REPORT

Franz Josef Natural Hazards Options Assessment and Cost Benefit Analysis

Prepared for: West Coast Regional Council

Prepared by: Tonkin + Taylor and EY

Date: October 2017

Tonkin+Taylor

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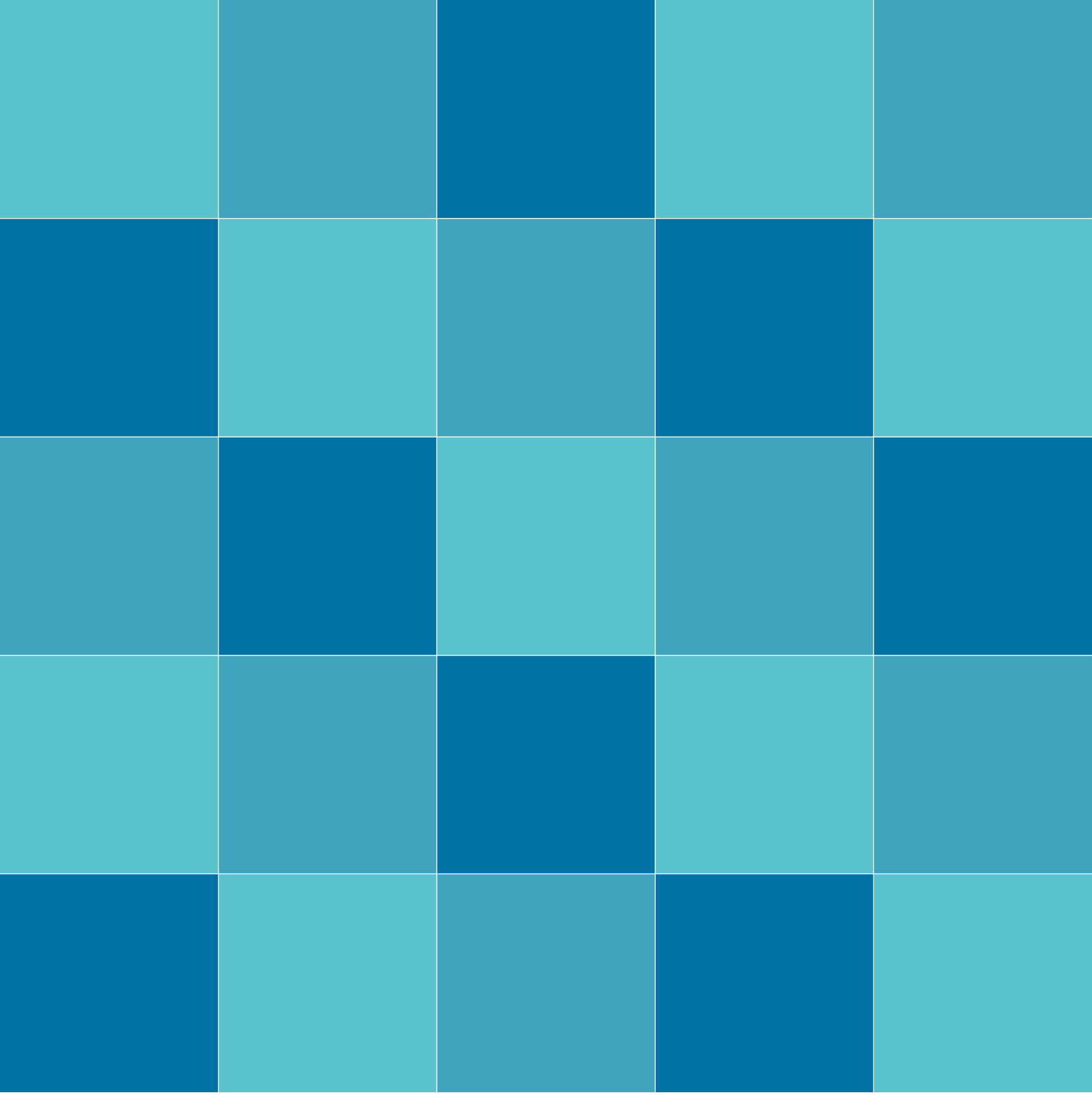

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Acknowledgements

We would like to acknowledge all those who contributed to this study, including: the Franz Josef Working Group; Franz Josef River Group; Franz Josef community members and business owners; West Coast Regional Council; Westland District Council; West Coast Economic Development; Ministry of Business, Innovation and Employment; Department of Conservation; Ministry for the Environment; NZ Transport Agency; Civil Aviation Authority; Department of Civil Defence and Emergency Management; and the study team.

Executive summary

Understanding how best to mitigate natural hazard risks is an issue faced across New Zealand, and inherently involves complex and difficult trade-offs. There is often no easy solution to the challenges faced, and this is the reality facing the small town of Franz Josef.

A prerequisite for all types of decision-making is a credible evidence base. Information can empower the necessary conversations and considerations that will help stakeholders to focus on the 'best' pathway forward.

Franz Josef is truly in a unique situation. While the Alpine Fault and Waiho River system generate significant risk, they are also responsible for the special natural environment that makes Franz Josef a nationally significant tourist destination.

This study concerns itself with the two primary natural hazards with the potential to affect the town.

The **Waiho River** is among the most difficult New Zealand rivers to manage. With bed aggradation rates averaging between 0.16m and 0.2m *per annum,* it is likely that in 30 years, or sooner as a result of significant storm events, the bed of the river will be equal to, or higher than, the level of Franz Josef township if there is no further intervention.

The **Alpine Fault** runs through the commercial centre of Franz Josef. A rupture of this fault will cause strong ground shaking and deformation of the ground surface around the fault. Despite inherently resilient, low-rise, lightweight, building stock, it is expected that there would be considerable damage to existing buildings as well as the infrastructure that supports the town. Regionally, it is expected that many of the essential services that support Franz Josef would also be cut-off due to road closure (including Arthurs Pass). Additionally, there is the latent presence of an **earthquake-triggered large landslide** which would significantly compromise all of the value at stake in the town including life, capital values and tourism flows.

The base case analysis completed as part of this study led to the conclusion that, due to bed aggradation, a significant intervention is required within 30 years to mitigate flooding risk. As a result of bed aggradation, with all other things being equal, we would expect the current value of buildings and property in Franz Josef to diminish in the longer term, unless action is taken. There is also the risk that a significant event could occur much earlier than modelling (based on annual averages) predicts. Significant aggradation may occur in a single flood event and average annual bed aggradation *could* accelerate. Further, while of unknown but low probability, an earthquake-triggered large landslide *could* occur as a result of an Alpine Fault earthquake event. Therefore, a collective decision needs to be made in conjunction with all stakeholders as to what the appetite is for living with these natural disaster risks.

The low rating base (510 residents in the wider Franz Josef area), coupled with the significant tourism value at stake (estimated expenditure in Fran Josef in 2016 was $122m), puts Franz Josef in a unique position. Franz Josef has a high, if not the highest, visitor night-to-resident ratio in the country (2.9 visitor nights, per day, per resident), and this affects the ability to locally fund natural disaster risk mitigation options.

T+T and EY were commissioned to undertake a Natural Hazards Options Assessment and Cost Benefit Analysis to develop an appropriate evidence base to assist decision-making about 'the best' way forward. A full description of the methodology of the study is provided in Appendix A.

A spectrum of options was identified and assessed, from major projects which would significantly change the risk profile of the community, to minor or supporting projects that could be implemented in their own right or incorporated as part of a programme. In particular:

- 12 options were identified that focus on avoiding hazards

- 53 options were identified that focus on managing hazards and reducing the consequences of disruption
- 4 options were identified that look to transfer the burden of risk to third parties

A qualitative assessment using a multi criteria assessment (MCA) framework was used as an initial filter of the long list of options. The MCA was based on the investment objectives and critical success factors that were agreed by the Franz Josef Working Group, as well as leveraging leading practice research. This phase of the analysis indicated that:

- There is no one option or small package of low-cost options that significantly changes the risk profile of the town – particularly over the medium- to long-term
- There are some lower-cost and no-regrets options that do perform well and should be considered for implementation, regardless of any major package pursued, including finalisation and implementation of the community resilience plan

Following the MCA assessment, three packages of options (essentially various combinations of the 69 options identified) were considered that would offer the most significant increase in resilience to earthquake and flooding risk. But these come at a high financial cost, with benefits not always distributed evenly across the community. Each of these packages has a different profile and level of residual risk.

- ***Avoid nature's most significant challenges***: This package seeks to physically avoid the natural hazard challenges in Franz Josef by moving the township to Lake Mapourika, out of the area subject to flooding from the Waiho River and away from the Alpine Fault and the range-front landslide risk. This package may create new investment opportunities, in addition to protecting the tourism value currently generated by the township.
- ***Live with nature's challenges***: This package involves generally decreasing stopbank management and allowing the river to fan out in its natural pattern, which will reduce flooding risk and flood management costs. It also allows for relocating township assets off the active known fault line in the short- to medium-term. However, over time, the value of the land to the south of the Waiho River will be eroded due to increased flooding risk.
- ***Defend against nature's challenges***: This package involves continuing to build stopbanks and implementing a gravel extraction programme to allow the township, and the businesses and residents in the wider Franz Josef area to remain in their current location with lower flooding risk. It also allows for relocating township assets off the active known fault line in the short- to medium-term to reduce earthquake-related risk. The costs of gravel management will occur in perpetuity and the town will remain exposed to residual flooding risk from stopbank failure or overtopping.

To understand the economic impacts of each package of options at a more detailed level, cost benefit analysis (CBA) was employed. CBA as an economic tool is designed to show the best value for money solution over a particular time period, based on the inputs that can be measured. On this basis, the CBA indicates that *Defend against nature's challenges* and *Live with nature's challenges* perform the best of the three options.

These findings are not surprising given that *Defend against nature's challenges* and *Live with nature's challenges* seek to mitigate the natural hazard risks, by protecting the existing value of the township *in situ*. *Defend against nature's challenges* is the only package that maintains the existing value of the town to the north and south of the Waiho River. Comparatively, the high up-front costs associated with *Avoid nature's most significant challenges* and the long-term nature of the benefits that are expected to accrue (and which extend beyond the modelling period), translate to a lower benefit cost ratio over the modelling period.

However, it is important to note that the actual costs of *Defend against nature's challenges* and *Live with nature's challenges* will likely occur in perpetuity, while the modelled costs occur over a 50-year period. CBA therefore significantly underestimates the true costs of these interventions over time.

The evidence base associated with the MCA and CBA is only part of the context that should inform decision-making. There are always choices about what the future of Franz Josef should look like – and it may be that a combination of living with nature, defending against nature and avoiding nature's significant challenges might be preferable.

Decision-making also needs to consider the risk appetite for certain natural hazard risks, the nature of natural hazard risks occurring in perpetuity (not over the 50-year time period of traditional economic modelling), and future aspirations for the town. More detailed consideration of, and engagement with, stakeholders about non-financial aspects is also required.

What is not in question is that any solution must be developed collaboratively. The scale of the value at stake in Franz Josef demonstrates that this is a local, regional and national conversation. In particular, we recommend that the following next steps be undertaken moving towards a formal business case:

- ***Establishment of a governance group*** which includes community, iwi, local government and central government representation
- ***Commencing relevant Resource Management Act processes***
- Developing a structured approach to ***stakeholder engagement***
- Commencing an extended period of work with stakeholders to ***support the development of a preferred package*** appropriate for a formal business case

This is a unique opportunity, not only to protect the value at stake in Franz Josef, but to make a decision that would generally be taken after an event has occurred, not before; and agree the 'best way' forward for the town in the context of these very real natural hazard challenges.

The remainder of this report outlines the considerable efforts that have gone into this study from the T+T and EY team, the Franz Josef community and other relevant stakeholders. It is hoped that this study will form the evidence base needed to progress decisions about the future of Franz Josef.

1 Introduction | setting the scene

The primary focus of this study was to evaluate various options to mitigate natural hazard risk in Franz Josef township. This evaluation was expected to utilise cost benefit analysis (CBA) modelling techniques to understand the comparative performance of a pragmatic suite of options in mitigating this risk.

This work is intended to form, and in some instances reform, the evidence base so that relevant decision makers can engage in even more informed conversations about the future of Franz Josef. Stakeholder and community engagement has been an important part of this study; however, considerably more consultation is required to build consensus around the preferred way forward.

1.1 Key considerations

Four important considerations have shaped our assessment and underpin many of the perspectives and findings presented throughout the remainder of this report.

The nature of natural hazard risk

Natural hazards are by their very nature uncertain, dynamic and exist in perpetuity. While assumptions can be made based on good science about the expected probability and magnitude of consequences of events, we ultimately do not know precisely when an event will occur and what the impacts will be. For example, while the probability of an event occurring may be once every 10 years, it could happen two times in the next year and then not again for the next 50 years.

Probabilities are therefore useful for us when thinking about relative impacts. But they should not blind us to the realities - the potential significant impacts of low probability events occurring. This uncertainty is no more relevant anywhere than in Franz Josef, given the size and scale of potential natural hazard events.

The interface between modelling and reality

There is a limit to the extent to which modelling and economic analysis can be used as a formal projector of future outcomes. Throughout this study we have sought to balance the competing tensions between what might happen in reality *versus* what we can justify for the purposes of modelling. An example of this is the timeframes for analysis. While 50 years may be considered 'long-term' for modelling purposes, planning timeframes are considerably longer and must consider the needs of future generations. In addition, modelling considers changes on an annual average basis, which effectively assumes consistent increases or decreases, or recurring patterns of events. This does not reflect how natural hazard events and impacts are likely to occur. For example, consideration of bed aggradation in the Waiho River is undertaken based on an annual average, however a large storm event would likely result in a much greater level of aggradation than an annual prediction.

The interface between Franz Josef and wider systems

Franz Josef is situated at the nexus of a range of competing natural and man-made systems including: climatic, hydrological, geological, social and economic. It is therefore challenging to completely isolate impacts on Franz Josef from natural hazard events (and impacts) elsewhere in a system. This dynamic is present across much of our analysis and reasonable estimates have been made about system-wide impacts wherever appropriate and possible. For example, we have assumed a set of particular road closures following an Alpine Fault rupture isolated in Franz Josef. These assumptions necessarily extend beyond Franz Josef and extend across the West Coast and the South Island.

The scale of the solution needs to match the scale of the problem

In undertaking this analysis we have thought carefully about a wide range of options that could improve the resilience of Franz Josef to natural hazard events. However, given the scale of the potential risks, it has emerged that 'smaller solutions' will be unlikely to mitigate natural hazard risk, to a material extent, by themselves. Do-nothing or do-minimum is not an option forever – although it may be appropriate in the short-term. If no action is taken, then the value that is present in Franz Josef will eventually erode.

We expect that much of the content in this report may be confronting. Serious issues are contemplated in this report and we have not considered them lightly. We understand the importance of making the best decisions and believe that this report will provide the Franz Josef community, as well as wider stakeholder groups, with an improved evidence base to enable important discussions to be had and decisions to be made about risk, tolerance and the future prosperity of Franz Josef.

1.2 Overview of approach and report

This report sets out the findings of the assessment, which drew on previous studies of the area and engagement with stakeholders. In particular, the Franz Josef Working Group (FJWG), was engaged to provide feedback representing the community's perspective at key points during the process. The broader community was also engaged through town-hall type presentations to gather broader input through the process.

The first step in this study was synthesising previous studies and hazard information, and engaging with the Franz Josef community, to develop a picture of the natural hazard risks and value at stake. This provides the Strategic Case, or case for change, for future business case development.

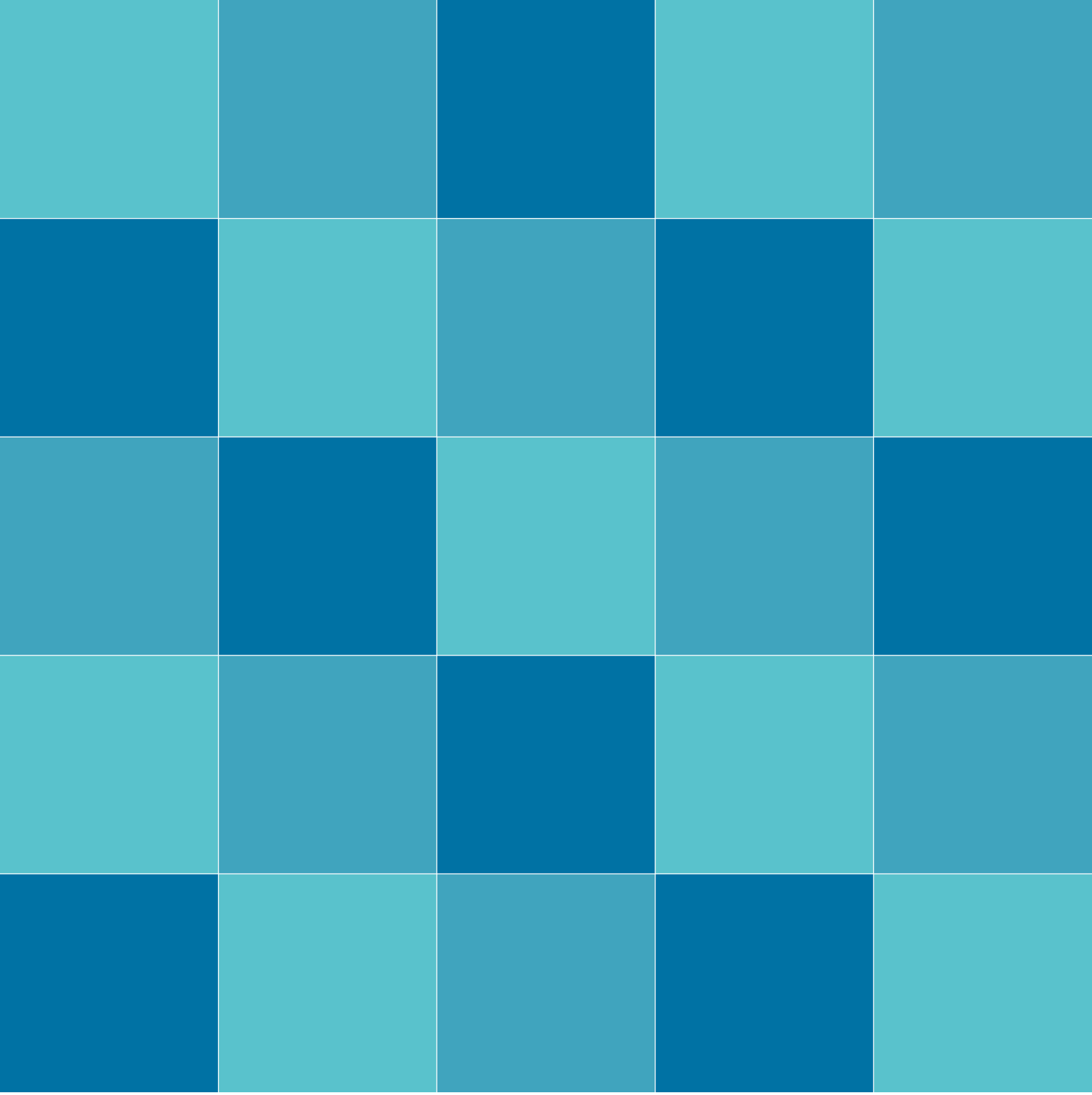
The Economic Case sets out the options assessment, including options identification; criteria for assessment; and multi-criteria and cost-benefit assessment results. The criteria for assessment included investment objectives and critical success factors, and were developed and refined with the FJWG. The objectives and factors then formed the basis of the multi-criteria assessment (MCA), through which the long list of options was assessed. This first-cut of options resulted in identification of:

- Three 'packages' of options that represent alternative approaches that seek to protect, to varying degrees, the value at stake
- No-regrets measures that support a range of resilience and broader outcomes at low cost

The packages were then further refined and cost-benefit analysis undertaken.

The final chapters summarise the findings of the study and provide recommendations on the next steps to progress the options through further engagement with the community and key stakeholders.

A full description of the scope of this study is provided in Appendix A, followed by details of the study from each key stage.



Strategic case

2 The case for change

There are three main characteristics of Franz Josef township (the township or Franz Josef) and the surrounding area that drive the case for change:

- Franz Josef is very close to an iconic tourist attraction and helps to support local, regional and national tourism objectives
- Franz Josef is subject to a number of natural hazards that have potential serious implications for life and economic activity
- Franz Josef, West Coast Regional Council and Westland District Council have a small rating base, which poses challenges in funding investments to mitigate disruption risk. Because of this, incremental and reactionary natural hazard protection measures have traditionally been explored, with a limited ability to look at more significant interventions that would change the risk profile of the township in the longer term.

This strategic case demonstrates the need for action to mitigate the risks that natural hazards present to Franz Josef township.

2.1 Context

2.1.1 Geographic overview

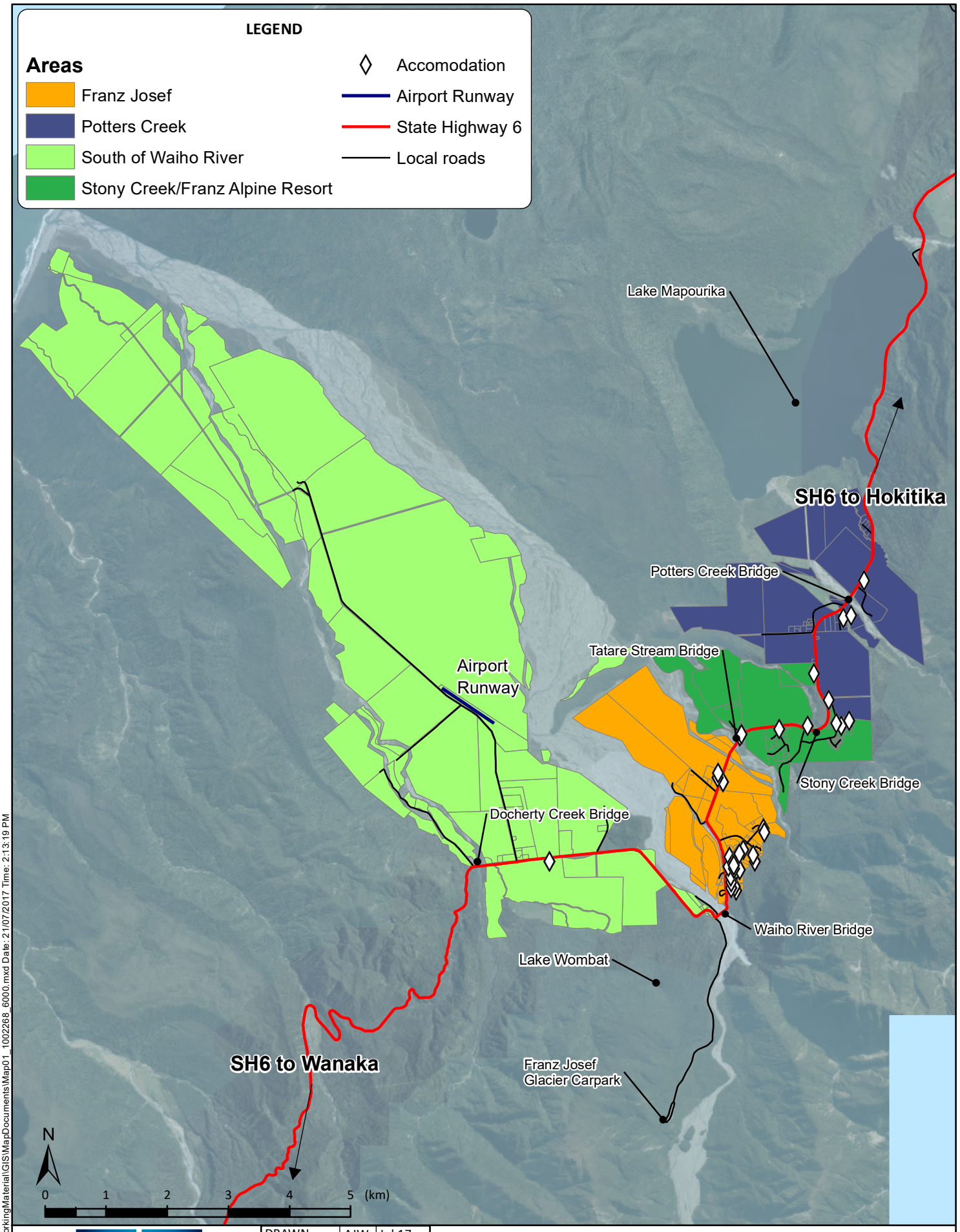
Franz Josef township is located on the West Coast of New Zealand and is close to the Franz Josef Glacier (as well as other tourist attractions, including the Fox Glacier). Franz Josef is roughly 135 km from Hokitika to the north and roughly 145 km from Haast to the south.

The administrative (and geographic) boundaries of the West Coast Region are split into the Buller, Grey and Westland districts (Figure 2-1). Franz Josef sits within the Westland District Council (WDC) boundary[1] and is within the West Coast Regional Council (WCRC) boundary.

Figure 2-1: Administrative and regional boundaries of the West Coast Region (Source: LGNZ)

The geographic area considered in the assessment is shown on Figure 2-2.

[1] Image sourced from Local Government New Zealand (LGNZ) http://www.lgnz.co.nz/home/nzs-local-government/new-zealands-councils/ accessed March 2017.



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Wider Franz Josef Area

2.1.2 Population

The wider Franz Josef area has a resident population of 510 people[2]. By comparison, the West Coast Region's population is estimated at 32,700 with district splits of:

- Grey, with an estimated population of 13,650 (42 percent of the region's population)
- Buller, with an estimated population of 10,350 (31 percent)
- Westland, with an estimated population of 8,720 (27 percent)[3]

2.2 Value at stake

The following section summarises the value at stake from a natural hazard disruption in, or in close proximity to, Franz Josef township. For the purposes of this study, we have focussed on:

- Stocks, which include the built environment and key services in the township
- Flows, which is the value generated regionally or nationally as a result of tourist and freight movement though the area

The value described in this chapter is purposefully at a high-level aggregation to support the case for change, but is further disaggregated as part of the economic case. We also recognise the unique social, cultural and natural value of the township and the wider Franz Josef area.

For the remainder of this report 'value' will include economic, environmental, social, and cultural aspects, unless otherwise indicated.

2.2.1 Natural value and comparative advantages

While the Alpine Fault and Waiho River system generate risk, they are also responsible for the unique natural environment that makes Franz Josef a nationally significant location from a tourist perspective[4]. Franz Josef is within the 2.6 million hectare UNESCO-recognised World Heritage site, Te Wahipounamu (Figure 2-3). Unique to Franz Josef is its proximity to Franz Josef Glacier and the outstanding ecological value of Westland Tai Poutini.

Franz Josef has a strong comparative advantage across a range of industries that concord with the tourism sector including: *Accommodation and food services*, *arts and recreation, transport, postal and warehousing* (Figure 2-4). Franz Josef's proximity to the Franz Josef Glacier, and its comparative convenience as a 'break point destination' along a common tourist corridor, help to explain this comparative advantage.

[2] Statistics New Zealand. (2016). Estimates about Franz Josef. Retrieved from http://nzdotstat.stats.govt.nz/WBOS/Index.aspx?DataSetCode=TABLECODE7502 Dataset: Subnational population estimates (TA, AU), by age and sex, at 30 June 1996, 2001, 2006-16 (2017 boundaries)

[3] Ministry of Business, Innovation and Employment. (2016) Tai Poutini West Coast Growth Study. Retrieved from http://www.mbie.govt.nz/info-services/sectors-industries/regions-cities/regional-growth-programme/pdf-image-library/tai-poutini-west-coast-growth-opportunities-report.pdf

[4] MSH Architects Ltd. (2014). Franz Josef Urban Revitalisation Master Plan. 29 p.

