern
A1	1	1	3	Sharp bend
A2	1	1	2	
A3	1	1	1	
B1	1	1	1	
B2	1	1	1	
B3	1	1	1	Increased traffic through street
C1	1	1	1	
C2	1	1	1	Increased traffic through street
C3	1	1	1	Additional cyc/peds
C4	1	1	1	
D1	1	1	1	
D2	1	2	2	Sight distance & sharp bend
E1	1	1	1	
E2	1	1	1	
EQ	1	1	1	
F1	1	2	2	Sight distance & sharp bend
F2	1	1	1	
F3	1	1	1	
G1	1	1	1	
G2	1	1	1	
G3	1	1	1	
H1	1	1	1	
H2	1	1	1	

Site Name	Cyc/Ped	Sight Distance	Sharp Bends	Point of Concern
H3	1	2	1	
I1	1	2	1	
J1	1	2	1	
J2	1	2	1	
J3	1	1	1	
J4	1	2	1	
K1	1	1	1	
K2	1	1	1	
L1	1	1	1	
L2	1	1	2	
N1	1	1	1	
N2	1	1	1	
N3	1	2	1	
P1	1	2	1	
P2	1	2	1	
Q	1	2	1	

4.3 Resilience

It is envisaged that the proposed local road connections will not impact the current local network resilience. However, option A1 - Taylors Road / PP2O Tie-in - Connect current SH1 via Waitohu stream bridge / Taylors Road is a potential concern due to the required underpass at the Waitohu Stream Bridge, where there is an increased risk of scour or flooding, therefore this option was rated slightly less resilient than others. This is a bigger concern for Option A1 than A3, as all traffic accessing the old highway is required to use it, not just those accessing Taylors Road.

Overall, the expressway will improve the overall resilience between Ōtaki and North of Levin, therefore options have either scored a 1 or 2.

4.4 Connectivity

Connectivity was assessed from a traffic perspective only. As previously mentioned, all options will be designed to provide adequate connectivity to the local road network and affected property access. Property accesses on severed road links, made redundant, will be relocated onto another local road to allow required movements.

Table 4-2 shows the travel time impacts for longest detour for each option caused by the expressway. The results show that for the most part, detours will cause a minor increase in travel time. There are a few options that will increase general commuter travel times by over three minutes, and two options that will cause an increase of over five minutes.

Table 4-2: Travel time for the longest detour

Site Name	Origin	Destination	Length	Travel Time
A1	Taylors Road	SH1	50	3.6
A2	Taylors Road	SH1	200	14.4
A3	Taylors Road	SH1	1200	86.4
B1	Manakau H Drive	SH1	2200	158.4
B2	Manakau H Drive	SH1	2450	176.4
B3	S Manakau Road	SH1	2900	208.8
C1	Manakau H Drive	SH1	2200	158.4
C2	S Manakau Road	SH1	2900	208.8
C3	Manakau H Drive	SH1	2200	158.4
C4	Manakau H Drive	SH1	2200	158.4
D1	N Manakau Road	SH1	50	3.6
D2	N Manakau Road	SH1	50	3.6
E1	Kuku Road	SH1	0	0
E2	Kuku Road	SH1	0	0
EQ	Quarry Access	SH1	0	0
F1	Muhunoa E Road	SH1	0	0
F2	Muhunoa E Road	SH1	0	0
F3	Muhunoa E Road	SH1	2000	144
G1	McLeavey Road (Muhunoa E Road)	SH1	2000	144
G2	McLeavey Road (Muhunoa E Road)	SH1	2000	144
G3	McLeavey Road (portion made redundant)	SH1	0	0

Site Name	Origin	Destination	Length	Travel Time
H1	Arapaepae Road	SH1	2000	144
H2	Muhunoa E Road	SH1 (via Mcl Rd)	2000	144
H3	Muhunoa E Road	SH1 (via Kim Rd)	4000	288
I1	Muhunoa E Road	SH1 (via Tara Rd)	6650	478.8
J1	Muhunoa E Road	SH1 (via Kim Rd)	4000	288
J2	Muhunoa E Road	SH1 (via Kim Rd)	4000	288
J3	Kimberley Road	SH1	1900	136.8
J4	Kimberley Road	SH1	2270	163.44
K1	Queen Street	SH57	0	0
K2	Queen Street	SH57	0	0
L1	Waihou Road	SH57	1400	100.8
L2	Waihou Road	SH57 (via Wake Rd)	4300	309.6
N1	Sorenson Road	SH1	0	0
N2	Sorenson Road	SH1	0	0
N3	Sorenson Road	SH1	50	3.6
P1	Heatherlea Road	SH1	50	3.6
P2	Heatherlea Road	SH1	400	28.8
Q1	North Avenue	SH1	1500	108

Alternative destinations were not assessed as at this level of assessment; only key faults that would cause issues meeting the project objectives were considered. Assessing other destinations that are important to local communities would be identified in the social, community and recreation assessment. Furthermore, impacts to the local road connectivity and district development were also evaluated separately.