Figure 2-3: Te Wahipounamu South West New Zealand World Heritage Area[5]

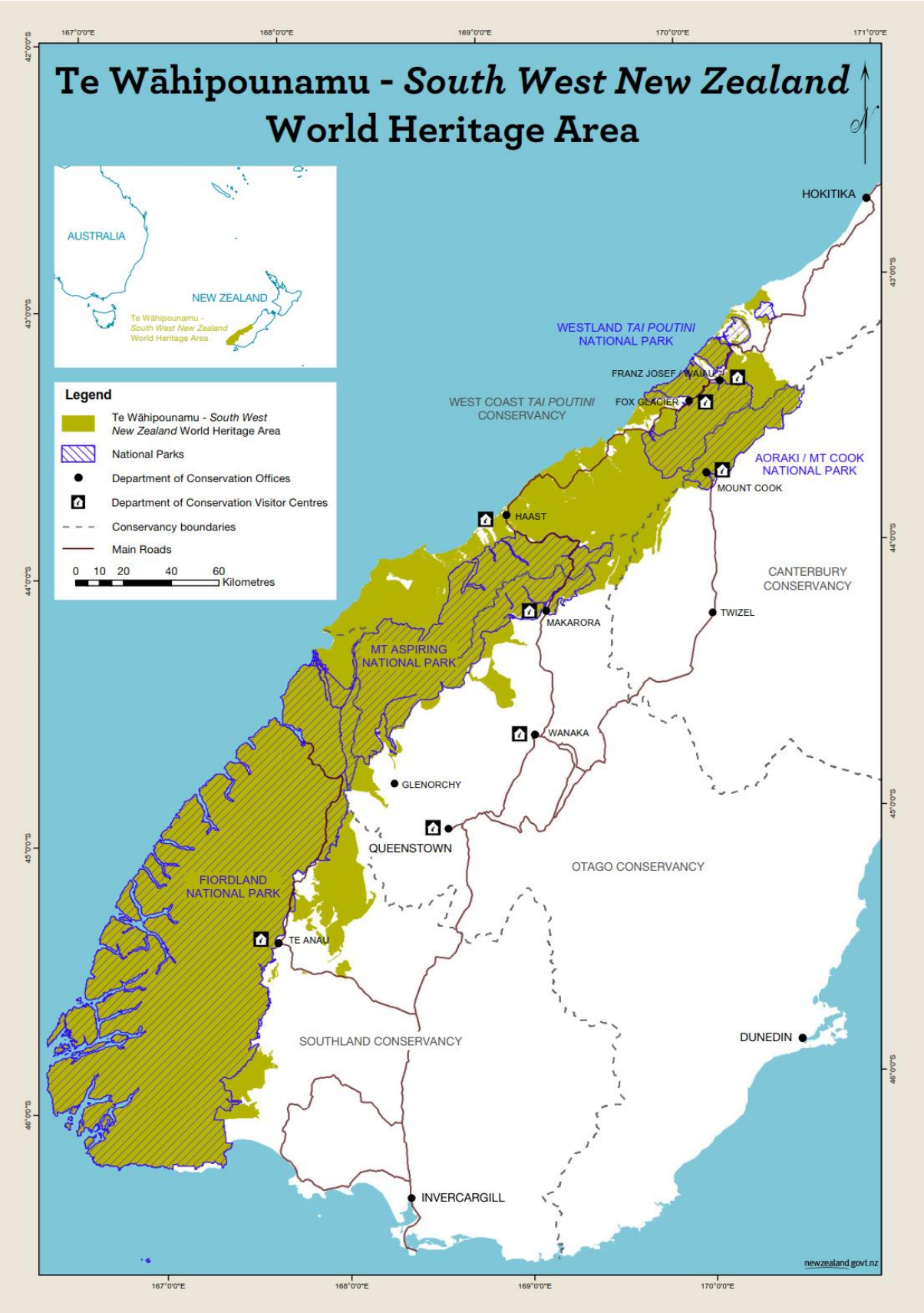
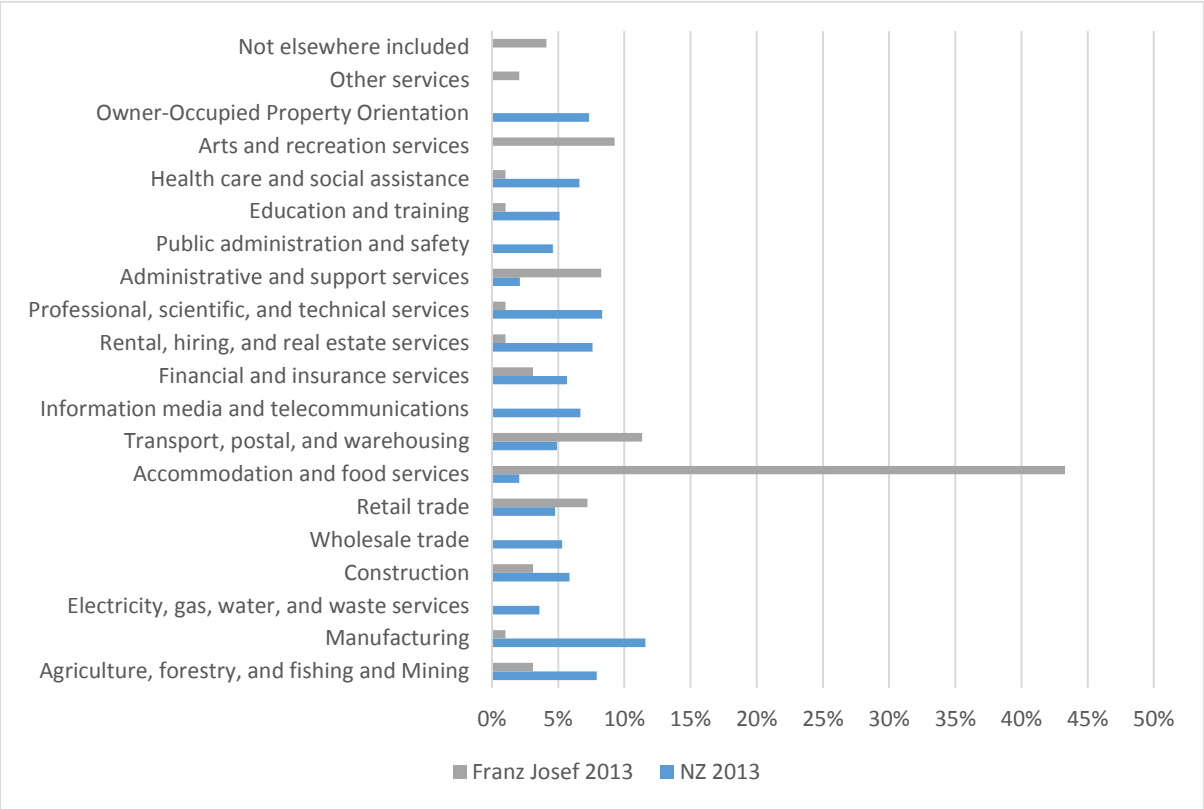


Figure 2-4: Proportion of jobs, by ANZSIC Level 1, 2013 (Franz Josef and New Zealand comparison)[6]



2.2.2 Social and cultural value

The size and location of Franz Josef contributes to a close-knit community, capable of achieving high levels of social cohesion. They are people who value the unique natural assets of the region and their way of life as West Coasters.

The community is interested in encouraging an increase in permanent residents and places a high value on maintaining existing facilities, including the primary school and kindergarten, as well as developing new facilities, such as a gym and covered playground. Cultural value also resides in key assets in the town, including the Catholic and Anglican churches and community practices represented and reinforced by assets such as the volunteer fire station.

Ngāi Tahu is recognised as tangata whenua of the area and Runanga o Makaawhio is the local runanga. As such, the area is of special intrinsic and cultural value to the iwi. Specific taonga were not identified during the study. Ngāi Tahu Tourism operates in the area and provides connection for its customers and people to their place and Ngāi Tahu.

The community generally considers itself to be resilient and recognises that it will need to have a certain level of independence in the event of an Alpine Fault rupture in particular.

5 Department of Conservation, Te Wahipounamu http://www.doc.govt.nz/te-wahipounamu
6 Statistics New Zealand (2013) Census

2.2.3 Economic value

Economic value in Franz Josef comprises both town assets and infrastructure (stocks) and flows which leverage the town assets (natural, social, cultural, and economic) to create further value.

2.2.3.1 Stocks

2.2.3.1.1 Buildings

The building stocks, valuations and rates described in the following section are intended to provide a general overview of the economic value at stake in Franz Josef township (taken as the area between Waiho River and Tatare Stream) and the wider Franz Josef area[7]. Unless otherwise stated, all data are based on information provided by West Coast Regional Council and Westland District Council.

The Franz Josef area (Figure 2-2), including the township, has approximately 144 properties. This stock is made up of one and two-storey residential and commercial buildings. The capital value of these properties is collectively ~$113 million, with ~$43 million in land value and ~$70 million in improvements. The rates from these properties is ~$907,000 per year.

The wider Franz Josef area, from Docherty Creek to Potters Creek, includes rural areas and the Franz Alpine Resort residential area at Stony Creek. It represents an additional ~$76 million dollars of capital value, with ~$47 million in land value and ~$29 million in improvements. The rates from these additional properties is ~$462,000 per year.

The township has a volunteer fire station, Department of Conservation (DoC) workshop and fire depot, petrol station (including underground storage tanks), community hall, Police station, health centre and Catholic and Anglican churches.

1.5 km north of the township are the kindergarten and primary school. The kindergarten has approximately 40 children on the roll[8] and the school, 35 students[9].

2.2.3.1.2 Utilities

There is a centralised town potable water supply, wastewater and stormwater (three waters) network. This includes wastewater treatment oxidation ponds on the edge of the Waiho River (see Figure 2-5) downstream from the town. WDC reports the approximate value of the three waters network at $4.4 million, based on linear rates for pipes and reported replacement value for plant. However, it is possible that the full replacement cost of the network is significantly greater than this.

Electricity is supplied to Franz Josef from the north via the Westpower 33 kV line, which is connected to the national grid at Hokitika. Trustpower has generation capacity on this line at Wahapo Lake which is approximately 16 km north of Franz Josef.

Two telecommunication towers are located in Franz Josef and all major mobile telecommunication providers have coverage.

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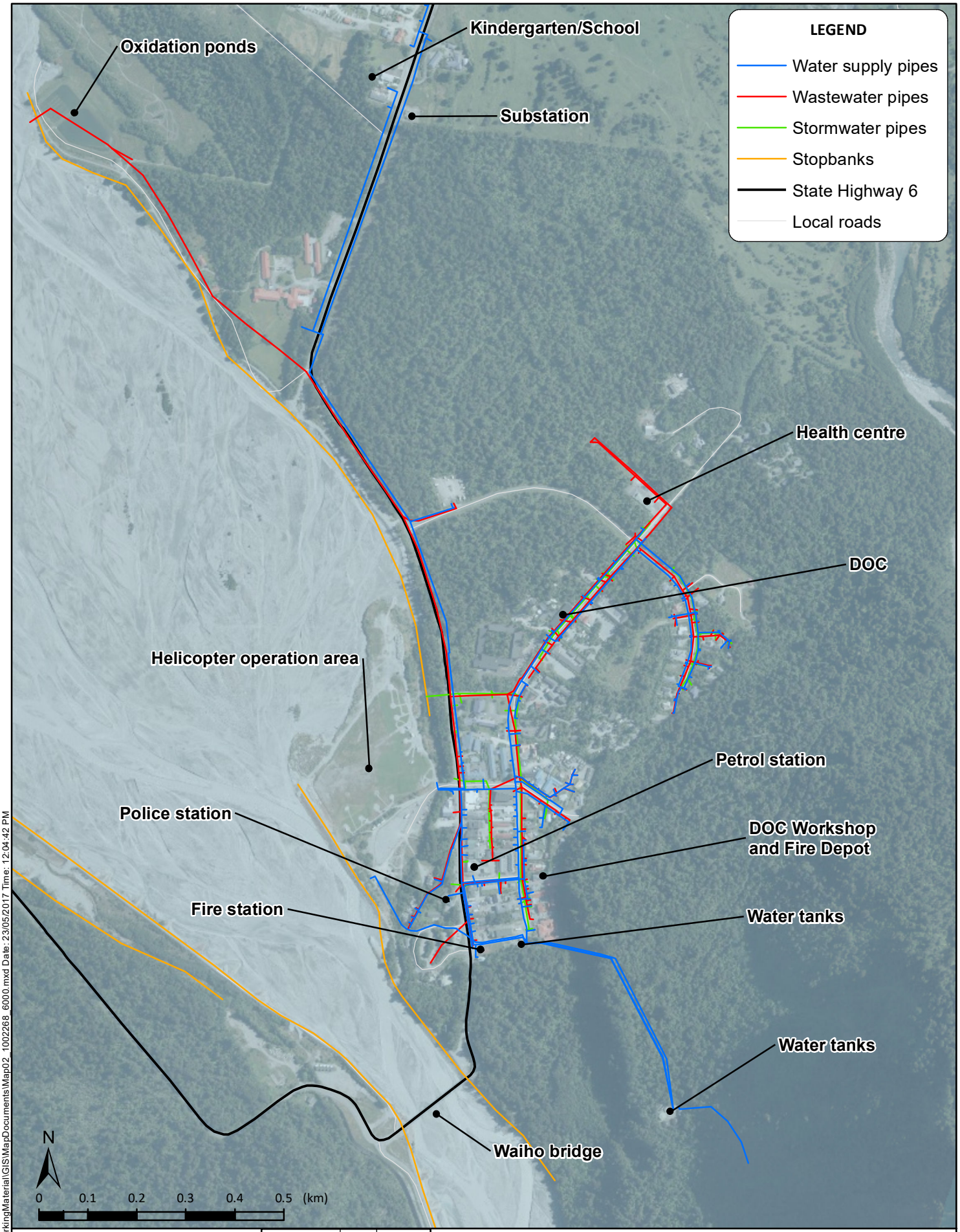
7 These data should not be relied upon for any purpose without further verification.

8 Provided anecdotally by Franz Josef Working Group, March 2017.

9 Education Review Office, Franz Josef Glacier School – 15/09/12 http://www.ero.govt.nz/review-reports/franz-josef-glacier-school-15-09-2015/ accessed March 2017.



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Infrastructure Network

2.2.3.1.3 Roading

State Highway 6 owned by the New Zealand Transport Agency (NZTA) runs through the township (see Figure 2-5). From the north it crosses Potters Creek, Stony Creek and the Tatare River, and to the south it crosses the Waiho River. It also crosses the Alpine Fault rupture zone.

The local roads in the township total 2-3 km in length and are a combination of sealed and gravel roads. These are owned and maintained by Westland District Council.

2.2.3.1.4 Aerodrome and heliport

The Franz Josef Aerodrome (the Aerodrome) is to the south of Waiho River (see Figure 2-5), across the SH6 bridge, approximately 6 km from Franz Josef. The length of the sealed runway is 800 m, which allows small aircraft to land.

The primary helicopter landing area is immediately adjacent to the Franz Josef main street and has multiple, above-ground aviation fuel storage tanks. This area is protected from the Waiho River by stopbanks. A number of smaller helicopter landing areas exist across the wider Franz Josef area.

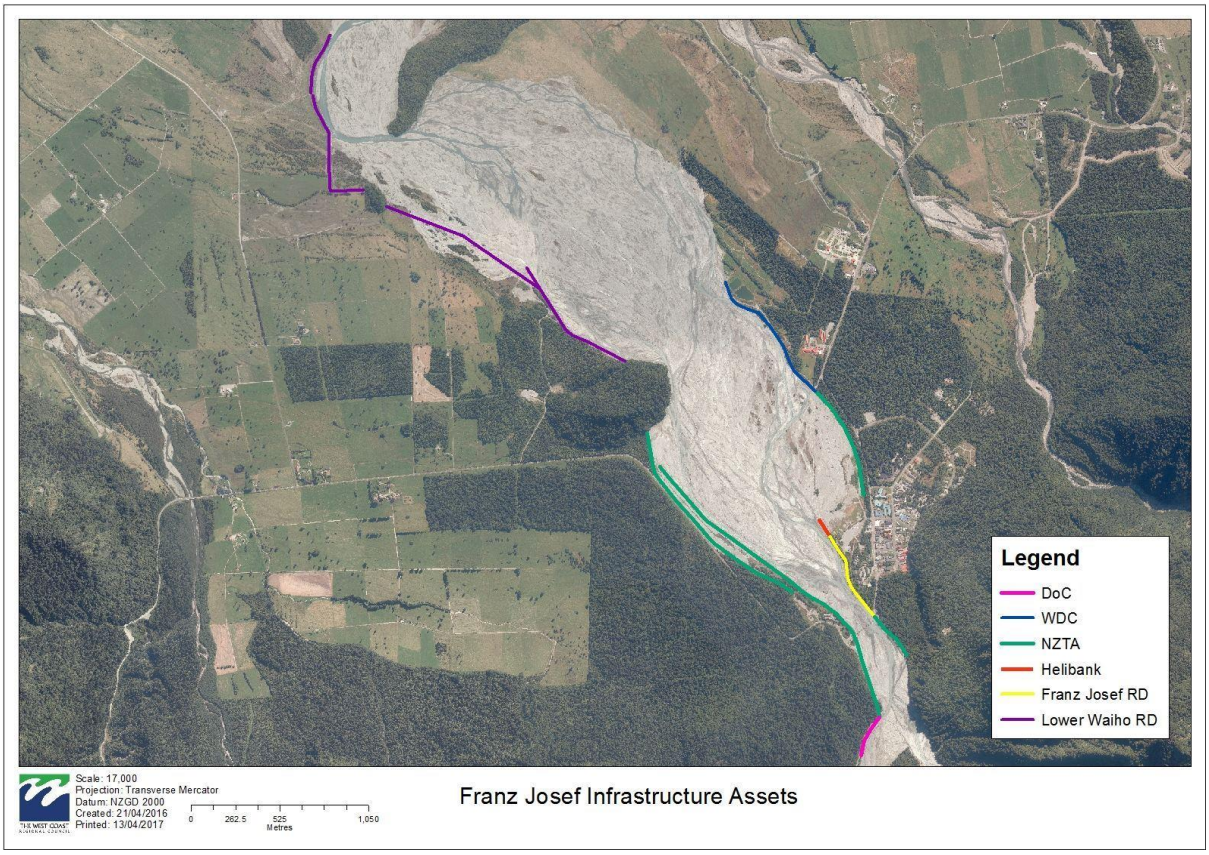
2.2.3.1.5 Stopbanks

The land and assets adjacent to the Waiho River are protected from the flooding by stopbanks as shown on Figure 2-6. The Franz Josef stopbanks which protect the township are funded under the WCRC Franz Josef Stopbank Rating District[10]. Other stopbanks in the area are funded by NZTA, Hokitika Airport Authority, Westland District Council and WCRC under the Lower Waiho Stopbank Rating District. We estimate the stopbanks in the wider Franz Josef area have a capital value of $5 million to $10 million[11].

[10] Franz Josef Stopbank Rating District Infrastructural asset register 30 June 2014 wcrc.govt.nz

[11] Lower Waiho Stopbank Rating District Infrastructural asset register 30 June 2014 wcrc.govt.nz

Figure 2-6: Stopbank management in the Franz Josef area noting which organisations manage the Heliport stopbank, Franz Josef RD and Lower Waiho RD stopbanks (Source: WCRC)



2.2.3.2 Flows

There are many economic flows through Franz Josef that can be measured in a range of ways. The main challenge in presenting these is that very few, if any, Franz Josef-specific statistics exist for those flows that characterise the value at stake. We have therefore derived indicators using a range of trusted methodologies as well as validating them through discussion with relevant stakeholders.

2.2.3.2.1 Gross Domestic Product

The most common metric of regional economic performance is often Gross Domestic Product (GDP). GDP includes all private and public consumption, Government outlays, investments and exports minus imports that occur within a defined territory. Put simply, GDP is a broad measurement of the overall economic value added by an area over a set period of time[12].

We estimate the GDP contribution of Franz Josef to be ~$23m per year (see Appendix C for further information on calculation methodology). Sensitivity analysis suggests that this is appropriate as a figure of ~$25m is estimated under the GDP per capita approach, and a figure of ~$21m is estimated using a GDP per employee approach.

Given the inherent characteristics of the Franz Josef economy, GDP is not extensively used in the remaining analysis, as impacts on capital values and tourist flows are considered to be more relevant measures of economic value gained / lost. However a GDP estimate is useful to understand an

[12] http://www.investopedia.com/terms/g/gdp.asp

indication of the size and magnitude of value added by the Franz Josef economy in relation to the regional and national economy.

2.2.3.2.2 Tourism flows

Tourism is the dominant demand vector for Franz Josef. These flows are assumed to be significantly driven by the environmental value inherent in the Franz Josef community. For example, 700,000 visitors arrived at the glaciers (Franz Josef and Fox) in 2016[13]. This number represents roughly 20% of total visitor arrivals to New Zealand in the same year.

It is estimated that visitor nights in Franz Josef township and surrounds were approximately 553,000 in 2016 (using Ministry of Business, Innovation and Employment (MBIE) and Statistics NZ tourism statistics). Table 2-1 provides a more detailed breakdown of the Franz Josef tourism statistical estimates. Notably, the visitor night to resident ratio of around 2.9 : 1 (2.9 visitors per day, per resident) is one of the highest, if not the highest, in New Zealand.

We estimate that the total expenditure by domestic and international tourists in Franz Josef township was $122 m in 2016 (see Appendix C for further information on calculation methodology). While not all of this value, for a range of reasons, stays within the region, it is another way of understanding the wider value at stake[14].

Table 2-1: Tourism data, year to March 2017

Item	2016
West Coast Visitor Numbers ('000)	551
Franz Josef Visitor Numbers ('000)	263
Franz Josef Visitor Nights ('000)	553
Franz Josef visitor expenditure ($m)	122
Expenditure per visitor night ($)	222

2.2.3.2.3 Freight flows

With a small and isolated resident population, it is of note that key inputs for business are predominantly imported, including labour (seasonal employment) and goods for consumption within the town (retail, FMCG). Many key services are also imported (for example, we understand that commercial laundry services are imported from Rolleston prison and fuel from Nelson or Christchurch).

This reliance on imports cannot be ignored when considering the value at risk, as it helps demonstrate the regional and national significance of Franz Josef. While a significant amount of expenditure occurs in Franz Josef, the beneficiaries of this expenditure are actually considerably broader in a geographic sense.

We understand that no (or a very limited amount of) trans-regional freight passes through Franz Josef. The export freight business generated within the West Coast appears to travel to major sea ports (Lyttelton or Port Chalmers) via Arthurs Pass and SH1[15].

[13] Tourism West Coast Marketing Plan (2016)

[14] Value may not stay in Franz Josef because inputs (such as food, beverages, retail goods) may be produced elsewhere and capital may be owned by those living outside of Franz Josef (for example, returns to capital from Scenic Circle will accrue, in some part, to the parent company). It is also worth noting that as many as half of these visitors will make day trips to the Glacier(s) and therefore spend very little within Franz Josef township or the wider area.

[15] Freight Task data taken from Ministry of Transport (2012) Freight Demand Study. Identification of fastest routes taken from Google Maps. This hypothesis has been tested and supported through numerous forums.

2.2.4 Existing commitments

Activities or programmes that have been committed to (i.e. where funding has been allocated) by the public and private sector are important, as they provide insight into the investment priorities of the township, as well as potentially informing options to manage natural hazard risk.

WDC and the Franz Josef community have invested significant time and effort in a land use planning approach to manage the risks associated with an Alpine Fault rupture. This was in the form of Proposed Plan Change 7 to the Westland District Plan, which was subsequently appealed and withdrawn. WDC and the community have also invested in the development of an Urban Revitalisation Master Plan and Design Guidelines, produced in 2014.

The Westland District Council Long Term Plan adopted in June 2015 outlines the following existing commitments and planned investments:

- Community Emergency Response Plan is in place for Franz Josef
- $35,000 investment in 2015/16 for township development and improvement projects
- $40,000 investment for new footpaths in the township in 2015-2017
- $96,000 for footpath improvements over the period 2017-2025
- A commitment for the Franz Josef water supply to meet key performance measures in the period 2015-2018
- Investment of $100,000 in water meter replacements made in 2016
- Investments totalling $240,220 in water supply upgrades scheduled for 2023-2024
- Commitments to investigate relocation and increase the capacity of the wastewater treatment plant, including future commitments, totalling $339,370 on wastewater infrastructure between 2019-2022 and $9,631,000 for the new wastewater treatment plant / protection wall over the period 2017-2021

The Westland Annual Plan 2016/17 outlines a commitment of $200,000 for design and planning proposals for the wastewater treatment plant, which must be designed to meet set discharge standards by 2018.

We understand that a resilience plan is being developed in conjunction with the Ministry of Civil Defence and Emergency Management (MCDEM) and that planning for a gym is underway.

NZTA has issued a Request for Proposal committing $1.6 m to raise the Bailey bridge over the Waiho River. This is expected to be completed by late 2017 or 2018.

Additionally, we understand that funding has been secured for upgraded toilet facilities near the iSite in the centre of town, along with funding for a cycle track.

We also note that there may be other private business owners and investors with commitments in the township. We have heard a number of concepts and ideas in undertaking this study, but as at June 2017, have not seen any further proposals that can be considered fully committed to, or where a commitment for funding currently exists.

2.3 Natural hazard risk

Significant work has been undertaken to understand the risks presented by natural hazards to Franz Josef township, summarised most recently by GNS Science[16]. While the township may be impacted by multiple natural hazards, two events present a significant risk to Franz Josef:

- An Alpine Fault earthquake with two key components:
  - Alpine Fault rupture
  - earthquake-triggered large landslide
- A major flooding of the Waiho River

Figure 2-7: Fault rupture across road and rail in the 14 November 2016 Kaikoura EQ (T+T)

2.3.1 Alpine Fault rupture

A rupture of the Alpine Fault will cause strong ground shaking and deformation of the ground surface around the fault. GNS (2016) has documented the probability of a rupture of magnitude 8.1 at Franz Josef to have the same probability as a 150-year average recurrence interval (ARI) event.

The expected alignment of the surface rupture has been indicated to pass through the township (shown on Figure 2-10 and Figure 2-11), with the ground deformation across the surface rupture area of 2m vertical and 8m horizontal relative movement (GNS, 2016). Along each trace of the fault, GNS demarcated a 130m to 190m wide area, labelled a *Fault Avoidance Zone*. We have applied this to identify the area of potential ground deformation for the assessment of loss, noting that the area of ground deformation in an actual Alpine Fault rupture is likely to vary from this visualisation. Figure 2-7 illustrates what a fault rupture can look like.

Figure 2-10 shows the spread of shaking as contours of maximum (peak) ground accelerations that may be felt. 0.75g is 75% of the force of gravity. Within the 0.75g contour the accelerations may be higher closer to the fault. In the Christchurch and Kaikoura earthquakes, near-fault shaking reached 2g; however, this was in isolated locations and not likely over the full fault length.

Figure 2-8: Landslides on to SH1 in the 14 November 2016 Kaikoura Earthquake

Landslides from the terrace and range-front slopes as a result of an Alpine Fault rupture may also affect the township. Large-rock landslides are discussed as an associated, but separate, risk in the following section. For landslides that do not turn into large rock landslides, the impact area is likely to be limited to those buildings immediately at the base of the terrace slope. Figure 2-8 illustrates what landslides can look like.

[16] Langridge, R. M., Howarth, J. D., Buxton, R., R., & Ries, W. F. (2016). A Natural Hazard Assessment for the township of Franz Josef, Westland District, GNS Science Consultancy Report 2016/33. 61 p.

A rupture event could also result in a range of potential cascading effects including liquefaction[17], lateral spread[18] and minor to catastrophic landslides, which could potentially inundate the town and/or the Waiho or Callery Rivers. Consequentially, the river(s') flow could be dammed, allowing water to build up to the point at which it presents an additional flooding hazard.

The impacts on the township could therefore include significant injury and potentially loss of life, as well as significant damage to property and the environment. Road access to and from Franz Josef could be closed from months to a year, due to bridge collapse and landslide inundation of the routes to the north and/or south. This would affect local tourism, with flow-on effects in the Region and nationally.

Significant, yet lesser damage is likely in the rest of Franz Josef, which would experience strong shaking, without Fault rupture. More frequent, but less severe, earthquake shaking events are also possible.

2.3.2 Earthquake-triggered large rock landslide

It is possible that an earthquake associated with an Alpine Fault rupture could also trigger a large rock landslide. This risk is considered separately from the overall earthquake risk in the previous section, as it is associated with specific and potentially significant consequences.

The criteria for an earthquake-triggered landslide are:

1. Long sackungen (cracking) at top of slope
2. Notable amounts of throw (movement) on the sackungen
3. Tectonically damaged rock
4. The presence of slope bulging or over steepened slopes below the sackungen
5. Asymmetry in the sackungen distribution (*GNS 2016 after Barth 2013*)

GNS (2016) has indicated "the range-front hillslope immediately to the east of Franz Josef meets most of these criteria and hence has the potential to fail in a catastrophic large rock landslide" (*Barth, 2013; Davies, 2015*).

An example of a rock landslide debris, which likely occurred as a result of an Alpine Fault rupture, can be seen just north of Hari Hari, approaching the Wanganui River crossing (*Chevalier et al., 2009*). The shaded area in Figure 2-9 indicates the area from where the material came down and where it now rests. This is only part of the landslide debris. The arrow indicates where the rest of

Figure 2-9: Historic example of a large rock avalanche landslide, which likely occurred as a result of an Alpine Fault rupture just north Hari Hari, approaching the Wanganui River bridge.

[17] Liquefaction is the process where saturated sandy and silty soils temporally experience a loss of strength during exposure to shaking. Soils behave more like a liquid than a solid, resulting in potential damage to properties and infrastructure.

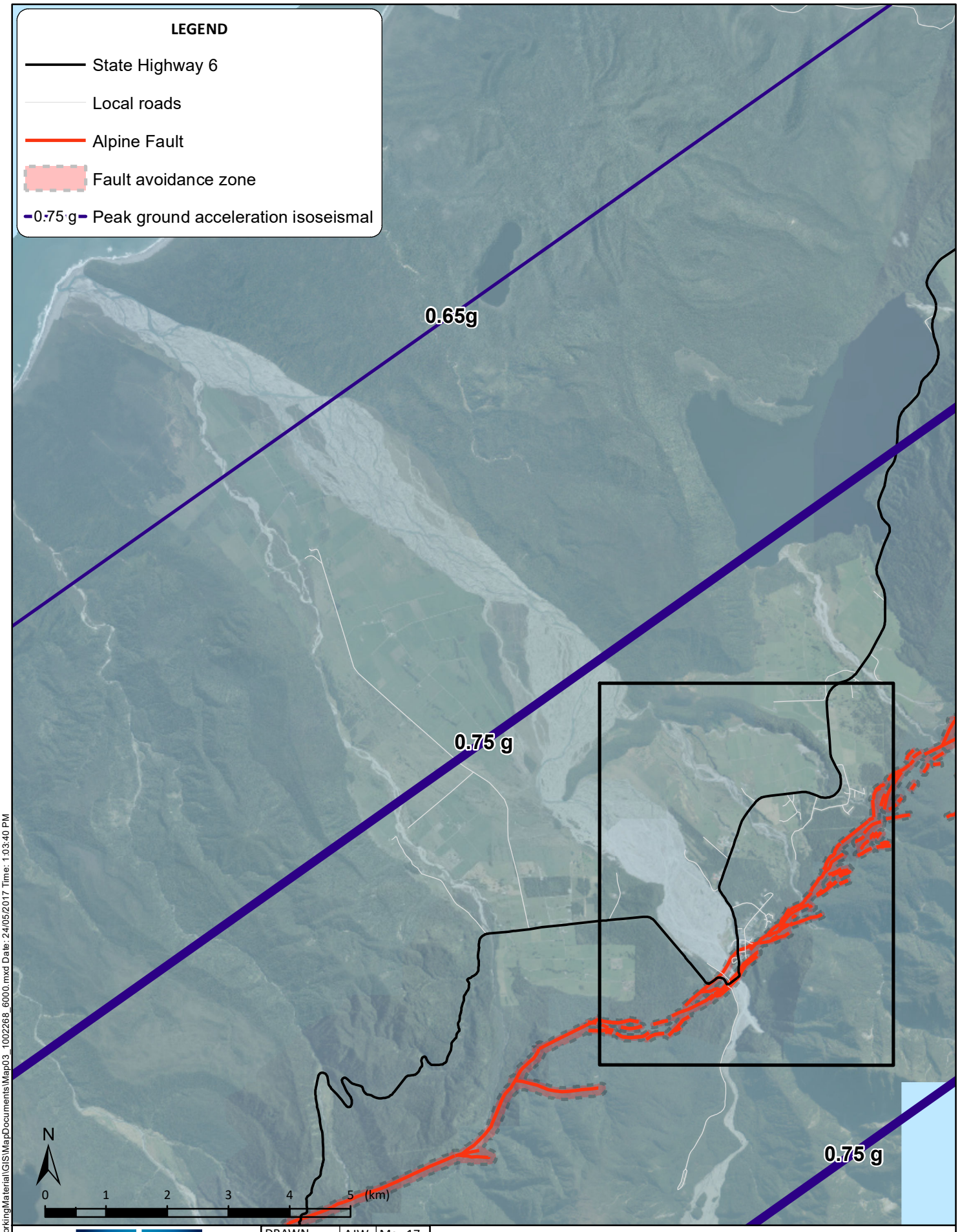
[18] Lateral spreading is horizontal land movement towards a free face such as rivers, streams, channels or dips where the land is not physically constrained. As the soils liquefy under seismic shaking, tension cracks develop as the land moves towards the free face.

the material would have been, however, this has been eroded away by the Wanganui River over time.

The reality is that the likelihood of a large rock landslide occurring in the next Alpine Fault rupture is unknown and uncertain. There is a lower probability of a large rock landslide than an actual rupture of the Alpine Fault itself. However, there is no good evidence to estimate the likelihood of it occurring in the next Alpine Fault rupture. No study has considered the progressive development of failure mechanisms with each Alpine Fault rupture event. Due to the uncertainty of the sequence of events that would lead to a large rock landslide it is unlikely, even impossible, that we can determine a probability of this occurring.

To define the area of impact we have followed the GNS (2016) scenario description; "in the event of catastrophic failure, the potential for long runout and large surficial area of the debris could result in a considerable portion, if not the entire town, being overrun." The area that could be impacted is shown in Figure 2-11 and is based on previous general extents indicated by Davies (2015).

In the event of a large rock landslide, loss of life and loss of capital is likely to be very high and could result in Franz Josef township being abandoned. It would be expected that there would also be significant impacts on regional and national tourist flows.



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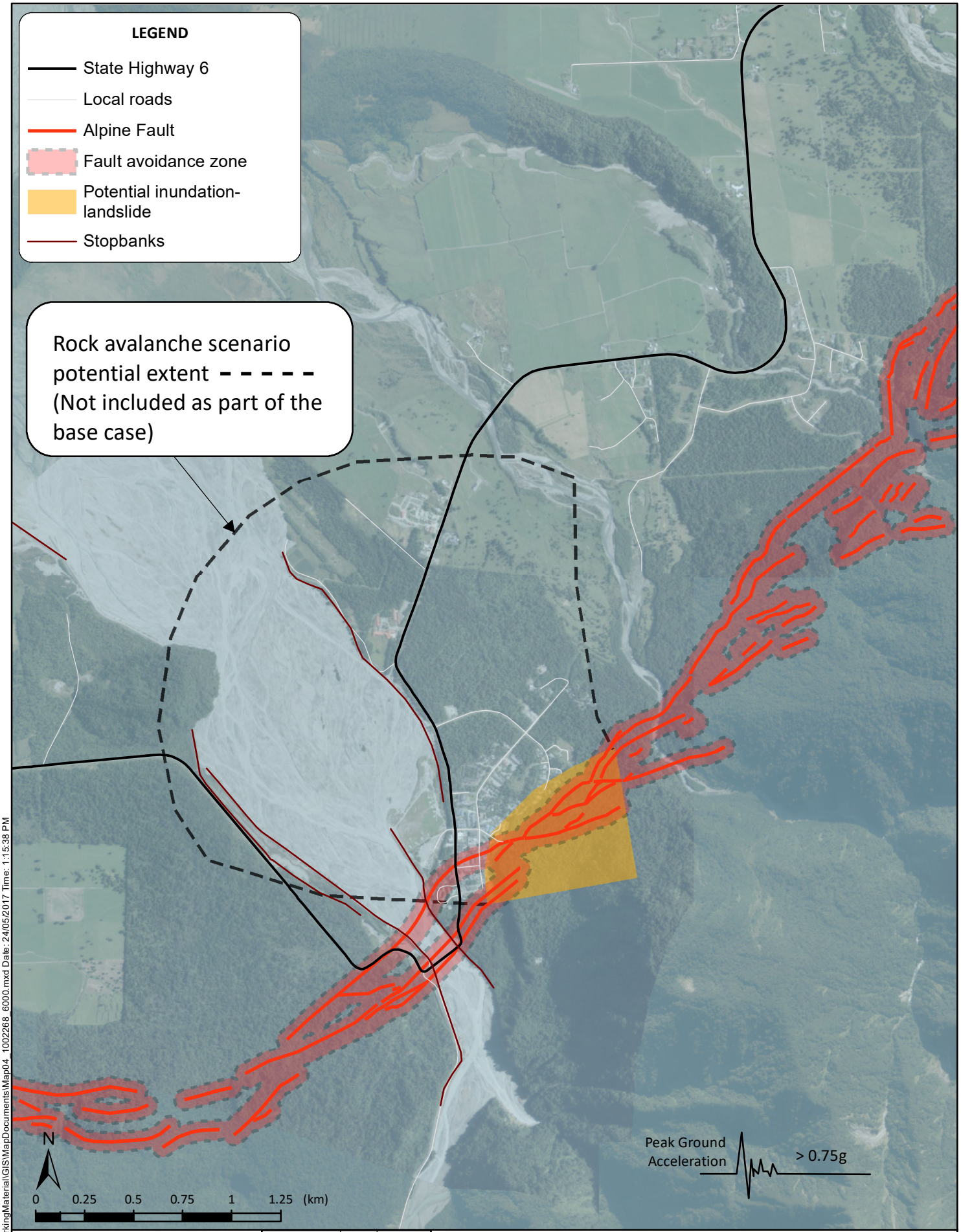
FRANZ JOSEF NATURAL HAZARDS OPTIONS ASSESSMENT

Earthquake Scenario



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FRANZ JOSEF NATURAL HAZARDS OPTIONS ASSESSMENT
Earthquake Scenario

2.3.3 Major flooding event of the Waiho River

The significant flood hazard to the town of Franz Josef from the Waiho River is widely documented and reported (*GNS, 2016; Hall, 2012; Land River Sea, 2014; McSaveney and Davies, 1998*).

A major flood event will test the limits of the stopbank flood protection infrastructure on both sides of the Waiho River (Figure 2-17 and Figure 2-18). Currently, parts of Franz Josef are at similar levels to the river bed and well below the river flood levels. The town is currently protected by its location behind higher riverbanks upstream and the adjacent stopbanks. The stopbanks in the town are designed for a 1-in-100 year level of service, whereas elsewhere stopbanks provide considerably less protection. For all stopbanks, the level of service is continually lessened by aggradation of the river bed. This means the town becomes more vulnerable with bed aggradation.

Figure 2-12: Flood waters in crossing from the Waiho River to the Tatare Stream in the 27-28 December 2010 Weather event

The current flood hazard includes the helicopter operation area and possibly parts of the northern end of the town, which is lower than the current bed level (Figure 2-13). These areas are currently protected by stopbanks from the Waiho Bridge to the end of the helicopter operation area on the true right side. However, there is still residual risk from overtopping or breaches of these stopbanks.

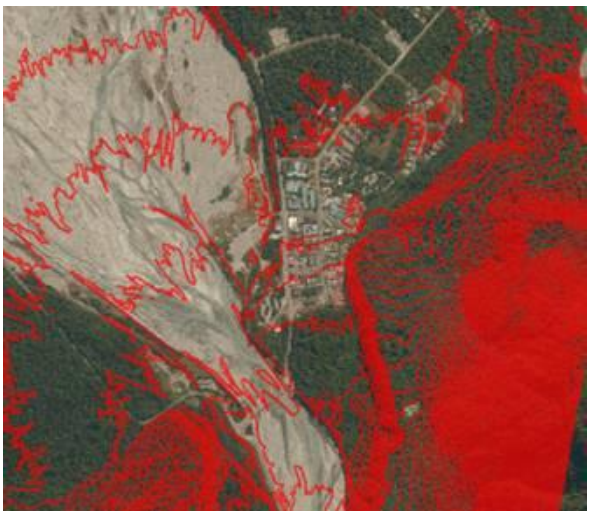


Figure 2-13: 5m contours (red lines) showing the relative level of town to the approximate 2016 river bed (Source: Land River Sea Consulting, 22 July 2016 Waiho River Workshop 2016)

December 2010 and March 2016 storm events evidence the risk posed by flooding (Figure 2-12 and Figure 2-14, respectively). In particular, the March 2016 event severely impacted the Scenic Circle Group complex and town wastewater treatment ponds (to the north of the Franz Josef town centre)[19].

Unmanaged, the flood hazard will increase over time due to river bed aggradation, effectively reducing the capacity of the river channel before causing overtopping of the banks and threatening the Waiho Bridge.

[19] Flooding occurred when an access road embankment to the wastewater treatment pond was breached. Aggradation of the river bed had reduced the protection provided by the access road embankment, which caused it to overtop.

Figure 2-14: Flooding of the Waiho River in March 2016 impacting the wastewater treatment ponds

Long term bed aggradation is reportedly in the order of 0.16m to 0.2m per year at the Waiho Bridge (GNS, 2016 after Optimix, 2002 and Land River Sea, 2014). It is also possible that aggradation may be significantly faster than 0.2m per year during individual flood events (GNS, 2016*).* The high aggradation rates are attributed to the constriction of the Waiho fan by the stopbanks (*Davies et al, 2001, 2003).* Climate change may also exacerbate the flood risk, due to predicted increases in rainfall and changes in sediment supply.

In ~20 years, without mitigation and at average aggradation rates, the bed will have aggraded 4m and the 100-year flood level will be above the river banks upstream of Franz Josef (upstream of the bridge), giving the township a new risk of flooding (GNS, 2016 after Land River Sea, 2014). This is shown in Figure 2-15 and Figure 2-16.

In ~30 years, without mitigation and at average aggradation rates, the bed level will potentially be 6m above its current level and similar to the crest of the town banks/stopbanks. This represents the point at which part of the town effectively becomes part of the river bed. The potential extent of flooding is shown on Figure 2-19 and Figure 2-20. It extends into the town and covers a greater area beyond the true left bank, to the south of the Waiho River. At some point, it will become untenable for residents and businesses in part of the town to remain without intervention.

The impact of increasing flooding over time has a corresponding impact on the amount and severity of damage to property. Loss of life is possible for breaches affecting SH6 and for flooding of dwellings, such as occurred when the Scenic Circle Hotel was flooded. These risks will increase as more of the township becomes susceptible to flooding. This will impact tourism locally, with flow-on effects in the region and nationally.

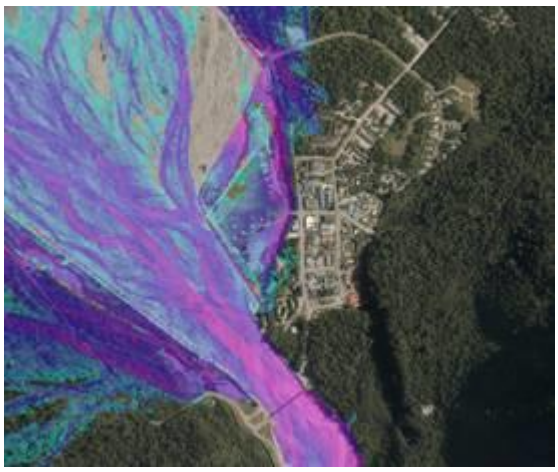


Figure 2-15: Flood model for 4m bed aggradation – 20-year, 1900 cumec flood

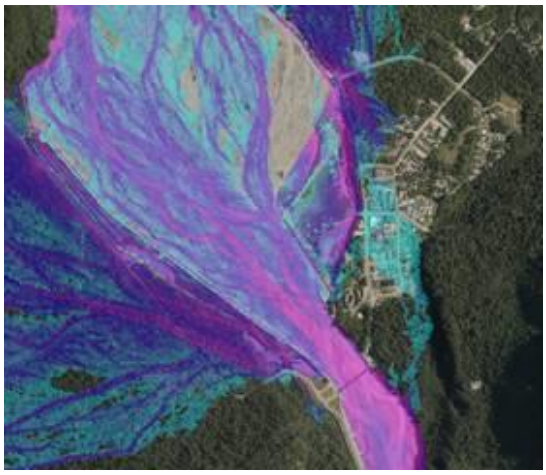
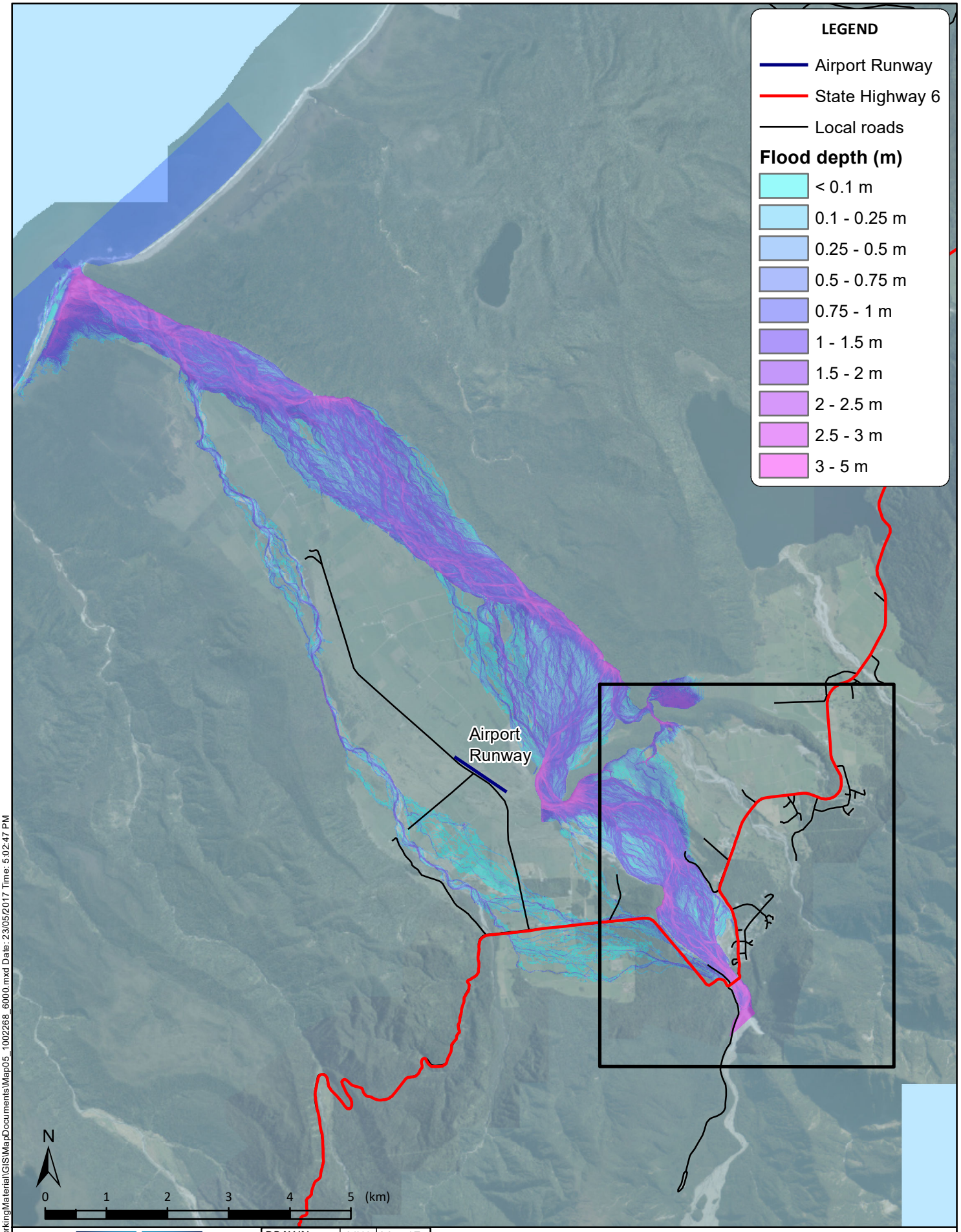


Figure 2-16: Flood model for 4m bed aggradation – 100-year, 2500 cumec flood



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Flood Depths 100 year ARI flood
with 0 m bed aggradation

FIGURE No.: 2.17
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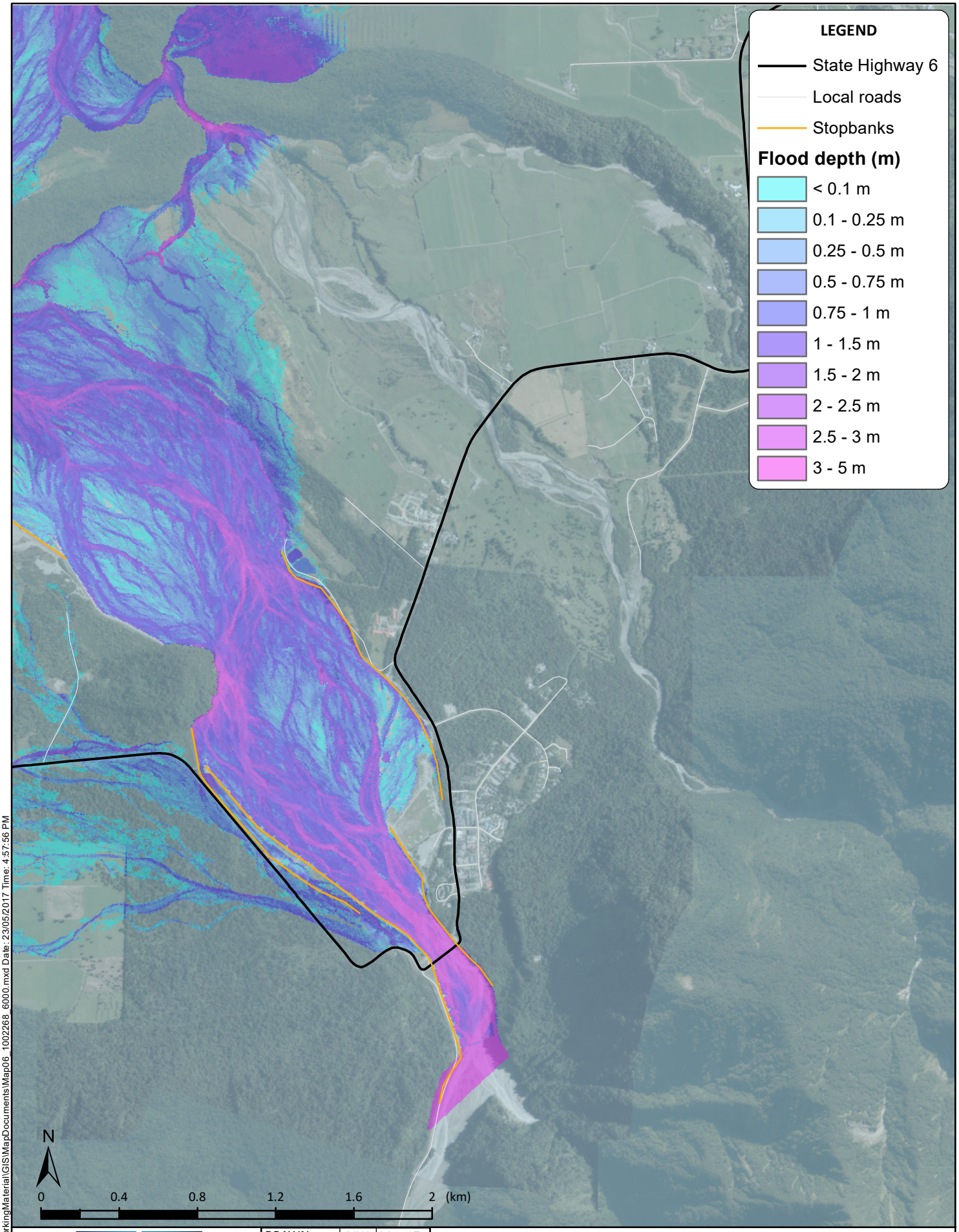

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Flood Depths 100 year ARI flood
with 0 m bed aggradation

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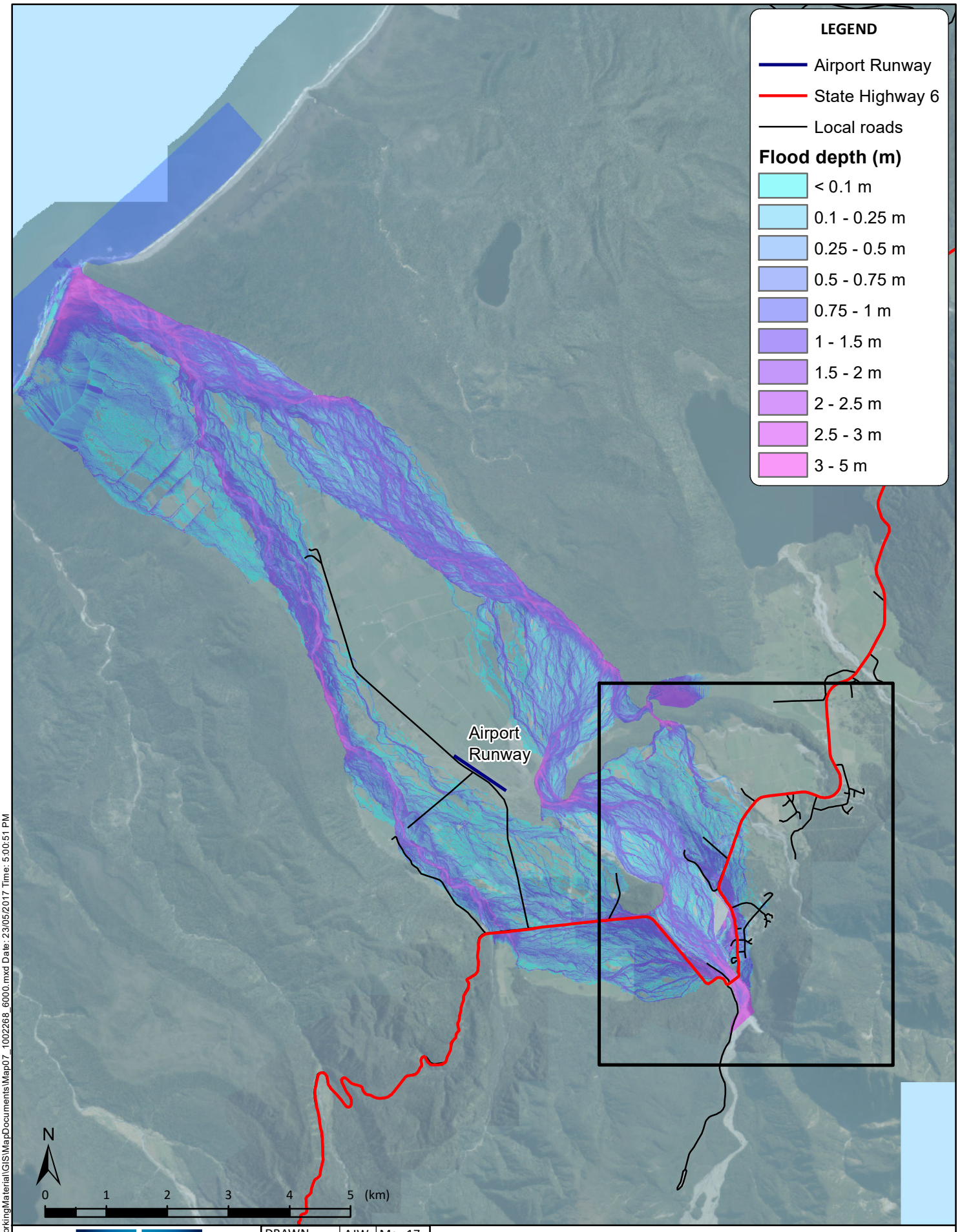