4.5 Overall

Table 4-3Table 2-6 shows the overall scores of 1 and 2, and a single 3, for the local roads catergory, revealing that these options primarily have minor difficulties when related to the Fit to Project Objectives.

The scores indicate:

- Since enhanced movement relates to the State Highway, this project objective scored consistently for all options.
- Safety marginally varies for each option (A1, D2 and F2 will have sharp bends and sight distance concerns).
- Resilience is consistent for nearly all options.
- Connectivity marginally varies for each option (I1 and L2 will have travel times over 5 mins to reach the current SH1).

Table 4-3: Overall score for local roads

Option	Enhanced Movement	Safety	Resilience	Connections
A1 - Taylors Road / PP2O Tie-in - Connect current SH1 via Waitohu stream bridge / Taylors Road				
A2 - Taylors Road / PP2O Tie-in - Connect via a new underpass (Taylors Road realignment abandoned)				
A3 - Taylors Road / PP2O Tie-in - Connect via a new underpass (Taylors Road via Waitohu Stream bridge)				
B1 - South Manakau Road - Reconnect South Manakau Road via an underpass (expressway over)				
B2 - South Manakau Road - Reconnect South Manakau Road via an overbridge (expressway under)				
B3 - South Manakau Road - Sever South Manakau Road and provide access via Honi Taipua Street				
C1 - Honi Taipua Street - Sever Honi Taipua Street and access via Manakau Heights Drive				
C2 - Honi Taipua Street - Reconnect Honi Taipua Street via an overbridge (expressway under)				
C3 - Honi Taipua Street - Reconnect Honi Taipua Street via a footbridge only (expressway under), vehicle access via Manakau Heights Drive				
C4 - Honi Taipua Street - Sever Honi Taipua Street and create a Mokena Kohere Street footbridge				

Option	Enhanced Movement	Safety	Resilience	Connections
D1 - North Manakau Road - Reconnect North Manakau Road via an overbridge (expressway under)				
D2 - North Manakau Road - Reconnect North Manakau Road via an underpass (expressway over)				
E1 - Kuku East Road - Reconnect Kuku East Road via an overbridge (expressway under)				
E2 - Kuku East Road - Reconnect Kuku East Road via an underpass (expressway over)				
EQ - Quarry Access - Provide access under the Ohau River Bridge (expressway over)				
F1 - Muhunoa East Road - Reconnect Muhunoa East Road via an overbridge (expressway under)				
F2 - Muhunoa East Road - Reconnect Muhunoa East Road via an underpass (expressway over)				
F3 - Muhunoa East Road - Sever Muhunoa East Road and provide access via Arapaepae Road or Mcleavey Road				
G1 - Mcleavey Road - Reconnect Muhunoa East Road via an overbridge (expressway under)				
G2 - Mcleavey Road - Reconnect Muhunoa East Road via an underpass (expressway over)				
G3 - Mcleavey Road - Sever Muhunoa East Road and provide access via Muhunoa East Road or Arapaepae Road				
H1 - Arapaepae Road south of Kimberley Road - Sever Arapaepae Road and provide access via Muhunoa East Road				
H2 - Arapaepae Road south of Kimberley Road - Sever Arapaepae Road and provide access via Mcleavey Road				
H3 - Arapaepae Road south of Kimberley Road - Sever Arapaepae Road and provide access via Kimberley Road / new link				
I1 - Muhunoa East - Muhunoa East, Mcleavey and Kimberley severed, new connecting road built				
J1 - Kimberley Road - Reconnect Kimberley Road via an overbridge (expressway under)				
J2 - Kimberley Road - Reconnect Kimberley Road via an underpass (expressway over)				
J3 - Kimberley Road - Sever Kimberley Road and provide access via Arapaepae South and a new link				
J4 - Kimberley Road - Sever Kimberley Road and provide access via Tararua Road and a new link				
K1 - Queen Street - Reconnect Queen Street via an underpass (expressway over)				
K2 - Queen Street - Reconnect Queen Street via an overbridge (expressway below ground level)				
L1 - Waihou Road - Reconnect Waihou Road via a new link to McDonald Road				
L2 - Waihou Road - Reconnect Waihou Road via a new link to Wakefield Street				2
N1 - Sorenson Road - Reconnect Sorenson Road via an underpass (expressway over)				
N2 - Sorenson Road - Reconnect Sorenson Road via an overbridge (expressway under)				
N3 - Sorenson Road - Retain Sorenson Road status quo based on alignment selection				
P1 - Heatherlea East Road and Koputaroa Road - Reconnect Heatherlea East Road and Koputaroa Road via an intersection to a new roundabout on SH1				
P2 - Heatherlea East Road and Koputaroa Road - Reconnect Heatherlea East Road and Koputaroa Road via an interchange on SH1				
Q1 - Avenue North Road - Convert to cul de sac, active mode access to SH1 only				

From project objectivesperspective only option I1 received a red evaluation. Further issues may be identified as work progresses throughout the Projects development. This will be taken into account in the recommendation of the emerging emerging preferred option.