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FRANZ JOSEF NATURAL HAZARDS OPTIONS ASSESSMENT

Flood Depths 100 year ARI flood
with 6 m bed aggradation

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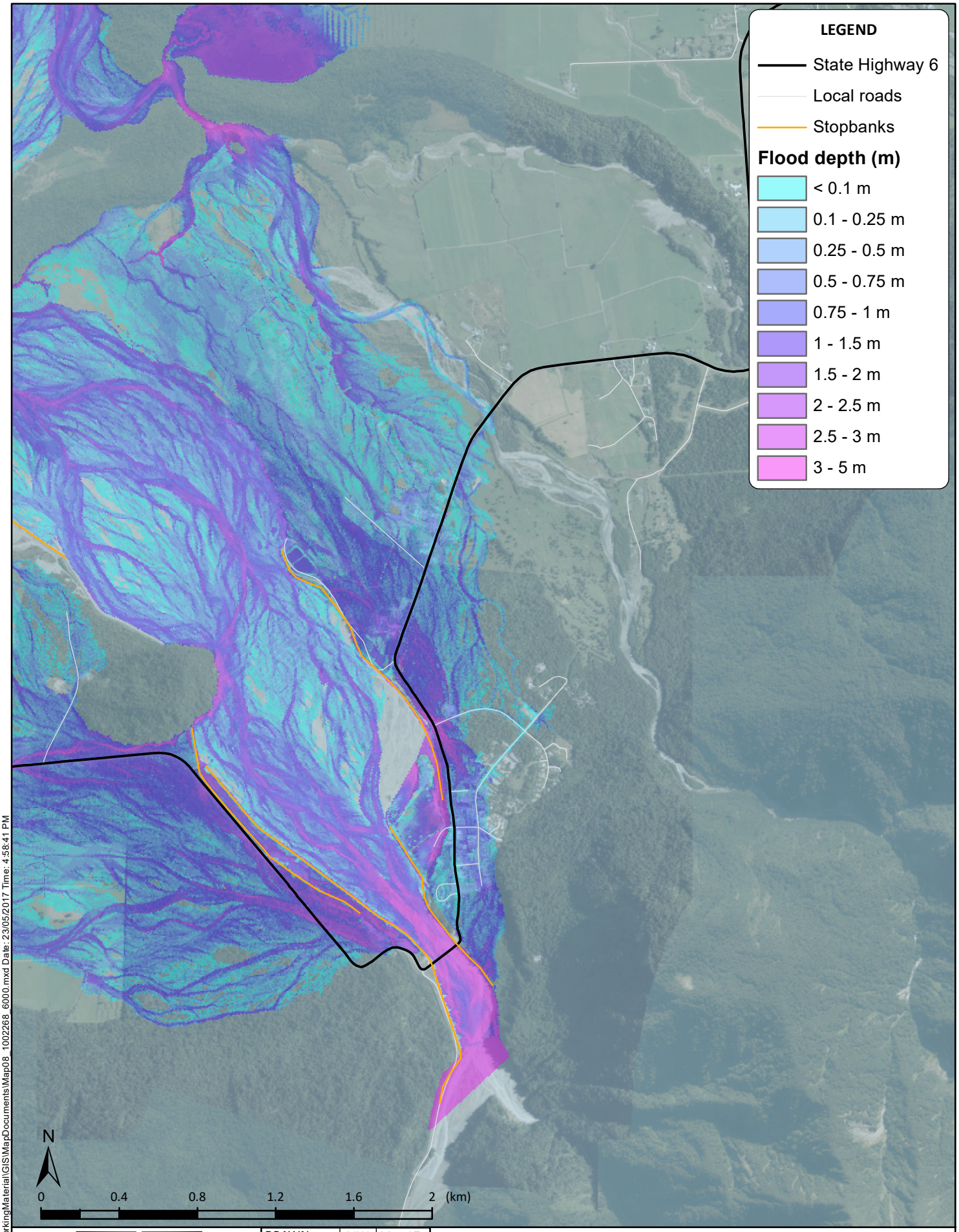

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PROJECT No.: 1002268

WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTIONS ASSESSMENT

Flood Depths 100 year ARI flood
with 6 m bed aggradation

FIGURE No.: 2.20
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2.4 Summary

The case for change outlines the value at stake in Franz Josef, which includes natural, social, and economic stocks and flows. In particular there is significant value generated by tourist expenditure primarily due to the inherent environmental value of the region, including the proximity to Franz Josef Glacier.

This value is at risk from two key natural hazards:

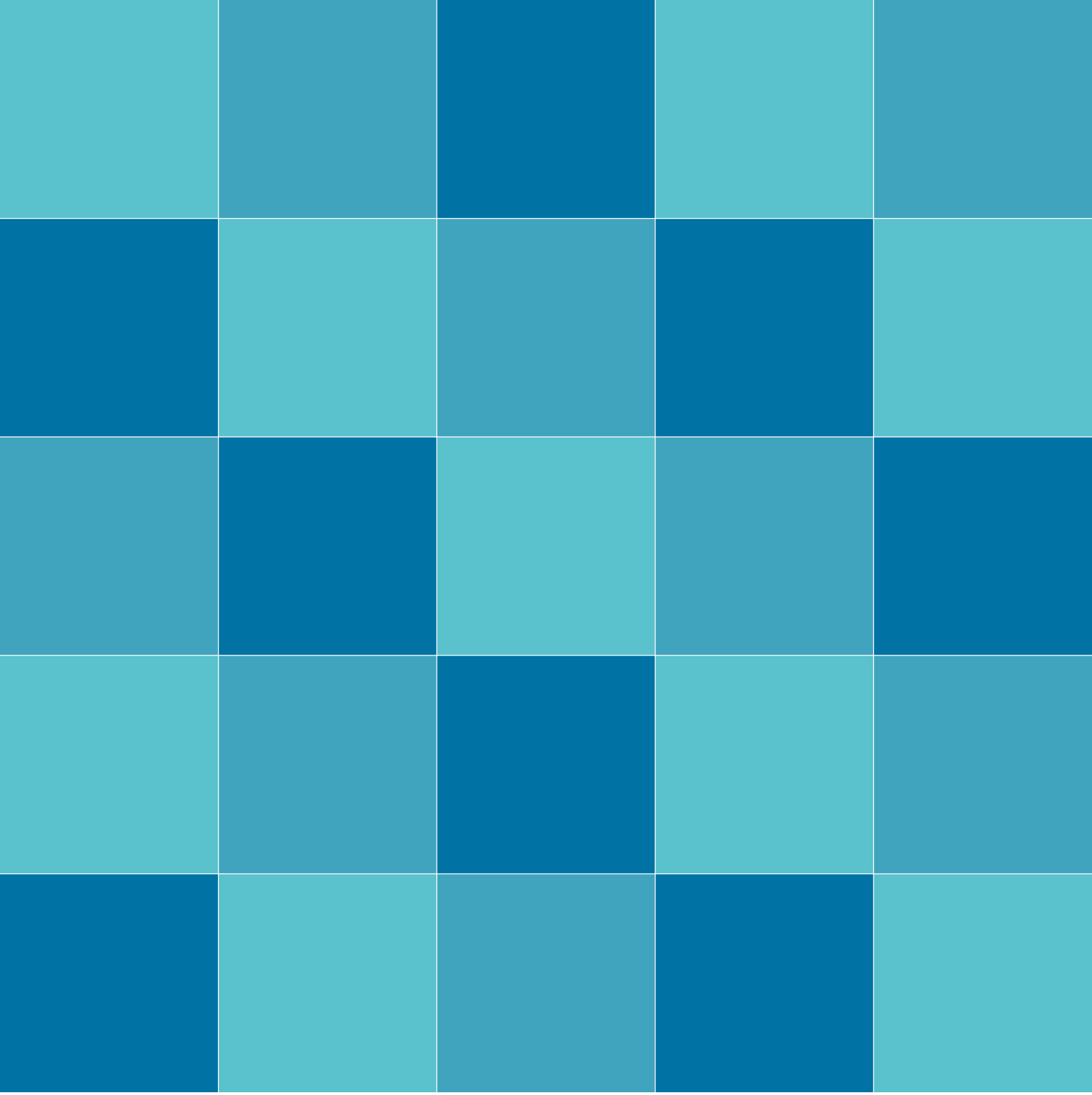
- Alpine Fault rupture
- Waiho River flooding

If left unmanaged, due to bed aggradation, it is likely to be less than 30 years before the Waiho River will result in the majority of the township needing to be relocated. This places a level of urgency on a decision to manage the hazard risk.

An Alpine Fault rupture event would cause significant disruption to the Franz Josef township, including impacts from shaking across the wider Franz Josef area.

It is also possible that the rupture could trigger a large landslide, which could have catastrophic consequences in terms of loss of life, building stock and tourist revenue. Decision-makers should consider this risk when making decisions about the future of the township and the wider Franz Josef area.

The case for change is therefore strong – and the opportunity for the township (and other stakeholders) to collaboratively agree a vision for the future is great. Having greater certainty about the township's future will give people the long-term confidence needed to invest, visit, and live in Franz Josef. It will maximise the town's potential for its residents and New Zealand. The case for change has demonstrated that doing nothing in Franz Josef is not a viable option if the value that is present within the community is to be retained.



Franz Josef Natural Hazards Options Assessment and Cost Benefit Analysis

Economic case

The following sections outline the process that has been employed to determine preferred packages of options that will address the natural hazards challenges and assist decision-making about the future direction for Franz Josef. Specific components of the economic case include:

- Collaboratively developed and agreed investment objectives and critical success factors (Section 3 and 4)
- A long-list of options which have the potential to change the exposure or potential impact of natural hazards (Alpine Fault rupture and Waiho River flooding) in Franz Josef (Section 6)
- Development of a multi-criteria assessment (MCA) framework to evaluate a long-list of options (using investment objectives and critical success factors to underpin this MCA) (Section 5)
- Development of three preferred packages of options based on results of the MCA for detailed evaluation using cost benefit analysis (CBA) (Section 8)
- Characterisation of the base case against which the preferred packages of options would be assessed in the CBA (Section 9.3)
- Development of a CBA model and testing of packages of options to arrive at a preferred path to mitigate natural hazard risk in Franz Josef (Section 9)

3 Investment objectives

On 7 March 2017, a community workshop was held with key stakeholders from the Franz Josef Working Group (FJWG) to gain a better understanding of issues relevant to this assessment. This workshop, and subsequent discussions with affected stakeholders, formed the basis to determine investment objectives which were tested and agreed with FJWG on 29 March, 2017.

Setting good investment objectives is a critical part of any business case as they specify the desired outcomes for a proposed investment and inform the assessment of potential options. Successful investment objectives are SMART (Specific, Measurable, Achievable, Relevant, and Time-bound).

Investment objectives inherently contain considerable context, but have been described at a high level to aid communication and enable comparison between fundamentally distinct options.

For this analysis, two investment objectives have been developed.

3.1 Investment objective one | mitigate natural hazard risk

The potential to minimise the threat or impact of disruption from earthquake and flooding (including life-risk, impacts on the built environment and economic flows) is the primary and stated investment objective for this study. Mitigating natural hazard risk includes:

- ***Temporal aspects***: Will the option remain effective over the timeframe for analysis (the 50-year timeframe for a CBA)? Will it remain effective beyond this timeframe?
- ***Spatial characteristics***: Will the option have the same efficacy across the township and the wider Franz Josef area? Will the option provide resilience to particular areas / assets?
- ***Resilience v recovery***: Does an option provide for effective response in the event of a natural hazard occurrence or does it build resilience *ex ante*?

Reducing the potential threat or impact of disruption due to natural hazard risks in Franz Josef, across the resident population and the considerable tourist population, is the clear focus of this assessment. A summary of this investment objective is provided in Table 3-1.

Table 3-1: Investment objective one (SMART)

Investment Objective One	Mitigate Natural Hazard Risk
S- Specific	The mitigation of natural hazard risk from earthquake and flooding events is a stand-alone concept. While there are degrees to which these risks are present, the nature of these risks is well defined.
M – Measurable	Many aspects of the risk of a natural hazard event can be defined in terms of probability and consequence. Each individual option to mitigate this risk will adjust either the probability of an event occurring, or the consequence of it happening. We have taken different approaches to measuring different aspects of natural hazard effectiveness through this analytical exercise. For example the MCA employs a seven-point scale approach across a number of criteria. In the CBA a greater reliance has been applied on probability and consequence has been applied.
A – Achievable	Published natural hazard assessments have been undertaken for both types of events[20]. These findings have been used as the basis for assessments of probability and consequence of hazard occurrence in the CBA. Options can then be assessed on the same basis, with the delta between the 'risk' under the base case and the 'risk' under the option scenario being the achievable assessment.
R – Realistic	While there is always an element of uncertainty involved in any forecast, the ability to mitigate natural hazard risk through actions that avoid, manage or transfer risk are employed across New Zealand, and indeed the world. Every option that has been carried through to the CBA is considered to be realistic and pragmatic.
T – Time-bound	This study considers the costs and benefits of various interventions to mitigate natural hazard risk over a 50-year time horizon. The reality is that costs and benefits will inevitably be understated because the 'risk' of inaction, or the cost of action, occurs in perpetuity, and some mitigation measures are required in perpetuity.

3.2 Investment objective two | provide investment certainty

If an option performs the primary function of minimising the threat or impact of disruption from natural hazards, then a subsequent investment objective is the promotion of investment certainty. This view was expressed strongly by the FJWG.

A significant constraint facing Franz Josef township, and the West Coast Region more broadly, is a small rating base. This materially affects the ability of the township to pay for any investments that reduce natural hazard risk. It also means that historic investments to manage risk have been limited to incremental, small-scale interventions.

The high tourist-resident ratio exacerbates this problem because it puts greater strain on existing services (i.e. increases the need for current expenditure)[21] as well as increasing the need to invest in hazard-mitigating activities (to protect current and future value at stake).

Enhancing investment certainty for Franz Josef can therefore be considered an important investment objective, as it will directly or indirectly support the conditions needed to make necessary investments in hazard-mitigating activities.

More specifically, any option that achieves the following objectives will contribute to investment certainty[22]:

- Supports the flow of goods, services and people (including the tourists) which may encourage more businesses to locate in Franz Josef
- Provides for an increased resident population to help contribute to the rating base

[20] See GNS (2016). *A Natural Hazard Assessment for the township of Franz Josef, Westland District. Written by Langridge, R. M., Howarth, J. D., Buxton, R., R., & Ries, W. F. GNS Science Consultancy Report 2016/33. 61 p.*

[21] An example of this opportunity cost is the need to upgrade wastewater treatment plant facilities

[22] Both considerations can also be encapsulated through diversification of tourist activities or provision of community facilities.

A summary of this investment objective is provided in Table 3-2.

Table 3-2: Investment objective two (SMART)

Investment Objective Two	Increase Investment Certainty
S- Specific	This objective is focussed on increasing levels of investment into new capital (built and human) in Franz Josef.
M – Measurable	Options that increase investment certainty can be obtained through stakeholder conversations, or inferred through past behaviour and focus on increases to: - The flow of goods, services and people (including tourists). This can be measured in NZ$. - Resident population. This can be measured in people. Over time, officially measuring capital value growth may also assist in this regard as the official 'end point' of investment certainty.
A – Achievable	
R – Realistic	While there is always an element of uncertainty involved in any forecast of investment certainty, assumptions can be tested with relevant stakeholders to assess whether an assessment is realistic.
T – Time-bound	This assessment considers the costs and benefits of various interventions to mitigate natural hazard risk over a 50-year time horizon. The reality is that costs and benefits will therefore be understated because the 'risk' of inaction, or the cost of actions, occurs in perpetuity.

4 Critical success factors

Critical success factors (CSFs) set out the criteria that are essential for the successful delivery of an option (or package of options).They necessarily complement, but are distinct from, the investment objectives set out earlier.

In general terms, investment objectives describe *what* we want to achieve, whereas critical success factors describe *how best* to achieve it. Together, they form the "assessment framework" that all options are initially assessed against. More detail about the assessment process is provided in Section 5.

The development of these critical success factors has been informed by Treasury Better Business Case best practice and work undertaken for the New Zealand Transport Agency (NZTA) looking at the value of resilience[23], along with key contextual information including analysis of information supporting the case for change and through workshops with key stakeholders from the FJWG.

Each critical success factor has been weighted, and agreed upon by the FJWG, to reflect the relative importance of each factor in driving successful delivery of the investment objectives. The identified critical success factors, their rationale and their respective weightings are set out in Table 4-1.

[23] Money, C, R Reinen-Hamill, M Cornish, N Bittle and R Makan (2017) *Establishing the Value of Resilience*. NZ Transport Agency research report 614. 64pp. https://www.nzta.govt.nz/resources/research/reports/614/https://www.nzta.govt.nz/resources/research/reports/614/.

Table 4-1: Critical success factors

Criteria	Description	Weighting
Efficacy to challenge(s)	How effective is an option at reducing or mitigating natural hazard risk(s)? Consideration is also given to whether an option increases exposure to other natural hazard risk(s). Specifically, efficacy is defined as the extent to which an option: - Protects life and reduces chance of injury - Protects built environment capital - Improves community self-sufficiency - Enables effective external rescue/response - Enables the restoration of 'business-as-usual' We have explicitly looked to balance short, medium and longer-term efficacy (in relation to the 50-year CBA timeframe) to challenges through these five aspects, as well as impacts to the different values at stake.	35%
Investment Certainty	How effective is an option in increasing levels of investment certainty? Consideration is also given to whether an option reduces investment certainty. Specifically, investment certainty is defined as whether an option could be considered to reasonably contribute to an increased: - Flow of goods, services and people (including the tourism sector). - Resident population - Capital value uplift	5%
Community Acceptability	How much community support is present? Specifically, this considers the proportion of the community that would be likely to support an option – from none through to wide levels of support.	15%
Ease of implementation	How easy will it be to implement an option? Specifically, ease of implementation is considered across three dimensions: - Legislative/Regulatory: Is an option permissible within current regulatory and legislative frameworks? How much public consultation would be required to change current planning frameworks, for example? - Technical: Is it technically possible to implement an option? Have similar options been implemented elsewhere? - Political: What levels of stated local government and central Government support currently exist, or could be reasonably be expected to exist, for an option?	15%
Value for money	What is the expected value for money assessment for the option, at a high level? Specifically, what is a reasonable estimate for: - Whole-of-life costs over a 50-year period for an option - Economic value protected (or enhanced) – primarily focussing on tourism expenditure, capital values of land and buildings and existing infrastructure. Consideration is also given to whether an option decreases the economic value at stake Viewed together, these aspects represent the beginning of the assessment of the economic costs and benefits of the options (noting that CBA is where a more detailed assessment takes place).	20%
Wider benefits	What are the wider (indirect) costs and benefits of an option? Specifically, what is a reasonable estimate of costs and benefits across the dimensions of: - Environmental: What is the impact on natural capital – including at the current location as well as any new option locations? - Social: What is the potential impact on the ability of the community to maintain social cohesion? - Cultural: What is the impact on cultural assets?	10%
Total		100%

5 Options assessment framework

The purpose of the options assessment framework (MCA) is to support quickly, but robustly, moving from a long-list of potential options to a practical short-list based on the agreed investment objectives and critical success factors. The short-list is then used as the initial basis for developing packages of options for further evaluation in the CBA.

The MCA framework developed for this study is based on the investment objectives and critical success factors developed in conjunction with the FJWG (see Sections 3 and 4), as well as a synthesis of leading-practice approaches to resilience[24] (see Appendix D). A conceptual summary of the MCA framework is provided in Table 5-1.

Table 5-1: Stylised summary of MCA framework

Option	Assessment Criteria						
	Investment Objective		Critical Success Factor				Score
	1	2	1	2	3	4	
A	High	Medium	High	Medium	Low	None	0.60
B	Medium	Medium	Medium	High	Medium	None	0.55
C	Medium	High	Low	Medium	Medium	None	0.53
D	Medium	Low	Low	Medium	Low	Medium	0.48
E	Low	Low	Medium	Medium	None	Low	0.22

The approach to assessing options within the MCA is predicated on:

- ***Understanding the service or function that an option protects***: This means making sure that functions of assets are protected, not just the assets themselves.
- ***Placing communities at the heart of decision-making:*** In the MCA for Franz Josef, this is directly manifest through the relatively high weighting given to community acceptability of each option. However, more broadly, options should be considered in the context of the consequences of a service or function being unavailable, and how the consequences of that unavailability change over time for different communities of interest.
- ***Taking a wide view of challenges:*** it is important to understand the wide spectrum of stresses and shocks to which our communities are vulnerable (which includes systemic or organisational challenges as well as natural hazards risks), and how these may change overtime to help answer the question: *What are we being resilient to?*
- ***Taking a wide view of value:*** Our approach recognises that there are other types of value in addition to traditional economic or financial value. This includes environmental, social and cultural value.
- ***Considering all pathways to resilience:*** Resilience can be achieved thorough a number of pathways, including though increased robustness and redundancy, recovery actions, and governance and leadership initiatives.

5.1 MCA scoring and weighting

The total MCA 'score' for each option is out of 1, based on the performance of each option across the critical success factors (Table 4-1). In general, the higher the MCA score, the more potential an option has to meet the critical success factors, and should therefore be considered as part of a

[24] Money, C, R Reinen-Hamill, M Cornish, N Bittle and R Makan (2017) *Establishing the Value of Resilience.* NZ Transport Agency research report 614. 64pp. https://www.nzta.govt.nz/resources/research/reports/614/.

potential package of options. More detail about the approach to packaging options is provided in Section 6.

There are some cases where a critical success factor is characterised appropriately by one aspect only, as in the case of contribution to investment certainty. There are others where a number of different aspects are used to determine performance, as in the characterisation of efficacy to challenges (these are detailed in Appendix D).

In accordance with standard MCA practice, aspects are generally 'scored' on a seven-point scale as per Table 5-2.

Table 5-2: Standard approach to MCA scoring

3	Significant Positive contribution to critical success factor
2	Moderate Positive contribution to critical success factor
1	Minor Positive contribution to critical success factor
0	Neutral contribution to critical success factor
-1	Minor Negative contribution to critical success factor
-2	Moderate Negative contribution to critical success factor
-3	Significant Negative contribution to critical success factor

There are occasions where only part of this scale is used, most notably when the scale is 'uni-directional' (positively or negatively). Appendix D provides an overview of how the MCA has been used and the application of the scoring framework.

6 Options and packages of options

A long-list of options were developed with stakeholders and assessed using the MCA. The process for identification of the option is outlined in the following section. The long-list of options is provided in Appendix E.

The long-list of options was assessed using the MCA, resulting in a shorter list of higher scoring options. These higher-scoring options were then combined into three logical packages of options for further assessment. The purpose of the packages was to more completely address the investment objectives and critical success factors than would be possible with a single option.

This does not strictly mean that the 'top' options have been selected, but rather that judgement has been exercised in selecting those options which perform comparatively well in the MCA, as well as initiatives required to support a potential package.

6.1 Options identification

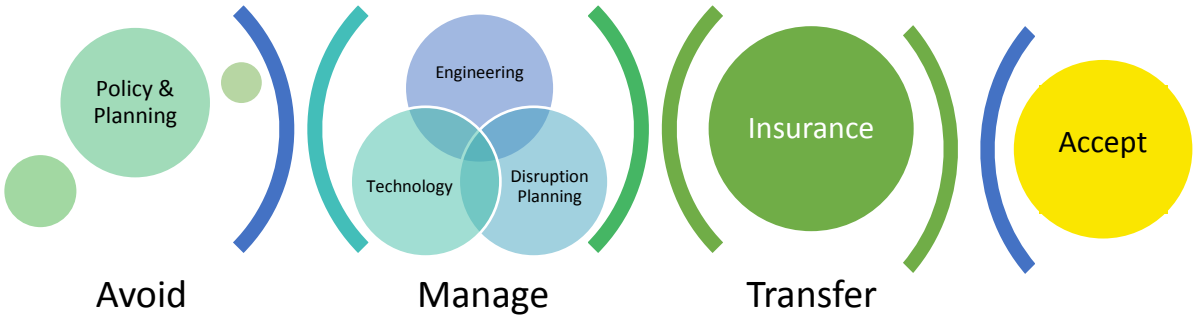
Options were identified across a series of workshops held in March, April and May 2017:

- ***FJWG and Franz Josef community:*** Engagement sessions were held with the FJWG and members of the Franz Josef community 28-29 March, 2017. Options were also discussed with the Franz Josef River Group and a range of individual stakeholders during this period. Additional information was provided by a number of individuals in subsequent weeks, based predominately on the outcomes of previous investigations into particular options.
- ***Subject matter experts:*** T+T and EY subject matter experts identified a range of options based on previous investigations, leading-practice and expert judgement.
- **External stakeholders:** As a result of engaging with stakeholders in central and local government and the private sector, further options connected to their particular subject matter expertise were also identified.

All ideation sessions were guided by the framework in Figure 6-1, which supports creating a common understanding and language around risk, and options to mitigate risk, throughout the study. The framework supports consideration of a diverse range of options to:

- ***Avoid***: Reduce the likelihood of disruption
- ***Manage***: Reduce the consequence of a disruption
- ***Transfer:*** Move the burden of risk
- ***Accept:*** it is not always preferable, necessary, or possible, to remove all risk and that depending on individual and community risk appetite, deciding to live with a degree of risk is an option

Figure 6-1: Framework for option identification



A total of 69 individual options were identified as a result of these sessions (see Appendix E):

- 12 options were based around ***avoiding*** hazards
- 53 options focused on ***managing*** hazards and reducing the consequences of disruption
- 4 options were based on ***transferring*** the burden of risk to third parties though a range of insurance products

Members of the community, FJWG and subject matter experts were encouraged to consider options across the spectrum from low complexity, which are potentially easy to implement in the short-term, through to more complex options, which would have a significant lag time to implementation. A degree of creativity was encouraged through these sessions to ensure that all ideas were captured and explored, even if they were perceived as difficult to implement. The assessment of practicality of implementation was then considered in the MCA process and even more extensively in the CBA process.

Of the 69 options, seven were major options identified which are the beginning of packages of options in their own right and have the potential to significantly alter the risk profile of the township and wider Franz Josef area. These seven options have all been considered through the respective lenses of various engineering specialists within our team:

1. Allow Waiho River to follow natural course to the south below Franz Josef
2. Allow Waiho River to follow natural course to the north below Franz Josef
3. Long-term management programme for engineered stopbanks
4. Move the centre of gravity of the township to the north
5. Relocate to Franz Alpine Resort / Stony Creek
6. Relocate to Lake Mapourika
7. Relocate to Lake Wombat

The initial characterisation of these options is provided in Appendix F. These, and the 62 other lesser options, were evaluated using an MCA framework developed to reflect the agreed investment objectives and critical success factors.

7 Multi-criteria assessment results

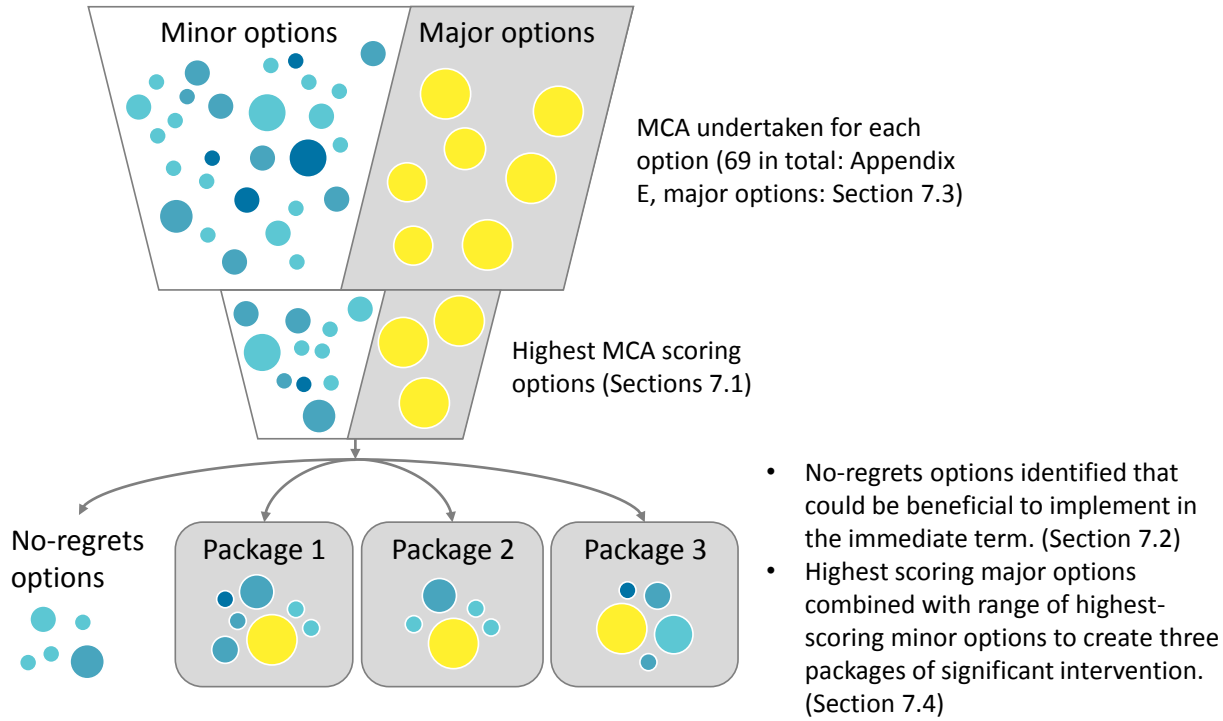
All of the options identified were assessed using the MCA framework.

The MCA results informed the identification and development of the following, which are each further detailed in this section:

- Highest ranked options and associated findings
- No-regrets options, which provide resilience benefits regardless of the final package chosen, and can be implemented in the shorter-term
- Major options and associated findings
- Three preferred packages of options identified and developed from the seven major options

This is shown schematically in Figure 7-1, with guidance on where these components are addressed in the following sections.

Figure 7-1: Schematic of assessment process and development of three potential programmes, and identification of a number of no-regrets options



7.1 Highest-ranked options

Table 7-1 lists the highest-ranked options in the MCA. Options that performed best in the assessment are generally lower cost, create additional benefits and have wide levels of support as well as existing regulatory drivers (Table 7-1). These options also tend to be implementable in the shorter term and many of them focus on improving community self-sufficiency. However, in isolation, these will not substantially protect the value at stake in the township and across the wider Franz Josef area.

The results of these options in the context of agreed investment objectives and critical success factors confirm:

- There is no low-cost, generally acceptable, easy to implement option which significantly alters the risk profile of the township and the wider Franz Josef area
- There is value in some of the lower-cost resilience measures identified
- Current activities including raising the Waiho Bridge and looking to create a more resilient waste water treatment plant have merit, even if they require complementary initiatives to remain effective in the medium- to long-term
- There may be merit in protecting the 55 km corner (even if it is in the short-term) because of the value at stake (including the waste water treatment plant and Scenic Hotel Group assets) in that area
- All packages should consider the resilience of the Aerodrome, as there is particular value at stake / protected by this asset during business-as-usual and in post-event recovery

Table 7-1: Highest ranked options based on multi-criteria assessment

Option	Service / function	Sector	Approach to Risk	Resilience Pathway	Committed or Future Initiative	Total MCA
Community resilience plan	Enables recovery (return to BAU)	Communications	Manage	Governance	Committed	0.60
Education	Enables recovery (return to BAU)	Communications	Accept	Recovery	Future	0.59
Raise Waiho Bridge - long term	Protection of built environment capital	Roads	Manage	Robustness	Future	0.58
Raise Waiho Bridge - short term	Protection of built environment capital	Roads	Manage	Robustness	Committed	0.58
New wastewater treatment plant	Protection of built environment capital	Wastewater	Manage	Robustness	Committed	0.57
Collaboration with NZTA	Protection of built environment capital	Building stock	Manage	Governance	Future	0.57
Waiho River Management Plan	Protection of built environment capital	Building stock	Manage	Governance	Future	0.56
Additional stopbank (55km corner)	Protection of built environment capital	Building stock	Manage	Robustness	Future	0.54
Stores of fuel, food, water & medicine	Enable community sufficiency <7-days	Fuel	Manage	Redundancy	Future	0.54
Aerodrome resilience	Enable effective rescue/response/sustenance	Aerodrome	Manage	Robustness	Future	0.54

7.2 No-regrets options

Based on the ranked MCA scores (Section 7.1) we have identified a number of no-regrets resilience options, which provide resilience benefits regardless of the final package chosen, and can be implemented in the shorter-term. These include:

Community resilience planning: Completion of a community resilience plan (which is currently in progress) to:

- Establish evacuation and recovery strategies, which should include an agreed approach to supporting tourists (and being clear what can be expected in terms of decision-making with respect to evacuation)
- Understand current resources which would assist in the implementation of response and recovery strategies (e.g. fuel, vehicles, machinery, communication)
- Identify gaps in resources to support response and recovery
- Lay the foundations for additional initiatives and to support response and recovery. Some of these are included in the assessment, such as the development of community resilience hubs, public chemical or composting toilets and provision of satellite phones for emergency communication

Education on resilience and emergency response: This idea was explored at the town hall meeting and would support a shared understanding of the risks across the community, while allowing the community to co-develop and implement resilience strategies (as identified in the resilience plan).

Establishment of community resilience hubs: The development of (nominally three) community resilience hubs to house stores of food, potable water, fuel and medicine, support community self-sufficiency would come at low cost, with the potential to reduce life risk. The hubs would ideally be developed and implemented as part of the Community Resilience Plan.

Collaboration with NZTA and an integrated Waiho River management plan: Similar to resilience planning and education initiatives, these actions to support an integrated approach to management of the Waiho River score well because they endure over time, have wide levels of support and come at low cost. As an integrated approach to Waiho River management would involve a range of community, government and business stakeholders (including Ngai Tahu Holdings and Scenic Hotel Group), there is the potential for additional benefits including increased social cohesion, cultural understanding and business opportunities.

Further no-regrets options include:

- Additional community resilience measures to support self-sufficiency
- Resilience as part of asset management business-as-usual
- Increased business continuity cover to support return to business-as-usual

These are provided for reference in Appendix G.

7.3 Major options

The following sections detail the major options and three preferred packages built around key elements of the major options.

Major options included in the long-list represent significant interventions and seek to respond to the risks faced. The major options identified for Franz Josef are ranked in the lowest third of the MCA, with values lower than 0.5 (Table 7-2). This is primarily driven by potentially high implementation costs and barriers, as well as current levels of community acceptance.

The findings from the MCA results for these major options conclude that:

- ***Moving key assets out of the active known fault zone*** has the potential to reduce injury- and life-risk, and would support post-event recovery. This option would need to be packaged with others in order to provide a long-term, effective solution for the township.
- Seeking to protect the current value in the town though ***a stopbank and gravel extraction programme*** is a potentially feasible option for the 50-year period considered by this study. The costs of gravel extraction will be incurred in perpetuity in order for this option to be effective beyond the CBA 50-year timeframe.
- ***Moving the centre of gravity of the town north*** (north-east of the current health centre) does not alter Franz Josef's exposure to the risk of an earthquake-triggered large landslide, but would allow the town to grow essentially in its current location, largely removed from flooding and direct Alpine Fault rupture risks. This option would need to be packaged with other options in order to provide an effective long-term solution for the township.
- ***Allowing the river to flow to the south*** provides greater capacity to manage the river and sediment across the natural fan of the river bed, noting that initially releasing to the north may be also required in order to create time for the appropriate transition for Southside residents and businesses. This option may also require ongoing gravel extraction in the medium- to long-term in order to continue to be effective.
- ***Moving to Lake Mapourika*** is the most preferable of the "avoid" options. The "avoid" options are the only options that completely alter the risk profile of the township in the long term, particularly with regards to significant flooding and a large landslide.

Table 7-2: Possible major options

Option Name	Function / Service	Sector	Approach to Risk	Resilience Measure	Total MCA
Long term management programme for engineered stopbanks with a gravel management programme	Protection of built environment capital	Building stock	Manage	Robustness	**0.38**
Move centre of gravity of township to the north	Protection of built environment capital	Building stock	Manage	Robustness	**0.37**
Allow Waiho River to follow natural course to the south below Franz Josef	Protection of built environment capital	Building stock	Manage	Robustness	**0.35**
Relocate to Lake Mapourika	Reduction of Life/injury risk	Building stock	Avoid	Governance	**0.33**
Relocate to Lake Wombat	Reduction of Life/injury risk	Building stock	Avoid	Governance	**0.28**
Relocate to Franz Alpine Resort / Stony Creek	Reduction of Life/injury risk	Building stock	Avoid	Governance	**0.24**
Allow Waiho River to follow natural course to the north below Franz Josef	Protection of built environment capital	Building stock	Manage	Robustness	**0.22**

7.4 Packages

As the MCA shows that no single option addresses the natural hazard risks on its own and a package of options is required. In addition, at least one significant intervention is required to more fully protect the value at stake.

From the major options, we developed three packages of options, which each comprise a major option, supported by a range of other options that together seek to respond to the investment objectives and critical success factors.

The three packages were developed through a process of:

- Further developing the major options, this included combining some components of several of the major options. For example the option 'relocate from the fault zone', which refers to moving key assets such as the Police, fire, and petrol stations, has been included in all major options except those where the township is relocated elsewhere (as this is already captured in those major options).
- Considering the best performing major options available across different 'types' of response to the risks (e.g. avoiding or managing the risks). These were then used as the basis for the package.
- Identifying supporting (minor) options that contribute to the major option and seek to address the risks, infrastructure, and stakeholders that aren't protected by the major option alone.

Based on the MCA results and further option development, three packages of options were selected to explore through CBA:

- ***Avoid nature's most significant challenges***: This package seeks to physically avoid the natural hazard challenges in Franz Josef by moving the township to Lake Mapourika, out of the area subject to flooding from the Waiho River and away from the Alpine Fault and the range-front landslide risk. This package may create new investment opportunities, in addition to protecting the tourism value currently generated by the township.
- ***Live with nature's challenges***: This package involves generally decreasing stopbank management and allowing the river to fan out in its natural pattern, which will reduce flooding risk and flood management costs. This package also allows for relocating township assets off the active known fault line in the short- to medium-term. However, over time the value of the land to the south of the Waiho River will be eroded due to included flooding risk.
- ***Defend against nature's challenges***: This package involves continuing to build stopbanks and implementing a gravel extraction programme to allow the township, and the businesses and residents in the wider Franz Josef area to remain in their current location with lower flooding risk. It also allows for relocating township assets off the active known fault line in the short- to medium-term to reduce earthquake-related risk. The costs of gravel management will occur in perpetuity and the town will remain exposed to residual flooding risk from stopbank failure or overtopping.

These packages are detailed in Section 8, and tested using cost benefit analysis in Section 9.

8 Packages | protecting the value at stake

8.1 Avoid nature's most significant challenges

***Snapshot*: this package seeks to physically avoid the natural hazard challenges in Franz Josef by moving the township to Lake Mapourika, out of the area subject to flooding from the Waiho River and away from the Alpine Fault and range-front.**

Figure 8-1 and Figure 8-2 summarise the options included within this package, and provide an indication of the timeframe for each option within the package to be implemented.

Moving the town to Lake Mapourika avoids risk of an earthquake-induced large landslide and the risks from flooding of the Waiho River. It also relocates assets off the fault rupture zone of Alpine Fault where there is the highest risk of earthquake damage. If this transition is managed appropriately, it will provide strong investment certainty for the future.

New buildings and infrastructure would be required for the new town, which would come at a high cost. As Franz Josef would be relocated away from the fault rupture zone and the risk of a large landslide, there would be the opportunity for the new assets (buildings and infrastructure) to provide enhanced resilience in the event of an earthquake by including additional robustness in design. There is also the opportunity for the township to capitalise on developments in sustainable building to reduce environmental impact, provide enhanced social spaces and a positive tourist experience.

The package would cause disruption as assets, businesses, and residents are relocated, which would require careful coordination. A transition mechanism would need to be developed and agreed, which would enable the township to successfully relocate. This mechanism would likely be linked to the approach to developing the new town, which could include elements of public and private capital investment.

Many of the existing flood protection assets around the Waiho River would not be maintained and, ultimately, State Highway 6 would likely need to be eventually realigned to respond to increasing flooding events (noting that NZTA may still include elements of flood protection for its assets in their future alignment). This means that, in the medium-term, land owners on the south side of the Waiho River are likely to experience increasing flooding events if the NZTA stopbanks are not maintained or raised. Costs for loss of utility/value of the land to the south have been assumed in the CBA modelling. The loss of utility is uncertain, as the path of the river and flooding area could vary with time.

It is assumed that the Aerodrome will need to be relocated from the south when the NZTA stopbanks on the south side are removed. Stakeholder consultation suggests that is likely that the current commercial operation could be moved to the Lake Mapourika area, but this would not allow instrumented craft (including NZDF Hercules aircraft) to land. This would limit future commercial activities, as well as the ability of NZDF aircraft to land in a recovery capacity. The Civil Aviation Authority (supported by initial findings from *Project AF8,* June 2017) has suggested that an area south of Whataroa be explored for the development of an Aerodrome capable of fulfilling these future requirements.

There would be environmental impacts from construction of the new town, which would likely be on land currently privately held and used for farming. There are no identified heritage, historic, archaeological, or taonga sites in the proposed area. The town's churches may be able to be transported to the new town location; however, this would be a balance of cost and benefit. The current town would be decommissioned and areas that are not incorporated into the Waiho River over time could be returned to parkland, rural use or conservation estate.

The specific initiatives within this package include:

Short to medium term:

- Progression of short term waste water treatment plant option for the existing township until move to Lake Mapourika
- Maintenance of the existing stopbanks to protect the north and south side of the Waiho River until the move to Lake Mapourika is complete
- Purchase of land at Lake Mapourika
- Masterplanning of the new township and associated District Plan changes
- Construction of power, water and roading infrastructure at new town location
- Construction of community buildings at new town location
- Construction of residential and commercial buildings at new town location
- A new heliport at the new town location
- Relocation of the Aerodrome (nominally to a location south of Whataroa)
- Realignment of State Highway 6 (north and south of the Waiho Bridge)
- Compensation for loss of utility of land to south of the Waiho River
- Transition of existing township area to parkland, rural use or conservation estate

Long-term:

- Continued raising of the State Highway 6 Waiho Bridge across the Waiho River and potential realignment up the Waiho River

Potential stakeholder impacts of this package are outlined in Table 8-1 (Note: This is indicative and not exhaustive).

Table 8-1: Potential stakeholder impacts of *Avoid nature's most significant challenges* package

Stakeholder group	Potential impacts and obligations
Township residents (north of the Waiho River)	- Impacts of flooding and earthquake minimised - Significant disruption expected through transition period - Potential for inequity (perceived or actual) depending on transfer approach
Residents south of the Waiho River	- Significantly increased risk of flooding in the medium-term - Eventual loss of utility of land - Potential recipients of package to recognise the value eroded
Tourists	- Uncertainty of life-risk significantly reduced - Disruption during relocation
Local government	- Significant planning process - New roading and utilities infrastructure - Co-management of transition approach (for both North and South of Waiho River)
Central government	- Co-management of transition approach - Impacts on existing investments (NZTA) - Potential benefits for NZ tourism

Limitations:

- While we expect that the general location of the proposed new township at Lake Mapourika will have a lower risk from natural disasters, a specific assessment of the natural hazards and vulnerabilities for the new location would be required. This should be sufficient to fulfil the requirements of a masterplanning process.
- Commercial feasibility of development has not been assessed.

- No obligation for funding and financing of costs should be assumed.
- Further consultation on the location of the Aerodrome will need to be undertaken with the CAA, commercial operators and local stakeholders.
- We have based this assessment on the entire town moving i.e., residents being unable to stay in the current township and with no provision of compensation for residents and business owners to move out of the area.

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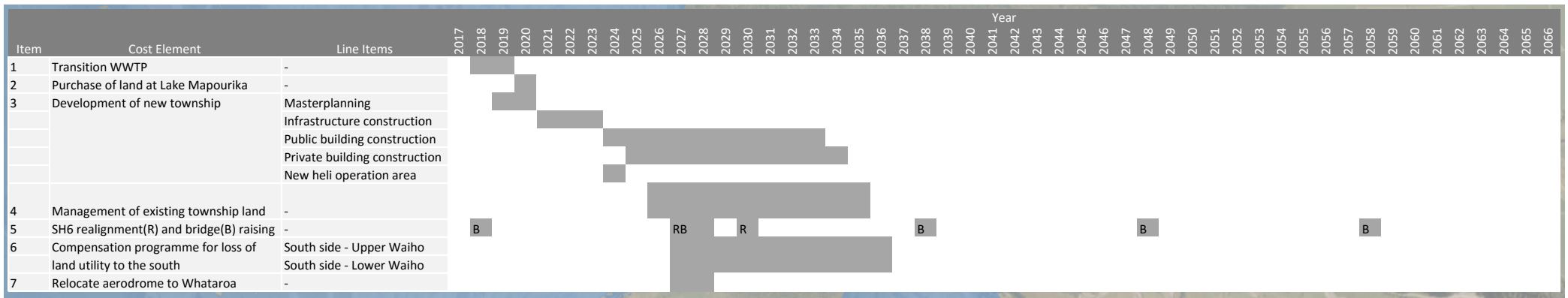
Item	Cost Element	Line Items
1	Transition WWTP	-
2	Purchase of land at Lake Mapourika	-
3	Development of new township	Masterplanning
		Infrastructure construction
		Public building construction
		Private building construction
		New heli operation area
4	Management of existing township land	-
5	SH6 realignment(R) and bridge(B) raising	-
6	Compensation programme for loss of land utility to the south	South side - Upper Waiho
		South side - Lower Waiho
7	Relocate aerodrome to Whataroa	-



7. Relocate aerodrome

Relocate aerodrome to Whataroa when NZTA stopbanks - south side are removed.

Lower Waiho Stopbanks

Current lower Waiho River stopbanks are assumed to provide negligible protection with time, after release of the NZTA stopbanks - south side. New stopbanks could be built by property owners.

1 Transition WWTP

Build temporary WWTP away from Waiho River flooding to provide service until Township is relocated.

5. Realign State Highway 6 - North side

Realign SH6 to the east, along base of slope, on approach to Waiho River Bridge.

6. Compensation programme for loss of land utility to the south

Assistance for commercial and residential properties as flooding erodes value of land.

4. Management of existing township land

Demolish buildings and infrastructure and remove to landfill.

Hold existing stopbank position

Maintain existing stopbanks until town moves to Lake Mapourika.

5. Waiho River Bridge Realignment

The Waiho River Bridge may need to be aligned in the future to most effectively cross the river.

5. Realign State Highway 6 - South side

Realign SH6 south away from the Waiho River along the base of hills.

LEGEND

- DOC
- NZTA
- Removed
- Realigned State Highway 6
- Existing State Highway 6
- Waiho River flood extent for option
- Fault avoidance zone

Notes: See figure list for source credits

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WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTION ASSESSMENT

Avoid nature's most significant challenges
Waiho River Area

FIGURE No. 8.1

Rev. 0

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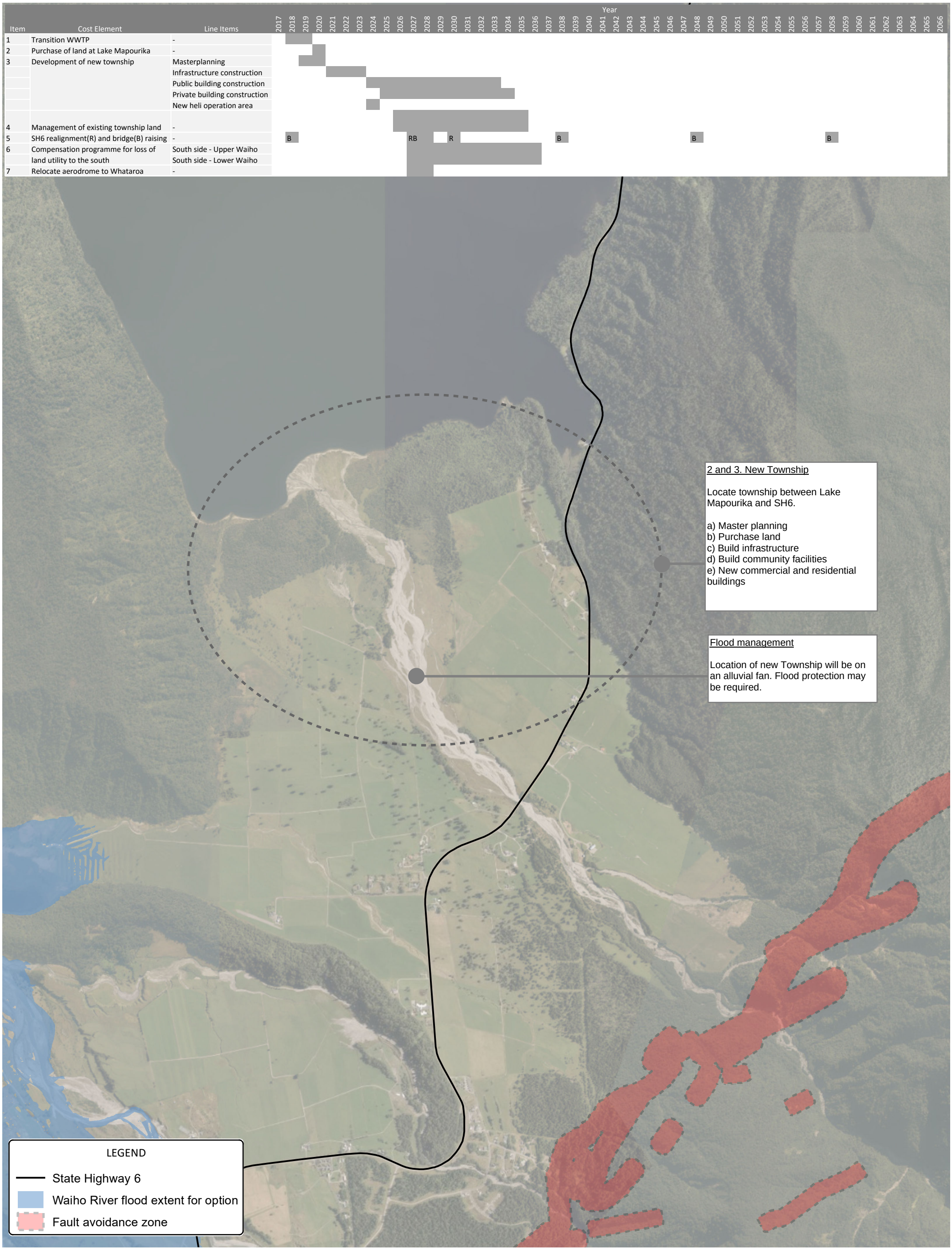
Item	Cost Element	Line Items
1	Transition WWTP	-
2	Purchase of land at Lake Mapourika	-
3	Development of new township	Masterplanning
		Infrastructure construction
		Public building construction
		Private building construction
		New heli operation area
4	Management of existing township land	-
5	SH6 realignment(R) and bridge(B) raising	-
6	Compensation programme for loss of land utility to the south	South side - Upper Waiho
		South side - Lower Waiho
7	Relocate aerodrome to Whataroa	-



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WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTION ASSESSMENT

Avoid nature's most significant challenges
Lake Mapourika Area

FIGURE No. 8.2

Rev. 0

8.2 Live with nature's challenges

***Snapshot*: this package involves generally decreasing stopbank management and allowing the river to fan out in its natural pattern, which will reduce flooding risk and flood management in the long-term, but require some relocation of assets in the short- to medium-term.**

Figure 8-4 to Figure 8-6 summarise the options included within this package, and provide an indication of the timeframe for each option within the package to be implemented.

Living with nature's challenges requires acceptance of the residual risk of an earthquake-induced large landslide and some residual risk from reliance on stopbanks (which may be overtopped in storm events larger that the protection provided for by the level of design service and/or could be breached for lesser events). It seeks to manage flood risk by allowing the Waiho River to open up to a more natural course by removing stopbanks to the north and south. Key assets are moved off of what will become the new flood plain and the active known fault zone. This should help provide investment certainty around the management of the river, but also leaves the uncertainty of the risk from an earthquake-triggered large landslide and, potentially, the cost of ongoing gravel management in the long-term.

A staged approach to stopbank removal has been allowed for, holding the position of the existing stopbanks initially, while relocation takes place. Ultimately, the waste water treatment plant access road, the town and heliport stopbank and the NZTA north and south stopbanks would be removed. A town-side stopbank would be constructed along the natural river bank. All assets currently protected by these stopbanks, including the waste water treatment plant, school and kindergarten, substation, heliport and Aerodrome, would need to be relocated. Commercial and residential property in these areas may need to be relocated or the owners compensated for loss of utility.

The *Living with nature's challenges* package removes controls on the river and allows the river to flow over a wider area of its natural fan. Studies[25,26] of the Waiho have shown that the high current rates of aggradation are caused by the narrowing of the river and that lower aggradation rates will occur if the river was less restricted. There is also potential for the river to downcut adjacent to the township as river flows and sediment is allowed back into former river channels. There is uncertainty as to the effectiveness and the period of reduced aggradation. Future studies should evaluate these physical processes to reduce the uncertainty. If bed aggradation returns or continues, a gravel management programme would be required to maintain the bed at a manageable level. This would require gravel extraction. Opening up the river will lower the height of the floodwaters overall.

The package also includes encouraging the centre of gravity of the township to move to the north end of the current township (around the existing health centre) to avoid flood and Alpine Fault rupture hazards. This would also allow for existing assets to be moved away from the active known fault line to help reduce life and injury risk, as well as improving community response and recovery post-event (Figure 8-3). They include the:

- Petrol station
- Fire station
- DoC workshop and fire depot
- Police station
- Community hall

[25] Davies TR., McSaveney MJ. and Clarkson PJ. (2003) *Anthropic aggradation of the Waiho River, Westland, New Zealand: Microscale modelling. Earth Surface Processes and Landforms 28(2): 209-218*.

[26] Davies TR. and McSaveney MJ. (2001) *Anthropic aggradation of the Waiho River, Westland, New Zealand*. In Mosley, M.P. (ed), Gravel Bed Rivers V, New Zealand Hydrological Society, Wellington.

- Our Lady of the Alps Church
- St James Church

Figure 8-3: Main community and utility buildings (labelled) that could be moved to the north of end of town to avoid the Alpine Fault rupture.

The specific initiatives within this package include:

Short-term – Remove waste water treatment plant and access embankment (see Figure 8-4**)**

- Hold existing stopbank positions via maintenance and minor raising
- Relocate the waste water treatment plant away from Waiho River
- Relocate the kindergarten and school to north end of town
- Relocate the electrical substation to north end of town
- Compensation for loss of utility of land to the north
- Remove the waste water treatment plant access road
- Relocate key community buildings off the Alpine Fault
- Relocate private buildings off the Alpine Fault

Short-term – Return heliport to river (see Figure 8-5)

- Relocate the helicopter operation area and associated utilities
- Build a new town-side stopbank along edge of natural town-side bank
- Realign State Highway 6 north of the township to the east
- Remove the NZTA 55km stopbank
- Remove the existing town and heliport stopbanks

Short to medium-term – Open up river to the south (see Figure 8-5**)**

- Realign State Highway 6 south of the Waiho Bridge along the base of the range-front
- Implement a compensation programme for loss of land utility to the south
- Remove the NZTA stopbanks south of the Waiho Bridge
- Relocate the Aerodrome (for the purposes of CBA modelling, to a location South of Whataroa)

Long term: 20+ years (see Figure 8-6)

- Raise stopbanks to maximum possible height (depending on bed aggradation levels over time)
- A gravel management programme (depending on bed aggradation levels over time), noting that this could then be required in perpetuity to maintain the level of the river bed

There are variations to the short-term options that would allow more of the north-side of town to be protected. These should be further investigated and may result in less disruption and better benefit cost ratios.

An additional option is to add a town (upstream) stopbank (1-2m). This would serve to reduce overall risk, and extend the timing of Phases 1 and 2. This option could also be added in response to gradual or sudden bed aggradation over time. It is also dependent on raising the new town-side stopbank and the residual risks associated with this would need to be managed.

Potential stakeholder impacts of this package are outlined in Table 8-2 (note this is indicative and not exhaustive).

Table 8-2: Potential stakeholder impact for *Live with nature's challenges* package

Stakeholder group	Potential impacts and obligations
Township residents	- Risk of flooding reduced - Impact from Alpine Fault surface ground rupture minimised
Residents south of the Waiho River	- Significantly increased risk of flooding in the medium-term - Eventual loss of utility of land - Potential for ongoing gravel extraction costs (in the long term) - Potential recipients of package to recognise the value eroded
Tourists	- Marginal change to life risk - Marginal impact on visitor experience
Local government	- District Plan amendments - Support for transition management approach - Potential for ongoing gravel extraction costs (in the long term)
Central government	- Management of transition approach - Impacts on existing investments (NZTA) - Potential for ongoing gravel extraction costs (in the long term) (NZTA)

Limitations:

- Additional research on the process of the Waiho River to confirm this package will likely achieve the objectives. This could include detailed flood and sediment transport modelling (computational and physical models).
- Timing of gravel extraction is important to this package and is dependent on additional research. No obligation for funding or financing of costs should be assumed.
- Any gravel management required will likely be in perpetuity.
- Further consultation on the location of the Aerodrome will need to be undertaken with the CAA, commercial operators and local stakeholders.

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Phase 1a Figure

Item	Cost Element	Line Items
	Phase 1: Open up river to north	
1	Hold existing stopbank position (excluding WDC access embankment)	-
2	Relocate WWTP	-
3	Relocate key assets	-
4	Compensation programme for loss of land utility to the north	-
5	Remove WWTP access road embankment releasing river north	-
6	Relocate key community buildings off Alpine Fault	Relocate Petrol station
		Relocate Fire station
		Relocate DoC workshop and fire depot
		Relocate Police station
		Relocate Community hall
		Relocate Churches
7	Programme for relocation of private building from Alpine Fault	CV of land and buildings
8	Relocate helicopter operation area and utilities	Cost for new helipad
		Power and telecommunication relocation
9	Build new Town-side stopbank	-
10	Realign State Highway 6 - North side	-
11	Remove NZTA 55km stopbank	-
12	Remove the Franz Josef and Heli stopbanks further releasing north	-
	Phase 2: Open up river to south	
13	Realign State Highway 6 - South side	-
14	Compensation programme for loss of land utility to the south	South side - Upper Waiho
		South side - Lower Waiho
15	Remove the NZTA stopbanks - south side	CAPEX
16	Relocate aerodrome	Aerodrome
	Long-term: 20+ years - Manage return to bed aggradation	
17	Raise stopbanks in the future	-
18	Gravel management programme	Land purchase for fill area
		Haul road
		Gravel extraction

Year: 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066

3. Relocate key assets

Kindergarten, School, Electrical substation to the growth area at north end of township.

2. Relocate WWTP

Build new WWTP away from Waiho River flood-ing.

4. Compensation programme for loss of land utility to the north

Assistance for commercial and residential properties as flooding erodes value of land.

5. Remove WWTP ac-cess road embankment

Allow river to go north by removing the access road embankment.

3, 6 and 7. Relocation area

Relocation to growth area at north end of township.

1. Hold existing stopbanks

Maintain existing Franz Josef and Heli stopbanks with minor raising.

6. Relocate key build-ings on Alpine Fault

Relocate petrol sta-tion, police station, fire station, doc workshop and fire depot, com-munity hall and churches to the north end of town.

1. Hold existing stopbank position

Maintain existing NZTA stopbanks with minor raising.

7. Programme for relocation from Alpine Fault

Work with commercial and residential properties to relo-cate from Alpine Fault Line.

LEGEND

- Franz Josef RD
- Lower Waiho RD
- State Highway 6
- DOC
- NZTA
- Waiho River flood extent for option
- Heli stopbank
- Removed
- Waiho River future unmitigated flood extent
- Fault avoidance zone

Notes: See figure list for source credits

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WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTION ASSESSMENT

Live with nature's challenges - Phase 1a

Open up river to north - Remove WWTP embankment

FIGURE No. 8.4

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Phase 1b Figure

Item	Cost Element	Line Items
	Phase 1: Open up river to north	
1	Hold existing stopbank position (excluding WDC access embankment)	-
2	Relocate WWTP	-
3	Relocate key assets	-
4	Compensation programme for loss of land utility to the north	-
5	Remove WWTP access road embankment releasing river north	-
6	Relocate key community buildings off Alpine Fault	Relocate Petrol station
		Relocate Fire station
		Relocate DoC workshop and fire depot
		Relocate Police station
		Relocate Community hall
		Relocate Churches
7	Programme for relocation of private building from Alpine Fault	CV of land and buildings
8	Relocate helicopter operation area and utilities	Cost for new helipad
		Power and telecommunication relocation
9	Build new Town-side stopbank	-
10	Realign State Highway 6 - North side	-
11	Remove NZTA 55km stopbank	-
12	Remove the Franz Josef and Heli stopbanks further releasing north	-
	Phase 2: Open up river to south	
13	Realign State Highway 6 - South side	-
14	Compensation programme for loss of land utility to the south	South side - Upper Waiho
		South side - Lower Waiho
15	Remove the NZTA stopbanks - south side	CAPEX
16	Relocate aerodrome	Aerodrome
	Long-term: 20+ years - Manage return to bed aggradation	
17	Raise stopbanks in the future	-
18	Gravel management programme	Land purchase for fill area
		Haul road
		Gravel extraction

Year: 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066

10b. Realign State High-way 6 - North side

Decommission existing SH6 alignment.

9. Build new Town-side stopbank

1 in 100 year flood design level stopbank to provide protection to the town area.

10a. Realign State High-way 6 - North side

Realign SH6 east away from the Waiho River and through the growth area of town.

11. Remove NZTA 55km stopbank

Remove the NZTA 55km hour stopbank to allow river maximum width to north.

12. Remove the Franz Josef and Heli stopbanks

Remove the Franz Josef and Heli stopbanks to re-turn helicopter operation area to river and allow aggradation to the north.

1. Hold existing stopbank position

Maintain existing NZTA stopbanks with minor raising.

8. Relocate helicopter operation area and utilities

Relocate helicopter operation area, power and communication utilities out of flood area when Franz Josef and Heli stopbanks are removed.

LEGEND

- Town-side stopbank
- Franz Josef RD
- DOC
- Lower Waiho RD
- NZTA
- Removed
- Realigned State Highway 6
- Existing State Highway 6
- Waiho River flood extent for option
- Waiho River future unmitigated flood extent
- Fault avoidance zone

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WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTION ASSESSMENT

Live with nature's challenges - Phase 1b

Open up river to north - Return heliport to river

FIGURE No. 8.5

Rev. 0

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Phase 2 Figure

Item	Cost Element	Line Items
	Phase 1: Open up river to north	
1	Hold existing stopbank position (excluding WDC access embankment)	-
2	Relocate WWTP	-
3	Relocate key assets	-
4	Compensation programme for loss of land utility to the north	-
5	Remove WWTP access road embankment releasing river north	-
6	Relocate key community buildings off Alpine Fault	Relocate Petrol station
		Relocate Fire station
		Relocate DoC workshop and fire depot
		Relocate Police station
		Relocate Community hall
		Relocate Churches
7	Programme for relocation of private building from Alpine Fault	CV of land and buildings
8	Relocate helicopter operation area and utilities	Cost for new helipad
		Power and telecommunication relocation
9	Build new Town-side stopbank	-
10	Realign State Highway 6 - North side	-
11	Remove NZTA 55km stopbank	-
12	Remove the Franz Josef and Heli stopbanks further releasing north	-
	Phase 2: Open up river to south	
13	Realign State Highway 6 - South side	-
14	Compensation programme for loss of land utility to the south	South side - Upper Waiho
		South side - Lower Waiho
15	Remove the NZTA stopbanks - south side	CAPEX
16	Relocate aerodrome	Aerodrome
	Long-term: 20+ years - Manage return to bed aggradation	
17	Raise stopbanks in the future	-
18	Gravel management programme	Land purchase for fill area
		Haul road
		Gravel extraction

16. Relocate aerodrome

Relocate aerodrome to Whataroa when NZTA stopbanks - south side are removed.

Lower Waiho Stopbanks

Current lower Waiho River stopbanks are assumed to provide negligible protection with time, after release of the NZTA stopbanks - south side. New stopbanks could be built by property owners. Only compensation programme is assumed.

18. Gravel management programme

Assumed bed levels reach a critical level for the raised stopbank height at Year 2046. Gravel extraction is assumed to be required in perpetuity from 2046 albeit at a reduced rate as there is a wider area for gravel storage across the released river fan. Gravel transported to a fill location around Lower Waiho area.

14. Compensation programme for loss of land utility to the south

Assistance for commercial and residential properties as flooding erodes value of land.

17. Raise stopbanks in future

Assume that bed aggradation will return in 2036 to river reach adjacent to town. Assume that stopbank raising can occur for 10 more years until their maximum height is reached.

13b. Realign State Highway 6 - South side

Decommission existing SH6 alignment.

15. Remove the NZTA stopbanks - south side

Remove NZTA true left stopbanks returning the Waiho River to the south. Assumed this causes the river to significantly cut down the current bed level upstream. It is assumed eventually bed aggradation will return. Assumed bed levels reach a critical level for the remaining stopbanks at their height again at Year 2036.

13a. Realign State Highway 6 - South side

Realign SH6 south away from the Waiho River along the base of hills.

LEGEND

- Town-side stopbank
- Franz Josef RD
- DOC
- NZTA
- Removed
- Realigned State Highway 6
- Existing State Highway 6
- Waiho River flood extent for option
- Waiho River future unmitigated flood extent
- Fault avoidance zone

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WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTION ASSESSMENT

Live with nature's challenges - Phase 2 & Long-term
Open river to south

FIGURE No. 8.6

Rev. 0

8.3 Defend against nature's challenges

***Snapshot*: This option package involves continuing to build stopbanks and implementing a gravel management programme to allow the township and the businesses and residents in the wider Franz Josef area to remain in their current locations with reduced flooding and earthquake-related risk.**

Figure 8-7 and Figure 8-8 summarise the options included within this package, and provide an indication of the timeframe for each option within the package to be implemented.

Defending against nature's challenges requires acceptance of the residual risk of an earthquake-induced large landslide and some residual risk from reliance on stopbanks (which may be overtopped in storm events larger than the protection provided for by the design level of service and/or could be breached for lesser events). It seeks to manage the flood risk by constraining the Waiho River within its current stopbanks (excluding the waste water treatment plant access embankment) and implementing a gravel management programme in perpetuity. Assets are moved off the Alpine Fault rupture zone (Figure 8-3). This provides investment certainty around the management of the river, but leaves the uncertainty of the risk from earthquake-triggered landslide.

The package requires the upgrade of the existing NZTA south and 55km corner stopbanks to a higher level of service and robustness, and the construction of an additional stopbank along SH6 from the 55km corner, extending to protect the kindergarten and school (called the school stopbank). The waste water treatment plant would be relocated and the owners of residential and commercial properties in the affected area to the north of the township may need to be compensated for loss of utility of the land.

This package requires ongoing gravel extraction to maintain a river bed elevation of no more than 2m above the 2016 level. The feasibility of the package is therefore contingent on an appropriate gravel disposal location. From a practicality perspective, disposal would occur in the wider Lower Waiho area to minimise haulage, and could be in one, or multiple locations. The haul road would be developed for purpose, but could intersect with existing roads where this makes sense.

This package would decrease the current visual amenity of the area, with increased engineered structures along the Waiho River and gravel management equipment operating in the river bed. There is also the potential for gravel deposit location(s) and gravel transportation machinery to disrupt visual amenity depending on the approach taken. Consideration of height, slope and revegetation of disposal site(s) will need to be considered to lessen the impact. The ecology of the Waiho River and surrounds may also be affected. The package does not impact on any identified heritage or taonga sites, but it is possible that the continual removal of material from the area would erode cultural value. Tourism may be impacted by both the construction and the visual amenity impacts.

The package also includes encouraging the centre of gravity of the township to be moved to the north end of the current township (around the existing health centre) to avoid flood and Alpine Fault rupture hazards. It would also allow for existing assets to be moved away from the active known fault line to help reduce life and injury risk, as well as improving community response and post-event recovery. (Figure 8-3) These should include:

- Petrol station
- Fire station
- DoC workshop and fire depot
- Police station
- Community hall
- Our Lady of the Alps Church

- St James Church

A safe-to-fail design would also be developed to allow the release of floodwaters along a predefined path to the south of the Waiho River. This would minimise the risk of over-topping to the north, where township assets and the most lives are at risk.

The specific initiatives within this package would all occur or commence in the short-term, and include:

Short- to medium-term - Defend with stopbanks (see Figure 8-7**)**

- Upgrade existing stopbanks
- Build in a safe-to-fail location in stopbank to the south
- Relocate the waste water treatment plant
- Build a new school stopbank
- Remove the wastewater treatment plant access road embankment
- Implement a compensation programme for loss of land utility to the north
- Relocate key community buildings off the Alpine Fault
- Relocate private buildings off the Alpine Fault

Long-term and in perpetuity - Gravel management (see Figure 8-8)

- Gravel management programme

Potential stakeholder impacts of this package are outlined in Table 8-3, note this is indicative and not exhaustive.

Table 8-3: Potential stakeholder impact for *Defend against nature's challenges* package

Stakeholder group	Potential impacts and obligations
Township residents	- Risk of flooding reduced - Impact from Alpine Fault surface ground rupture minimised - Impact of ongoing gravel extraction costs
Residents south of the Waiho River	- Risk of flooding minimised - Impact of ongoing gravel extraction costs
Tourists	- Marginal change to life risk - Negative impact on amenity value from ongoing gravel management programme
Local government	- Support for transition management approach - Risk of medium term and ongoing gravel extraction costs
Central government	- Management of transition approach - Impacts on existing investments (NZTA) - Risk of medium term and ongoing gravel extraction costs (NZTA)

Limitations:

- Additional research on the process of the Waiho River to confirm this package will likely achieve the objectives. This could include detailed flood and sediment transport modelling (computational and physical models).
- Commercial and environmental feasibility of gravel extraction has not been assessed.
- No obligation for funding or financing of costs should be assumed.
- Any gravel management required will be in perpetuity.

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Phase 1 Figure

Item	Cost Element	Line Items
	Phase 1: 1 to 10 years - Defend with stopbanks	
1	Upgrade stopbanks	-
	Build in safe to fail location in stopbanks	-
2	Relocate WWTP	-
3	Build new school stopbank	-
4	Remove WWTP access road embankment	-
5	Compensation programme for loss of land utility to the north	-
6	Relocate key buildings on Alpine Fault	Petrol station
		Fire station
		DoC workshop and fire depot
		Police station
		Community hall
		Churches
7	Programme for relocation from Alpine Fault	-
	Phase 2: 11 to 50 years - Gravel management	
8	Gravel management programme	
		Land purchase for fill area
		Haul road
		Gravel extraction

Year

2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066

2. Relocate WWTP

Build new WWTP away from Waiho River flooding.

3. Build new school stopbank

Build new 1 in 100 year flood design level stopbank to provide protection to NZTA road, school, kindergarten and substation

5. Compensation programme for loss of land utility to the north

Assistance for commercial and residential properties as flooding erodes value of land.

4. Remove WWTP access road embankment

Allow river to go north by removing the access road embankment.

1. Close stopbanks

Stopbanks at helicopter operation area may need to be closed with an additional stopbank due to more bed aggradation.

1. Upgrade stopbanks

Upgrade of Franz Josef, Heli and NZTA stopbanks to maintain 1 in 100 year flood design level. This requires 2m of raising over 10 years.

6. Relocate key buildings on Alpine Fault

Relocate petrol station, police station, fire station, doc workshop and fire depot, community hall and churches to the north end of town.

1. Build in safe to fail location in stopbanks

Creation of a safe to fail plug/spillway in the south stopbank at 1 in 100 year flood design level.

7. Programme for relocation from Alpine Fault

Work with commercial and residential properties to relocate from Alpine Fault Line.

LEGEND

- School stopbank
- Franz Josef RD
- DOC
- Heli stopbank
- Lower Waiho RD
- NZTA
- Removed stopbank
- State Highway 6
- Waiho River flood extent for option
- Waiho River future unmitigated flood extent
- Fault avoidance zone

Notes: See figure list for source credits

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A3 SCALE 1:20,000

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WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTION ASSESSMENT

Defend against nature's challenges - Phase 1
Upgrade stopbanks

FIGURE No. 8.7

Rev. 0

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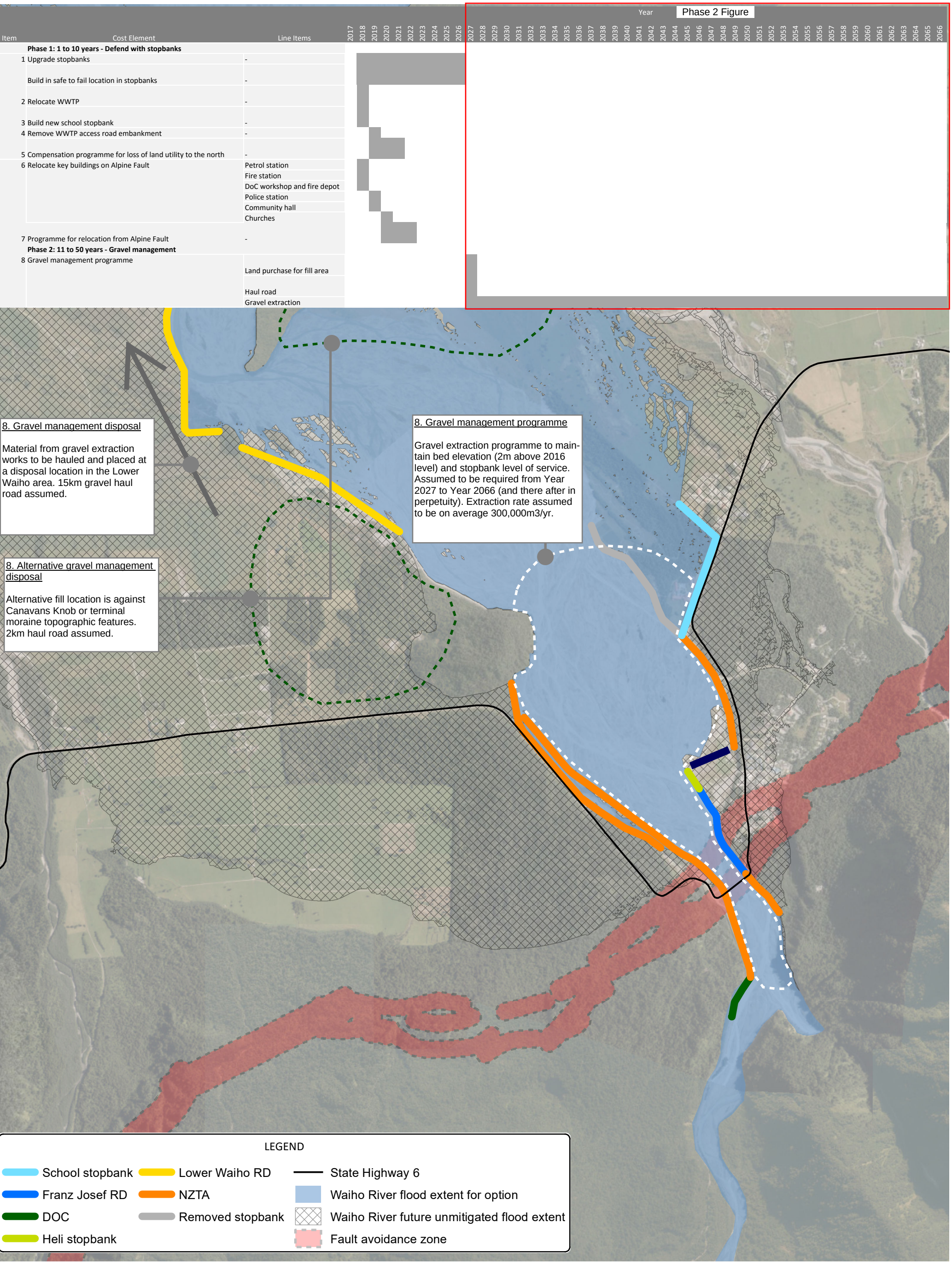
Phase 2 Figure

Item	Cost Element	Line Items
	Phase 1: 1 to 10 years - Defend with stopbanks	
1	Upgrade stopbanks	-
	Build in safe to fail location in stopbanks	-
2	Relocate WWTP	-
3	Build new school stopbank	-
4	Remove WWTP access road embankment	-
5	Compensation programme for loss of land utility to the north	-
6	Relocate key buildings on Alpine Fault	Petrol station
		Fire station
		DoC workshop and fire depot
		Police station
		Community hall
		Churches
7	Programme for relocation from Alpine Fault	-
	Phase 2: 11 to 50 years - Gravel management	
8	Gravel management programme	
		Land purchase for fill area
		Haul road
		Gravel extraction



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WEST COAST REGIONAL COUNCIL

FRANZ JOSEF NATURAL HAZARDS OPTION ASSESSMENT

Defend against nature's challenges - Phase 2
Gravel management

FIGURE No. 8.8

Rev. 0

9 Cost benefit analysis

CBA is a tool that is employed to better understand the costs and benefits of investments or interventions. CBA is often utilised when making decisions about investments in projects that have a finite life. For example, CBA is a commonly used technique when looking to understand the best value for money intervention for physical infrastructure. However the CBA for Franz Josef presents some challenges, in the sense that the costs and benefits of various options will inevitably occur in perpetuity, yet the analysis is conducted over a 50-year period. There are also very real challenges in attempting to monetise policy decisions that have not been made yet.

Regardless, the purpose of CBA is to provide a consistent basis by which to compare packages – using monetised costs and benefits of each package as the measure. Specifically, a CBA compares the incremental benefits and costs of different packages (the benefits and costs compared with doing nothing) to determine whether implementation of a given investment package results in efficient and effective social and economic outcomes. While CBA seeks to include environmental, social and cultural costs and benefits, only those that can be easily monetised are included.

CBA is not 'more important' than other analytical techniques. However, it does provide another lens by quantifying costs and benefits in monetary terms, where possible, and discounting them to a common point in time to determine the net benefits of each project.

The sections below provide a further description of the data inputs, important methodological characteristics of the CBA and the definition of the base case. The results are then presented. A full technical description of the components of the CBA and base case is provided in Appendices H and I.

9.1 Inputs

The CBA is highly dependent on the quality of the information inputs. In this study, inputs are often uncertain, as projections about future consequences of inherently uncertain natural hazard events must be made. Moreover, assumptions about policy decisions that have not been made yet, are inherent.

As a general principle, inputs have been derived based on currently available public information. Where publicly available information is not available, judgements have been made, supported by transparent assumptions, which have been tested with relevant stakeholders wherever possible.

Inputs for this study have therefore come from a number of sources including:

- T+T and EY expert judgements
- Assessment of impacts from other relevant hazard events (notably the Christchurch and Kaikoura earthquake events)
- Publicly available data from central Government sources (Statistics New Zealand, Ministry of Business Innovation and Employment and NZTA in particular)
- Local property value data from WCRC and WDC
- Other published reports as relevant

Where inputs have been encountered that have the potential for large divergences, sensitivity analysis has been applied demonstrating credible 'higher' and 'lower' bounds.

The Study team has identified a wide range of potential costs and benefits associated with each package of options. Each of the potential costs and benefits were further identified as either monetary or non-monetary and whether or not they could be appropriately quantified based on the information available for this study.

9.2 Methodology

9.2.1 Costs / benefits impact area (spatial extent)

Costs and benefits can be calculated and realised differently, depending on the perspective of the analysis. At the most basic level, for example, a benefit to a shop in terms of revenue is a cost to a consumer.

A variation of the same thing can happen when looking at benefits and costs from a local, regional and national perspective. In the case of this study, the impacts of a disruption to tourism expenditure due to an earthquake could be material to Franz Josef township, the West Coast regional economy and the national economy. Property values, while being a national capital stock loss, are considerably more material at local level than at national level.

These perspectives are all important to decision-making, particularly when there are local, regional, and national impacts and issues at stake. For the purposes of this study, impacts have been calculated and categorised across these different dimensions.

9.2.2 The use of average annualised loss methodology

An important characteristic of many of the benefit assumptions under the flooding and earthquake scenarios is the concept of 'average annualised loss' (AAL), which is the expected loss, on average, per year, from the full range of different likelihood events. In reality, in any one year, the loss value may be significantly below or above this average, as events have a large loss range. Most commonly there will be minor or no loss per year, until a significant event occurs.

The average annual losses estimated are approximate, based on a portfolio level assessment. They are used to determine the benefits for each investment package over the base case. Therefore the relative nature of how each loss is treated is important. We have applied a consistent approach to both the base case and the packages. A description of the assumptions and the underpinnings of AAL has been detailed in Appendix I.

9.2.3 Timeframes

A decision on the time horizon for the analysis is always a matter of judgement. Different dimensions of value will inherently have different timescales that lend themselves to analytical effort. However, we have selected a time horizon of 50 years to align with the Treasury CBAx model process.

This time horizon (or indeed any time horizon) will never fully account for the costs and benefits of an investment decision, as the costs, benefits and risks from natural hazards are dynamic, and occur in perpetuity.

9.2.4 Value-at-stake

While there is a wide range of value-at-stake within the Franz Josef community, the architecture of the CBA has been designed to focus on the material values that can be easily measured and monetised. Most notably, they are:

- Capital values of property (including land and improvements)
- Capital values of network infrastructure (such as roads, 3-waters, electricity, telecommunications and liquid fuels)
- Tourism expenditure losses avoided (at local, regional and national levels)
- Life and injury occurrences avoided

The 'benefits' for the CBA have therefore been assessed based on the expected proportion of the value-at-stake that each package will protect.

9.2.5 Cost estimates

Cost estimates have not been developed through rigorous technical or feasibility assessments. Accordingly, there is a level of uncertainty that is naturally associated with all cost assumptions. Wherever possible, these estimates have been linked to publicly available information, have been provided in the form of a cost range, or have been anchored by costs for similar projects. Where potential cost divergences are potentially material to decisions, we have also provided sensitivity assessments.

9.2.6 CBAx

Outputs from our bespoke CBA model has been used to populate the inputs for the CBAx model, as mandated by Treasury Better Business Case guidelines. CBAx is predominantly a tool that seeks to understand the national-level implications of decision-making. Therefore, for a study that is predominantly concerned with the local and regional impacts of natural hazards, we have decided to complement the CBAx analysis rather than replace it.

9.3 Base case

The base case describes the 'do-nothing' option for Franz Josef, capturing the expected losses or 'value-at-risk' associated with earthquake and flood events in the absence of interventions to avoid or mitigate the effects. The base case serves several purposes:

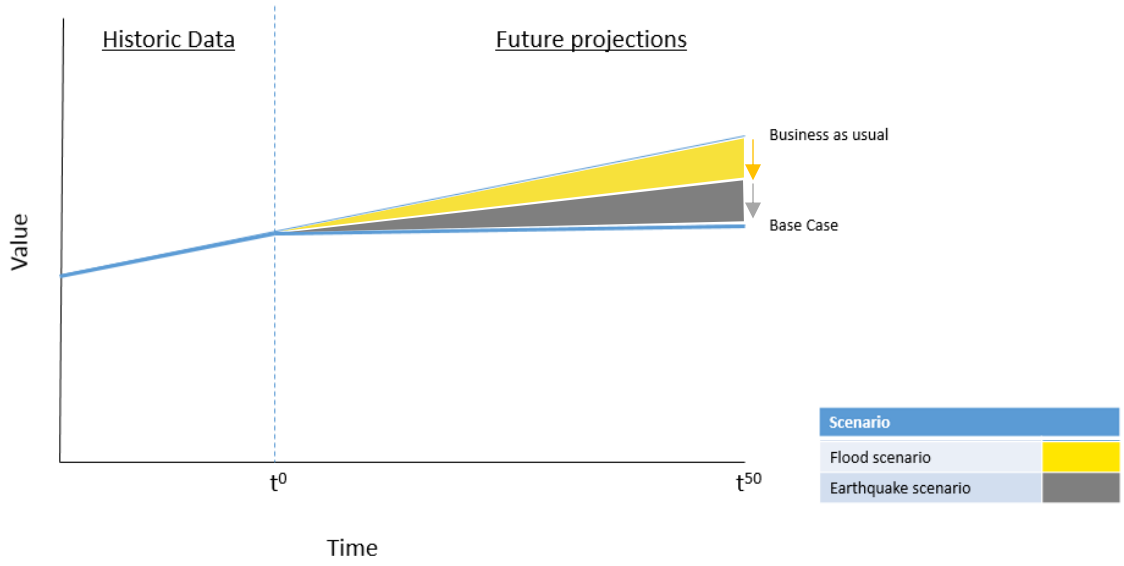
- To transparently outline key study assumptions about future investments, projected stocks and flows, size and magnitude of the impacts of each scenario and emergency response expectations
- To act as a reference point for a number of decisions made during the multi-criteria analysis (MCA), which narrowed the long list of options and supported the packaging of options
- To use as a baseline in the development of the cost benefit analysis (CBA) and translation into Treasury's CBAx tool. The CBA uses the base case as a consistent baseline to assess the short-listed packages of options and arrive at a preferred packages of options.

Owing to the unique nature of this study, the base case has been developed in a series of layers, each individually assessed, comprising:

- A business-as-usual (BAU) scenario (see Section 9.3.1)
- Losses expected from flooding of the Waiho River (see Section 9.3.1.1)
- Losses expected from earthquakes i.e. a rupture of the Alpine Fault (see Section 9.3.1.2)

Figure 9-1 shows how the base case is calculated, starting from an assessment of the business-as-usual scenario over time and then 'removing' the potential for flood and earthquake losses.

Figure 9-1: Stylised development of the base case



The remainder of this section describes the high-level features of each base case layer. A detailed description of the underpinning assumptions of the base case is provided in Appendix H.

9.3.1 Business-as-usual

The business-as-usual scenario is the first layer of the base case assessment and consists of a range of assumptions about key dimensions of value that exist within Franz Josef (as well as the enabling decisions that support this value) in lieu of any natural disaster event. In other words, in the eventuality that there is no natural disaster event in Franz Josef, what is a reasonable estimate of the expected growth pattern for a range of variables that define, or help support, the 'value at stake' over a selected time horizon?

The business-as-usual scenario is not a prediction of future growth patterns. Rather it is a plausible and credible baseline that serves to provide an integration point for the two natural hazard scenarios, and serves as a general anchor for the options assessment.

An example of an enabling decision dimension would be our assumptions about the Planning environment (such as that development will continue incrementally in areas with permissive development controls).

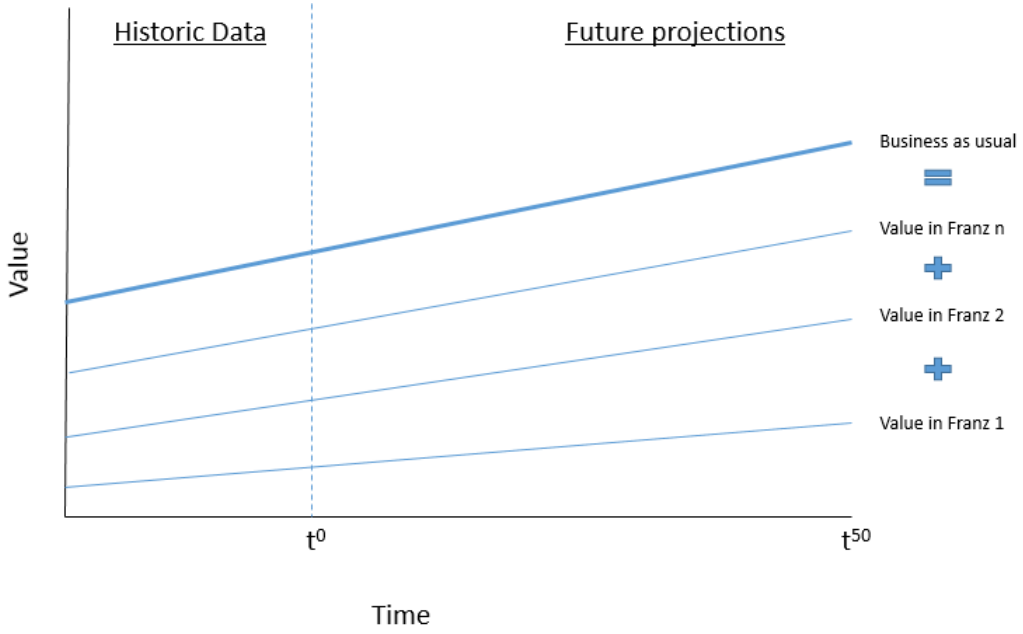
Examples of value dimensions include:

- Tourism (number of visitors and expenditure)
- Investment in major infrastructure (such as the wastewater treatment plant)

A stylised example of how these 'values' are stacked to develop a total 'value at stake' is provided in Figure 9-2. In this instance, 'Value in Franz Josef 1' might be the capital value of the building stock, and 'Value in Franz Josef 2' might be the value of tourism expenditure.

Once a picture of the forecast value at stake for Franz Josef is developed, natural disaster events are overlaid to understand the 'value at risk' for each natural disaster scenario and, ultimately, the risk-adjusted base case.

Figure 9-2: Stylised example of the business-as-usual projections



A summary of the business-as-usual values is provided in Table 9-1.

Table 9-1: Business-as-usual stocks and flows[27]

Aspect	Current – BAU value		Year 50 – BAU value	
	Count	Value> NZD	Count	Value> NZD
Population	510 residents 1,593# visitor nights on average over the year	8.8bn VoSL	571 residents 5,070# visitor nights on average over the year	23.7bn VoSL
Stocks				
Residential building stock	471 buildings*	$32m^	836 buildings*	$35m^
Commercial building stock		$60m^		$195m^
Other building stock		$4.3m^		$5m^
Land value		$90m^		$90m^
Total property stock		$187m^		$325m^
Potable water treatment	1 treatment facility	$2.3m	1 treatment facility	$2.3m
Waste water treatment plant	1 treatment facility	$3m	1 treatment facility	$3m
Three waters network	Pipes, manhole, pumpstations	$4.4m	Pipes, manhole, pumpstations	$4.4m
Flood protection	8.4 km stopbanks	$8.5m	8.4 km stopbanks	$8.5m
Power distribution network	33kv Transmission Line FJ zone substation Distribution network Distribution substation	~$1m	33kv Transmission Line FJ zone substation Distribution network Distribution substation	~$1m
Communications network	Cell towers Copper network	~$1m	Cell towers Copper network	~$1m
Road network	44 km roads 5 bridges'	$80m	44 km roads 5 bridges'	$80m
Aerodrome	1 Aerodrome	$2m	1 Aerodrome	$2m
Flows				
Tourism	278,000 tourists/yr 581,000 visitor nights/yr	$122m/yr	883,000 tourists/yr 1.85m visitor nights/yr	$411m/yr
Freight	68 trucks per day	N/A	110 trucks per day	N/A

* Building count for the Franz Josef and Stony Creek area has been manually assessed based on GIS data. The building count for the wider study area has been extrapolated based on this count and land use assumptions. There is naturally subjectivity in what counts as a 'building'.

^ Capital values include all properties in the wider, defined, Franz Josef area for this assessment. We divided multi rating unit properties into land, improvement and capital values per metre, and multiplied each property's area by these to inform land, improvement and capital values on a property level.

' Bridges on SH6 in the assessment area.

This number represents the number of visitor nights in Franz Josef in a year divided by 365 days.

VoSL = Value of statistical life applied is $4.2 million /person

> Values presented are based on current values, not inflated by the consumer price index or producer price index projections

[27] Across many of these metrics it is likely that new investment will be required over a 50-year period in reality (for example upgrades to electricity lines) but for the purposes of modelling we have not considered these upgrades.

9.3.1.1 Flood scenario

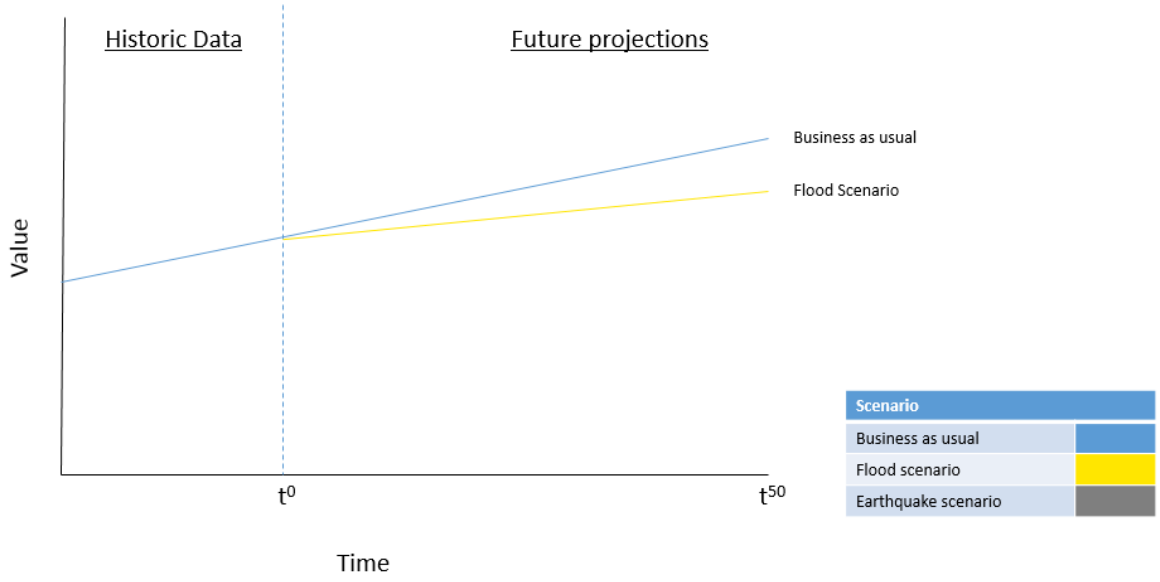
The first component of the flood scenario is to define the event. A full description of the flood scenario is provided in the Strategic Case (Section 2.3.3). Once the flood scenario is defined, assumptions about the expected loss profile are made across a number of dimensions. Individually and collectively these form the basis for calculation of 'flood impacts' and could include:

- Capital stocks (the expected physical loss for affected landowners)
- Tourism expenditure (what is the expected impact on tourist numbers and expenditure)

The sum of these impacts, when compared against the business-as-usual projection, will form the unadjusted 'value at risk'. This summation of these impacts is stylistically the same as is described in Figure 9-3.

Given that the probability of a flood event occurring in a given year is not 100%, we weight the impact of this event occurring by the probability and apply this annually over the 50-year timeframe. This provides an 'annual average loss' figure that layers over the business-as-usual projection. In other words, the CBA is aiming to naturally account for the potential value lost from a flood event by incorporating it into the 'business-as-usual' projection.

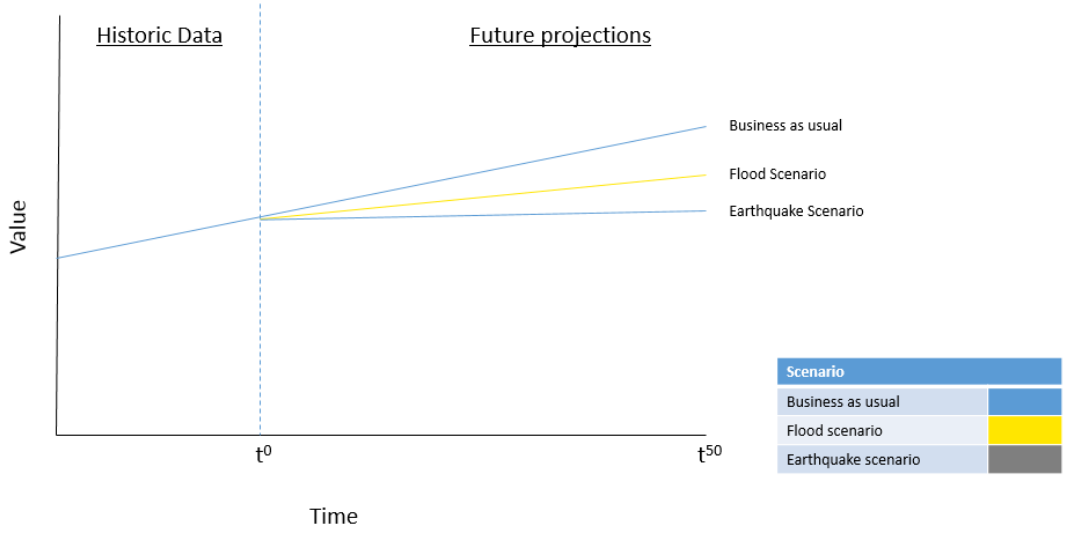
Figure 9-3: Stylised integration of flood scenario into the business-as-usual projection



9.3.1.2 Earthquake scenario

The steps taken under the flood scenario are then repeated for the earthquake scenario, with the final outputs being layered onto the preceding business-as-usual + flood scenario projection. A full description of the earthquake scenario is provided in the Strategic Case (Section 2.3.1) and Appendix H. A stylised example of this integration is provided in Figure 9-4.

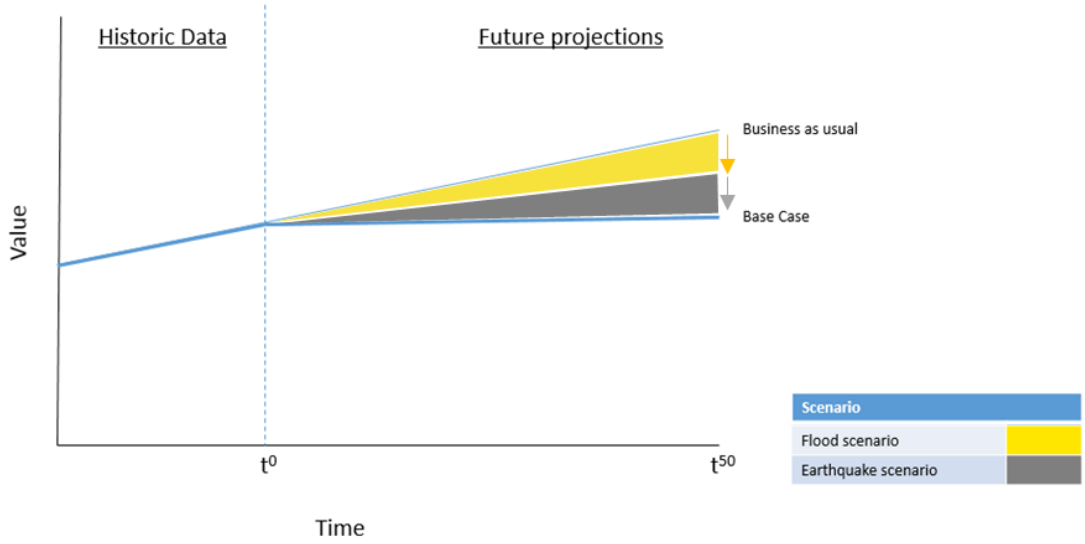
Figure 9-4: Stylised integration of earthquake scenario into the business-as-usual projection



9.3.1.3 Base case

The base case is then the integration of the three (business-as-usual, flood and earthquake) scenarios described above. A stylised example of this integration is provided in Figure 9-5.

Figure 9-5: Stylised base case



The previous (flooding and earthquake loss) tables can be combined to form a base case. Due to the temporal element of losses in the flooding scenario in particular, we have not presented the results in a tabular manner for simplicity. However we have taken this into account in the CBA model by summing the annual average losses under the flood and earthquake scenario for each year in the models timeline.

9.4 Results

As noted earlier, CBA as an economic tool is designed to show the best value for money solution over a particular time period, given the inputs that can be measured. On this basis, the results of the CBA (at a local level) are provided in Table 9-2, with the benefit cost ratio (BCR) which shows the hypothetical return on investment for every dollar spent.

Table 9-2 demonstrates that *Defend against nature's challenges* ranks the highest of the three packages. However, *Living with nature's challenges* also performs comparatively well, and is within reasonable bounds of *Defend against nature's challenges*. That is, while *Defend against nature's challenges* looks to best mitigate the natural hazard risks by protecting the most value at stake on a dollar-for-dollar basis over a 50-year period, *Living with nature's challenges* performs comparatively well too.

These findings are not surprising, given the high up-front costs associated with *Avoid nature's most significant challenges* and the long-term nature of the benefits that are expected to accrue (which extend beyond the modelling period). They are also unsurprising given that the actual costs of *Defend against nature's challenges* and *Live with nature's challenges* will likely occur in perpetuity, yet the modelled costs occur over a 50-year period.

The costs and benefits that fall outside of the modelling period are therefore crucially important considerations when making a decision on the preferred package(s).

Table 9-2: Cost benefit analysis results for Franz Josef over the 50-year study period[28]

	Avoid	Live With	Defend
	NZD ($000)	NZD ($000)	NZD ($000)
Benefits			
EQ Injuries and Deaths	$ 313	$ 505	$ 505
EQ Buildings and Land Damage	$ 927	$ 1,615	$ 1,615
EQ Infrastructure Damage	$ 210	$ 125	$ (204)
EQ Disruption to FJ Tourism	$ 3,780	$ 5,924	$ 5,924
FLOOD Injuries and Deaths	$ 458	$ 739	$ 739
FLOOD Buildings and Land Damage	$ 25,779	$ 26,976	$ 26,976
FLOOD Infratsructure Damage	$ 7,143	$ 10,911	$ 10,430
FLOOD Disruption to FJ Tourism	$ 80,215	$ 80,499	$ 80,499
Total Benefits	$ 118,825	$ 127,292	$ 126,482
Costs			
Purchase Land at Lake Mapourika	$ 1,386	$ -	$ -
Management of Existing Township Land	$ 10,495	$ -	$ -
Development of new Township	$ 255,180	$ -	$ -
SH6 Realignment	$ 14,514	$ -	$ -
Compensation package	$ 10,170	$ -	$ -
Transition WWTP	$ 2,932	$ -	$ -
Phase 1a - Open up river to North	$ -	$ 11,656	$ -
Phase 1b -Move Town on Active Fault Line	$ -	$ 19,692	$ 20,634
Phase 2 Return heliport to River	$ -	$ 12,215	$ -
Phase 3 Open river to South	$ -	$ 22,825	$ -
Upgrade town side stop bank	$ -	$ 122	$ -
Gravel Management Program	$ -	$ 5,080	$ 33,310
Defend with Stopbanks	$ -	$ -	$ 14,343
Total CAPEX (Base Case)	$ (4,291)	$ (4,291)	$ (4,291)
Total OPEX (Base Case)	$ -	$ -	$ -
Total Costs	$ 290,387	$ 67,299	$ 63,996
Net Benefits	$ (171,562)	$ 59,993	$ 62,486
BCR	**0.41**	**1.89**	**1.98**

9.4.1 Assumptions and sensitivity analysis

It is important to note that these results inherently include assumptions around material cost and benefit inputs that contain considerable uncertainty. For example:

- ***Gravel extraction volume*:** The volume of gravel extraction for the CBA analysis is 300,000 m^3/yr. This is based on a sediment budget calculated by Opus (2014), where the cumulative volume change for the river length of interest was in the range of 100,000 to 500,000 m^3/yr for the years 2002 to 2011. There is considerable uncertainty around future volume changes.
- ***Gravel extraction and disposal cost*:** The cost for gravel extraction and disposal for the CBA analysis is $3.6m/yr. This is based on general rates for bulk haulage and filling. A detailed assessment of this cost per year and the variables that make up this pricing could be done if this option is progressed further.

[28] These values are discounted over a 50 year time period. They do not represent nominal values. For a full breakdown of cost assumptions, see Appendix I.

- ***Compensation*:** Compensation is a difficult concept to model in the absence of any clear policy direction. By its very nature, compensation is an action that takes into consideration the unique circumstances of each and all participants. For instance, following the 2010-2011 earthquake sequence, some Christchurch landowners received 15% of the value of their property for the increased flood risk (see Box 9-1). Alternatively, a view that 100% of the capital value of properties could be considered in an *ex-ante* programme.[29] Regardless of the eventual approach taken (or not) the 'compensation number' utilised is material to the findings of the CBA.

Gravel extraction volume, gravel extraction and disposal cost and compensation are all differentiators in the analysis. It is therefore important to understand the effects that different assumptions can have on the overall ranking. To this end, sensitivity analyses are provided in Table 9-3 and Table 9-4 representing credible upper and lower bounds.

Table 9-3: Compensation sensitivity analysis

	Avoid nature's most significant challenges	Live with nature's challenges*	Defend against nature's challenges*
% of Property Value	50 year BCR	50-year BCR	50-year BCR
15%	0.420	2.258	2.039
57.50%	0.409	1.891	1.976
100%	0.399	1.627	1.917

* Wider Lower Waiho (site further from town) fill site used for extracted gravel

Table 9-4: Gravel extraction sensitivity analysis**

	Defend against nature's challenges
Fill disposal location	50-year BCR
Wider Lower Waiho	1.976
Adjacent to Canavans Knob	2.195

** 57.5% of Property Value used for compensation in gravel extraction sensitivity analysis

Additionally, tourism estimates also have a large potential variance depending on views around: cyclical growth, accommodation capacity, infrastructure capacity, competitiveness to other regions, national tourism trajectory and glacial retreat (or advance). Unlike estimates around gravel extraction volumes, gravel extraction and disposal cost and compensation, changes to tourism numbers broadly has the effect of altering the BCR of all packages i.e., it is ultimately not a major differentiator.

[29] In practice, it is feasible that a compensation programme might be also based on values beyond land/rateable values.

Box 9-1: Christchurch approach to compensation for increased flooding risk

The issue of increased flooding vulnerability (IFV) has been addressed in Christchurch and expert property valuers have considered that the decrease in valuation due to the increased frequency of flooding is, on average, approximately 15%. For the *Living with nature's challenges* option the stopbanks on the south side would be removed, thereby making increased flood frequency there certain. For the *Avoid nature's most significant challenges* option, landowners (including NZTA) to the south could elect to maintain the stopbanks at a particular level of service. In that case there would be no increased flooding vulnerability apart from that arising from bed aggradation.

9.4.2 Conclusion

While *Defend against nature's challenges* and, to a lesser extent, *Live with nature's challenges* perform well under CBA, this is not the only analytical technique that should be considered when selecting the preferred way forward. Moreover, when sensitivity analysis is considered, it is clear that several assumptions (with large uncertainties) have a large bearing on the CBA results, and that these are driven by policy decisions or community acceptability (which is outside of the boundaries of the CBA). Therefore further analysis should be undertaken, and wider issues considered, before a more definitive view about the true value for money of all packages can be determined.[30]

[30] Crucially, this analysis does not take into account a range of important considerations such as ability to pay, insurance costs and representation of 'building back better'. There is also a range of limitations inherent in the modelling. It would broadly be expected that any future business case process would look to develop these inputs further to the point where CBA becomes more meaningful. See Appendix I for the full assessment of these limitations.

Next steps

10 Key findings

This study has sought to explore the options available to mitigate natural hazard risk to Franz Josef township, the wider Franz Josef area (as well as the West Coast and New Zealand). The preceding analysis has identified five key findings that frame the recommendations in this report.

Franz Josef is unique

There is considerable value at stake within the Franz Josef community that warrants protection. Most notably, Franz Josef Glacier is believed to be the third most visited natural attraction in New Zealand, and this results in considerable visitor flow through Franz Josef township. In fact, with over 500,000 visitor nights in Franz Josef township in 2016, this is one of the highest, if not the highest, ratios of visitor night-to-residents in New Zealand.

Part of the reason why Franz Josef derives tourism value is because of the significant environmental value which exists. This inherent environmental value is partially responsible for the natural hazard risk that also confronts the township including:

- Alpine Fault rupture
- Flooding from the Waiho River

Do nothing is not an option

There is significant flood hazard at present, and due to ongoing bed aggradation that flood risk (and the cost of mitigating it) increases with time. There is already flood risk to assets below the river bed. If left unmanaged, it is likely to be less than 30 years before the Waiho River is above the level of the township. This places a level of urgency on a decision to manage the risk from this hazard.

Additionally, an Alpine Fault rupture event would cause significant disruption to Franz Josef township, including impacts caused by shaking across the wider Franz Josef area and uplift and / or lateral spread along the active fault line(s). It is also possible (if not probable) that an Alpine Fault rupture could trigger a large landslide, which would have catastrophic consequences in terms of loss of life, building stock and tourist revenue.

Significant interventions to mitigate risk are needed

If the value at stake within Franz Josef is to be protected, then a substantial investment programme is required, and significant decisions need to be made.

Smaller interventions are likely to be needed in the short-term to meet legislative requirements and buy-time to make 'the best decision' but in the medium- to longer-term, these will not be satisfactory.

The packages developed as a result of this study each incorporate significant interventions available to Franz Josef township (and New Zealand) to better mitigate natural hazard risks. These packages are:

- ***Avoid nature's most significant challenges***: This package seeks to physically avoid the natural hazard challenges in Franz Josef by moving the township to Lake Mapourika, out of the area subject to flooding from the Waiho River and away from the Alpine Fault and the range-front landslide risk. This package may create new investment opportunities, in addition to protecting the tourism value currently generated by the township.
- ***Live with nature's challenges***: This package involves generally decreasing stopbank management and allowing the river to fan out in its natural pattern, which will reduce flooding risk and flood management costs. It also allows for relocating township assets off the active known fault line in the short- to medium-term; however, over time the value of the land to the south of the Waiho River will be eroded due to increased flooding risk.

- ***Defend against nature's challenges***: This package involves continuing to build stopbanks and implementing a gravel extraction programme to allow the township, and the businesses and residents in the wider Franz Josef area, to remain in their current locations with lower flooding risk. It also allows for relocating township assets off the active known fault line in the short- to medium-term to reduce earthquake-related risk. The costs of gravel management will occur in perpetuity and the town will remain exposed to residual flooding risk from stopbank failure or overtopping.

There is no one obvious answer and significant optionality exists

No one package has outperformed others across all of the analytical techniques employed in this study. This is particularly relevant when considering the uncertainties involved in analysing the options, and the importance of the local community determining its own tolerance to risk. Each package has strengths and weaknesses that need to be considered.

A high level overview of the key differentiators of each package is provided in Table 10-1. Full descriptions of each package, including the outcomes of CBA, MCA and general strengths and weaknesses is provided in Section 11.

In addition, there exists a range of variability in how each package can be implemented.

Table 10-1: Key decision elements for each package

Decision Element		Avoid nature's most significant challenges	Live with nature's challenges	Defend against nature's challenges
Cost	OPEX	Low	Medium	High
	CAPEX	High	Medium	Low
Level of disruption expected as a result of implementation		High	Medium	Low
Negative visual amenity impacts		Low	Medium	High
Residual risk	Alpine Fault rupture	Low	Medium	Medium
	EQ-triggered landslide	Low	High	High
	Flood	Low	Medium	High
Existing value protected		Low	Medium	High
Potential value created		High	Medium	Medium

A collaborative approach to agreeing the future is needed

There are real costs and benefits that fall on different parties from any decision that is made. Each package includes major and minor options that will come with real trade-offs for real people (and agencies).

It is therefore vital that all relevant trade-offs are fully explored with all affected parties, and that a collaborative decision-making framework is established to consider all relevant opinions. Necessary participants in this process include:

- Central Government
- Local Government
- Iwi
- Affected community members
- Other relevant stakeholders

The case for change in Franz Josef is strong and the opportunity for the township and other stakeholders to collaboratively agree a vision for the future is great.

We are pleased to present this report and further the evidence base that will support future decision-making that will shape Franz Josef, and New Zealand, for years to come.

11 Packages to be progressed

Three very distinct and different option packages have been considered in the context of the investment objectives and critical success factors agreed with the Franz Josef Working Group and reflected through the multi-criteria assessment. A summary of each of these packages, including the MCA scoring, CBA results and summary of key benefits and costs follows.

Defend against nature's challenges is the only package that protects the present economic value at stake, and hence performs well from a cost benefit perspective. It is also the only package which allows the existing social and cultural value to remain *in-situ*. However, this comes at a cost to the environmental value of the area, due to the likely visual impact of stopbanks and ongoing gravel management. This package also results in the highest residual natural disaster risk. It is important to recognise that the financial, environmental and aesthetic costs associated with the viability of this package extend in perpetuity (i.e. beyond the 50 years of the CBA), and environmental and aesthetic costs are not considered in the CBA model.

Moving the town to Lake Mapourika to ***Avoid nature's most significant challenges*** does not protect any of the present environmental, social, cultural or economic value in the township, but there is the opportunity to generate significant new value in the new location. This approach also results in very little natural disaster risk going forward, and hence minimal ongoing natural disaster mitigation would be required. This could be a transformational opportunity for the township, but would also come with uncertainty in transition and would require considerable coordination on behalf of all affected stakeholders.

Live with nature's challenges is in essence a compromise that sits between the other packages. This package allows the existing value in the township to be protected by releasing the Waiho River to the north initially, and ultimately to the south, which will reduce the utility of the land in this area over time as the river establishes new flowpaths that utilise the wider floodplain. Assets are moved off the known active fault zone, but the risk of an earthquake-triggered landside is not altered.

Next steps could include exploring these packages further and agreeing a preferred package (or combination of packages) to take forward through a full business case process. In doing this, however, it is important to look at all the options within each of the packages and to critically examine where there is, or could be, stakeholder disagreement and seeing how these different perspectives could be addressed. It could be, that as part of this process, some elements become sufficiently critical that another package, or set of options, could come into play. A framework for this pathway forward is provided in Section 12.

Avoid nature's most significant challenges: This package seeks to physically avoid the natural hazard challenges in Franz Josef by moving the township to Lake Mapourika, out of the area subject to flooding from the Waiho River and away from the Alpine Fault and the range-front.

The most significant element of the package to *Avoid nature's most significant challenges* is the physical avoidance for the township of the three natural hazards identified – alpine fault rupture, earthquake-triggered large landslide, and flooding from the Waiho River. This package provides for relocation of the township assets on the north side of the Waiho River, and over time, property and assets on the south side of the Waiho River would be subject to increased flooding risk.

A new town would provide an opportunity to 'build better', potentially embracing the latest developments in community design, sustainable buildings and resilient infrastructure. This approach could provide enhanced community spaces and improved operational performance, with reduced environmental impact. Resilience could be increased through new design and construction approaches and the use of off-grid options to supplement traditional connected utilities. The town could be designed to maximise opportunities to diversify Franz Josef and the West Coast's tourism offering.

By implementing this package, there is significant up-front capital required. However, costs in perpetuity (which are outside of the CBA 50-year horizon) would reduce to typical maintenance activities. In addition, the potential value created (particularly social and economic value) would continue, and likely grow.

This package can be seen as an intervention before, rather than after, a significant natural hazard event. That is, if an event occurred, the response may include moving the town to a new location, and 'building back better'.

Summary of impact on value at stake and resilience

Value	Benefit	Cost
Environmental	- Allowing river ecology to return to natural processes - Environmentally preferable materials in buildings and infrastructure - Reduced environmental impact through improved operational performance of buildings and infrastructure	- Greenfield development - Impact during construction works
Social	- Improved town planning to enhance community spaces, access and cohesion - Healthy buildings in operation	- Loss of value south of the Waiho River - Short term loss of sense of place - Short term disruption during transition
Cultural	- Key cultural assets could be relocated	- Loss of connection to history of township
Economic	- Opportunity to diversify tourist offering - Long term investment certainty - Reduced ongoing costs in perpetuity (typical maintenance only)	- High up front capital cost - Loss of business on the south side of the Waiho River - Cost of realigning State Highway 6
Resilience	- Physical avoidance of active known fault line, range-front, and flooding from the Waiho River - Opportunity to increase resilience through off-grid infrastructure in new town	

MCA assessment results

Investment Objective		Critical Success Factor			
Mitigate natural hazard risk	Provide investment certainty	Community acceptability	Ease of implementation	Value for money	Wider costs and benefits
High	High	Medium	Low	Medium	Low

Cost – Benefit analysis

Local	NPV @ 6%	NPV @ 6%	NPV @ 6%
Option: Avoid	**5 Years**	**10 Years**	**50 Years**
Benefits			
EQ Injuries and Deaths	-	-	313
EQ Buildings and Land Damage	-	-	927
EQ Infrastructure Damage	-	-	210
EQ Disruption to FJ Tourism	-	-	3,780
FLOOD Injuries and Deaths	-	-	458
FLOOD Buildings and Land Damage	-	-	25,779
FLOOD Infrastructure Damage	-	-	7,143
FLOOD Disruption to FJ Tourism	-	-	80,215
Total Benefits	**-**	**-**	**118,825**
Costs			
Purchase Land at Lake Mapourika	1,386	1,386	1,386
Management of Existing Township Land	-	1,345	10,495
Development of new Township	7,732	81,342	255,180
SH6 Realignment	1,466	1,466	14,514
Compensation package	-	-	10,170
Transition WWTP	2,932	2,932	2,932
Total CAPEX (Base Case)	(4,291)	(4,291)	(4,291)
Total Costs	**9,226**	**84,181**	**290,387**
Net Benefits	**(9,226)**	**(84,181)**	**(171,562)**
BCR	**-**	**-**	**0.41**

Live with nature's challenges: This package involves generally decreasing stopbank management and allowing the river to fan out in its natural pattern, which will reduce flooding risk and flood management in the long-term, but require some relocation of assets in the short- to medium-term.

This package represents a mid-point between moving the township and defending all current assets. It aims to manage flooding risk through restoring natural river processes, and defend areas of the township that are able to be strategically protected.

Risk from alpine fault rupture is reduced through moving key assets off the known fault line, and ensuring town growth occurs away from the Alpine Fault in the future. The package does not change the risk associated with an earthquake-triggered large landslide.

This package allows the township on the north side of the river to remain, along with key social and cultural assets. However, once the stopbanks on the south of the Waiho River are removed, assets to the south would be subject to increasing flood risk, and ultimately their value would be diminished. This package therefore requires a policy decision regarding the approach to compensation for affected property and business owners.

There would be comparatively limited disruption to the township and tourism activities with this package, noting that the Aerodrome would need to be relocated to a new site south of the Waiho River.

It is possible that some gravel management may be required over time to maintain the service level of the stopbanks that would be retained to protect the township, and it is important to recognise that there is ongoing residual risk from stopbank failure. Gravel management may result in aesthetic and ecological impact, and may be required to be undertaken in perpetuity from the point of inception. Only 50 years of costs of any gravel management activity have been included in the CBA.

Summary of impact on value at stake and resilience

Value	Benefit	Cost
Environmental		- Potential for ecological impact of limited ongoing gravel management activity
Social	- Maintaining current sense of place (north of the Waiho River)	- Loss of south side community - Potential for aesthetic impact from limited gravel management activity
Cultural	- Maintaining cultural assets (north of the Waiho River)	- Potential loss of access to sites of cultural value south of the Waiho River
Economic	- Investment certainty over CBA period (50-years)	- Loss of business on the south side - Cost of realigning State Highway 6 - Potential for limited costs for ongoing gravel management activity (in perpetuity)
Resilience	- Moving key assets off active known fault line - Protection against flood risk	- No change in earthquake triggered landslide risk - Some residual risk from potential failure of stopbanks

MCA Assessment

Investment Objective		Critical Success Factor			
Mitigate natural hazard risk	Provide investment certainty	Community acceptability	Ease of implementation	Value for money	Wider costs and benefits
Medium	High	Medium	Medium	Medium	Low

Cost – Benefit Assessment

Local	NPV @ 6%	NPV @ 6%	NPV @ 6%
Option: Live With	**5 Years**	**10 Years**	**50 Years**
Benefits			
EQ Injuries and Deaths	22	122	505
EQ Buildings and Land Damage	84	449	1,615
EQ Infrastructure Damage	8	40	125
EQ Disruption to FJ Tourism	235	1,344	5,924
FLOOD Injuries and Deaths	32	178	739
FLOOD Buildings and Land Damage	108	696	26,976
FLOOD Infrastructure Damage	351	1,936	10,911
FLOOD Disruption to FJ Tourism	15	138	80,499
Total Benefits	**854**	**4,903**	**127,292**
Costs			
Phase 1a - Open up river to North	11,656	11,656	11,656
Phase 2 Return heliport to River	8,078	12,215	12,215
Phase 3 Open river to South	-	15,112	22,825
Phase 1b -Move Town on Active Fault Line	14,660	19,692	19,692
Upgrade town side stop bank	-	-	122
Gravel Management Program	-	-	5,080
Total CAPEX (Base Case)	(4,291)	(4,291)	(4,291)
Total OPEX (Base Case)	-	-	-
Total Costs	**30,103**	**54,384**	**67,299**
Net Benefits	**(29,249)**	**(49,481)**	**59,993**
BCR	**0.03**	**0.09**	**1.89**

Defend against nature's challenges: This package involves continuing to build stopbanks and implementing a gravel extraction programme to allow the township, and the businesses and residents in the wider Franz Josef area, to remain in their current location with reduced flooding and earthquake-related risk.

This package seeks to protect the majority of the township and properties south of the Waiho River from flooding risk and retains the existing social and cultural value in the area.

Flooding risk is managed through a long-term stopbank and gravel management plan, but the risk of stopbank failure or overtopping does mean there is residual risk, which could be significant during a severe flooding event. Risk from alpine fault rupture is reduced by moving key assets off the known fault line, and ensuring town growth occurs away from the fault line in the future. The package does not mitigate the risk of earthquake-triggered landslide.

Ongoing gravel management is required as part of this package to maintain the level of service of the stopbanks which would protect the township and wider Franz Josef area. These activities would have aesthetic and ecological impacts, and would be required to be undertaken in perpetuity. Only 50 years of gravel management cost activity have been included in the CBA.

There would be limited physical disruption for the township and tourism activities. However, the aesthetic impacts from the stopbanks and ongoing gravel management may result in tourist perception impacts.

Summary of impact on value at stake and resilience

Value	Benefit	Cost
Environmental		- Significant ecological impact of ongoing gravel management activity
Social	- Maintaining current sense of place (north and south of the Waiho River)	- Aesthetic impact from stopbanks - Aesthetic impact from gravel management activity
Cultural	- Maintaining cultural assets (north and south of the Waiho River)	- Potential impact on cultural value at gravel deposit site
Economic	- Investment certainty over CBA period (50-years) - Maintain alignment of State Highway 6	- Costs for ongoing gravel management activity (in perpetuity) - Potential tourism impact through aesthetic impact
Resilience	- Moving key assets off active known fault line - Protection against flood risk	- No change in earthquake-triggered landslide risk - Highest residual risk from potential failure of stopbanks

MCA Assessment

Investment Objective		Critical Success Factor			
Mitigate natural hazard risk	Provide investment certainty	Community acceptability	Ease of implementation	Value for money	Wider costs and benefits
Medium	High	Medium	Low	Medium	Medium

Cost – Benefit Assessment

Local	NPV @ 6%	NPV @ 6%	NPV @ 6%
Option: Defend	**5 Years**	**10 Years**	**50 Years**
Benefits			
EQ Injuries and Deaths	22	122	505
EQ Buildings and Land Damage	84	449	1,615
EQ Infrastructure Damage	(12)	(65)	(204)
EQ Disruption to FJ Tourism	235	1,344	5,924
FLOOD Injuries and Deaths	32	178	739
FLOOD Buildings and Land Damage	108	696	26,976
FLOOD Infrastructure Damage	322	1,784	10,430
FLOOD Disruption to FJ Tourism	15	138	80,499
Total Benefits	**804**	**4,646**	**126,482**
Costs			
Defend with stopbanks	14,038	14,343	14,343
Gravel Extraction	-	-	33,310
Move Town on Active Fault Line	20,634	20,634	20,634
Total CAPEX (Base Case)	(4,291)	(4,291)	(4,291)
Total Costs	**30,381**	**30,686**	**63,996**
Net Benefits	**(29,577)**	**(26,040)**	**62,486**
BCR	**0.03**	**0.15**	**1.98**

11.1 No-regrets options

The set of no-regrets options were identified in the analysis that achieved a high total MCA score. The following no-regrets options are likely to be low cost and increase resilience in the short term:

- Development and implementation of the Community Resilience Plan
- Education on resilience and emergency response
- Establishment of community resilience hubs
- Collaboration with NZTA and an integrated Waiho River management plan

A number of other no-regrets options have also been identified and could be considered for implementation (see Appendix G).

12 Next steps

The preceding analysis has demonstrated that the case for change is strong, and that if left unaddressed, there is a finite life for Franz Josef township and the wider Franz Josef area, as well as the value that it enables. Moreover, one option, or package of options, has not outperformed others across all of the analytical techniques employed in this study. Each package has strengths and weaknesses that need to be considered.

This is a unique opportunity, not only to protect the value at stake in Franz Josef, but to make a decision that would generally be taken after an event has occurred, not before, and agree the 'best way' forward for the town in the context of these very real natural hazards challenges.

This study has identified three distinct packages of options which seek to address, in various ways, the natural hazard risks faced in Franz Josef. This report and stakeholder discussions held to-date are key steps in moving towards the implementation of a solution that is acceptable to the broad range of stakeholders locally, regionally and nationally.

Given the likely requirement for central Government decision-making and/or investment in any package, it is expected that a business case will be required. The business case process forms a robust and transparent way of focussing all relevant stakeholders on the key components required to implement a preferred package. For instance, a business case can assist in detailing:

- ***Specific components of a package**:* Where this study has necessarily detailed some choices in how Franz Josef township may respond to natural hazard risk (for example how to manage any issues associated with the Aerodrome) a business case would be expected to chart a specific course of action.
- ***Formal identification of technical, legislative and regulatory barriers*:** Across many options there are significant barriers to implementation that may need to be overcome. It is expected that the business case process would identify these barriers explicitly and provide initial recommendations to how these can be navigated or mitigated.
- ***Principles and approach to any transition or compensation packages**:* In all scenarios, there is the need to manage transition (either away from active fault lines, or away from the risks of the Waiho River). The specific mechanisms to do this will be controversial and must be developed based on transparent principles that all relevant stakeholders are privy to.
- ***The development of any commercial structures needed to give effect to the package***: In those packages where there may be a need for a party to take on development risk (particularly in the *Avoid nature's most significant challenges* package) there will be the need to begin detailing the potential commercial structures that are available. This element will seek to answer questions around what types of risks can and should be borne by the Crown *versus* what risks can and should be borne by the private sector.
- ***Formalising governance structures**:* A decision to implement any of these options will need the establishment of a long-term governance arrangement. It is expected that the business case process can provide the detailed description of these structures.
- ***Building consensus**:* Where this study has focussed on building the evidence base, a business case is explicitly expected to begin to build consensus behind particular options. This is not to say that it will create agreement – but it should move all relevant parties closer to that end point.

Only by all parties being a part of the business case process can true consensus be worked towards. We recommend that next steps towards a business case are supported by:

- ***Establishment of a governance group*** which includes community, iwi, local government and central government representation
- ***Commencing relevant Resource Management Act processes***
- Developing a structured approach to ***stakeholder engagement***
- Commencing an extended period of work with stakeholders to ***support the development of a preferred package*** appropriate for a business case

Each of these steps are detailed in the following sections.

12.1 Establishment of a governance group

This study has demonstrated that Franz Josef is a place where there is significant value at stake for a wide range of stakeholders, and that the responsibilities for any action are likely to be broad. Moreover, given the significance of the interventions, a commensurate level of wider stakeholder engagement and deliberation is required, which has not been fully undertaken to date. Accordingly, we recommend that a governance group be established that is responsible for aligning thinking, refining the preferred package(s) for progression and working through relevant delivery models (if necessary) for the future of Franz Josef.

This group should be charged with leading the necessary consultation with all stakeholders to a level warranted for a decision of this magnitude. It should also be responsible for consideration of major issues such as residual risk; compensation approach; transition pathways; and promotion of sustainable, resilient design.

We recommend that the Governance Group consists of central and local Government participants, as well as specific Franz Josef community representation. This would be the best approach to seek to align the funders and the beneficiaries of any intervention(s). It would also encourage all of the relevant perspectives and expertise to be put on the table. The Tai Poutini Regional Economic Development Governance Group appears to be an established forum in which to consider issues for Franz Josef. However, a stand-alone forum may be more appropriate depending on the specific terms of engagement for the Tai Poutini Regional Economic Development Group.

The establishment of formal terms of reference to govern the roles and responsibilities of this proposed Governance Group will be necessary given the gravity of the deliberations that will need to be made. We recommend that the following principles be included (at the very least) in any Terms of Reference as they have underpinned this study:

- True collaborative engagement and transparency of decision-making (no surprises)
- Putting community at the heart of decision-making
- Pursuing options that seek to best align costs of intervention with beneficiaries
- Understanding and considering the wider value at stake

We recommend that WCRC be charged with leading the development of this Governance Group, given its role in commissioning this study.

12.2 Resource Management Act processes

Next steps could also include initiating the evaluation and assessment processes that will be required under the Resource Management Act (RMA) to support the regulatory decision-making that will be required for any of the packages to proceed. Initiating these will provide important additional information to inform further engagement on the options and the parallel process to develop a business case. It will also streamline and align the activities required in the next steps and help facilitate timely progress of decision-making about, and implementation of, a preferred option.

In addition, it would be useful to complete some early review of other potential regulatory tools that could be used to assist to streamline decision-making and implementation, for example tools available under the Civil Defence and Emergency Management Act or through some modified application of Special Housing or Special Economic Zone mechanisms.

Whichever option is preferred, it will require approvals under the RMA. These will include changes to the District Plan and resource consents.

For changes to a Plan, the RMA requires an evaluation that examines:

- The extent to which the objectives of the proposal achieve the purpose of the RMA
- Whether the proposal is the most appropriate way to achieve those objectives by identifying other reasonably practicable options and assessing the efficiency and effectiveness of the proposals in achieving the objectives

The assessment of efficiency and effectiveness requires benefits and costs of the environmental, economic, social and cultural effects anticipated from the proposal to be identified and assessed. This needs to expressly consider opportunities for economic growth and employment to be provided or reduced. If practicable, benefits and costs are to be quantified. In addition, the assessment must consider the risk of acting or not acting if there is uncertain, or insufficient, information about the subject matter of the provisions. Commencing the Section 32 evaluation process early will ensure the significant and valuable evidence base and stakeholder engagement completed to date is captured. Importantly, it will enable the wider context of the RMA purpose to be brought into further engagement and option development and evaluation.

All applications for resource consents are required to be supported by an Assessment of Effects on the Environment (AEE) that meets the requirements of Schedule 4 of the RMA. The AEE must include assessing proposals against Part 2 of the RMA (purpose and principles) and the objectives and policies of applicable RMA plans. This assessment will provide important regulatory context for further work to develop and evaluate options for Franz Josef. Importantly, the AEE must assess the effects of the activities that the proposed options will involve on the environment, options considered and measures to mitigate adverse effects. The information developed to assess environmental effects should form an important input to further work to develop, refine and evaluate options for Franz Josef.

12.3 Stakeholder engagement

In undertaking detailed stakeholder engagement on the packages presented, and to understand the acceptability of the packages and the options that comprise them, we recommend a structured engagement approach. This should enable stakeholders to provide detailed feedback on each option within the package, and where appropriate, identify alternatives. This allows for amending or refining options, while maintaining the objectives of the overall package.

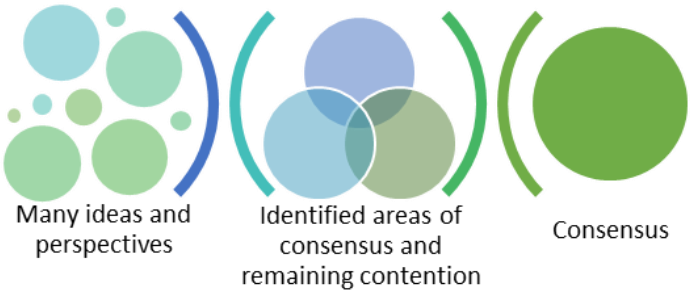
The structured approach would comprise engaging stakeholders to gather feedback on each option within the package, in order to identify components for which:

- The majority of stakeholders are positive
- Some stakeholders are positive and some are negative
- The majority of stakeholders are negative

For those components where there are some, or more, negative perspectives, the engagement would then focus on working with stakeholders to understand the cause of concern. This allows for identification of alternative approaches which would fulfil the intention of the option or package in a different way.

The alternatives can then be presented to stakeholders to again seek further feedback and identify which alternatives are most widely accepted. Some iteration of these steps may be required to continue to identify components viewed positively by stakeholders, and to work through remaining components to consider and address concerns.

Figure 12-1: Conceptual summary of a structural approach to decision-making



12.4 A path forward

Leveraging the governance and engagement frameworks summarised above, we propose an extended period of working with stakeholders to:

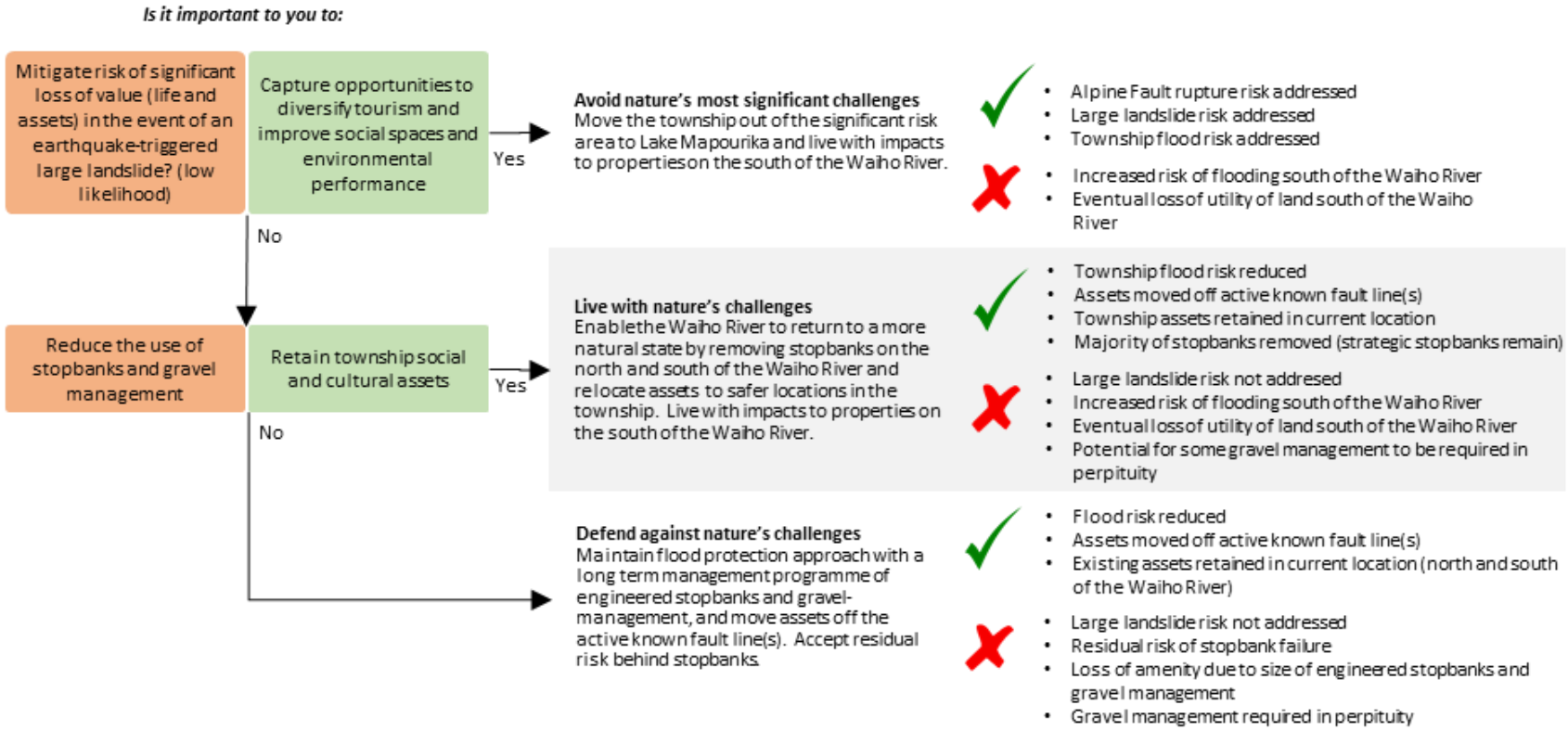
- Communicate the findings of this study to stakeholders, and in particular key elements of the three packages
- Identify representative stakeholders and form a governance group
- Undertake a structured stakeholder engagement approach to identifying and then refining a preferred package

This is a unique opportunity, not only to protect the value at stake in Franz Josef, but to make a decision that would generally be taken after an event has occurred, not before, and agree the 'best way' forward for the township in the context of these very real natural hazard challenges. To assist with communicating the three packages in order to make a decision on a path forward, the three packages are summarised in Figure 12-2 together with key questions in the form of a decision-tree to assist stakeholders in identifying their preferences.

While this study has shone some light on the complexity inherent in addressing natural hazard risk within Franz Josef, there are several important aspects on which decision-makers must form views to guide their own thinking on the preferred path forward. The decision tree (Figure 12-2) is designed to aid in the formation of these views and offers a simplistic, but potential useful, way of navigating a lot of the complexity and gravity of this decision.

It is hoped that this study will form the evidence base needed to progress future decisions about Franz Josef. What is not in question is that any solution must be developed collaboratively. The scale of the value at stake in Franz Josef demonstrates that this is a local, regional and national conversation.

Figure 12-2: Conceptual decision tree to support navigating a path forward



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14 Applicability

This report has been prepared for the exclusive use of our client West Coast Regional Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

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