RiverLink

RiverLink

Notices of Requirement for Designations and Applications for Resource Consent

Volume Two: Assessment of Effects on the Environment

Appendix E

Alternatives Assessment

Appendix E – Detailed assessment of alternatives summary

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1. Introduction

This appendix provides further detail on the process followed by Greater Wellington Regional Council (GW), Waka Kotahi NZ Transport Agency (Waka Kotahi) and Hutt City Council (HCC) in assessing alternatives for the development of the Project (and its individual core components). It is an expanded version of the summary provided at section 7 of the AEE.

1.1 Purpose of this document

This document outlines the process followed by GW, Waka Kotahi and HCC in assessing alternatives for the development of the Project (and its individual core components), in accordance with the RMA provisions relating to the consideration of alternatives for NoRs and resource consent applications, respectively.

When considering the NoRs, in accordance with section 171(1)(b), the decision-maker must have particular regard to:

"whether adequate consideration has been given to alternative sites, routes, or methods of undertaking the work if

(i) the requiring authority does not have an interest in the land sufficient for undertaking the work; or

(ii) it is likely that the work will have a significant adverse effect on the environment."

The words "*have particular regard to*" in section 171 mean that the decision-maker must "*consider the matters to which the subsection refers specifically and separately from the relevant considerations*". The words do not mean "*give effect to*". Accordingly, section 171(1)(b) does not set a 'pass' or 'fail' benchmark, but instead provides one (important) factor to be considered under section 171.

Under section 171(1)(b), the decision-maker evaluates the process followed by the requiring authority in considering alternatives. Importantly, the choice of site, route, or method of the work remains the requiring authority's to make.

While GW, Waka Kotahi and HCC need to consider alternatives in deciding the site or route of the Project, they are not obliged to choose the 'best' option. The policy function of deciding the most suitable option is up to the relevant Project Partner. The focus is on the process not the outcome.

As a starting point for an alternatives process a requiring authority must establish an appropriate range of alternatives for consideration. What will constitute an appropriate range of alternatives is a question of fact that will depend on the circumstances of each case. Key principles outlined by the Courts include that a requiring authority does not need to demonstrate that it has considered all possible alternatives, and in particular, it is not required to eliminate alternatives that are clearly speculative or suppositious.

In addition to the requirement to consider alternatives in respect of NoRs under section 171(1)(b), Clause 4 of Schedule 6 of the RMA applies to resource consent applications. It requires a description of any possible alternative locations or methods for undertaking the activity if it is likely that the activity will result in any significant adverse effect on the environment[1].

Other key aspects of decisions relating to alternatives can be summarised as follows:

- Where there are more significant adverse effects of allowing a requirement, section 171(1)(b) may require a more careful consideration of alternatives (although this will not

[1] An assessment against sections 105 and 107 of the RMA, including a consideration of alternatives, is provided at section 11.5 and 11.6 of the AEE respectively.

necessarily be required in every case). Likewise, the greater the impact on private land, the more careful the assessment of alternative sites not affecting private land will need to be.

- Consideration will not be "*adequate*" when a requiring authority has acted arbitrarily or given only cursory consideration to alternatives. But adequate consideration does not mean exhaustive or meticulous consideration.
- To demonstrate that it has not acted arbitrarily, a requiring authority's process for considering alternatives should be transparent. This should be demonstrated through robust contemporaneous documentation, which clearly explains the methodology used.
- It is more likely that consideration will be found to be adequate (and that the requiring authority did not act arbitrarily) when a structured and systematic process is followed.
- Depending on the circumstances of the case, it may be appropriate for detailed multi-criteria analysis to inform the requiring authority's decision as to the site or route of the work.
- That others may consider there to be a more suitable option is irrelevant.
- A decision-maker is not required to test each alternative against the provisions in Part 2 of the RMA. However, in some cases it may be necessary for a decision-maker to gain access to the weightings in a multi-criteria analysis, to be satisfied that adequate consideration has been given. Considerations inherent in Part 2 should therefore infuse any such multi-criteria process, including any weightings used to apply to scores.
- Late timing of consideration of alternatives can indicate predetermination. That said, section 171(1)(b) does not set a deadline by which alternatives must be considered in order for the consideration of alternatives to be adequate. It is a matter of fact as to whether the consideration of alternatives which occurs comparatively late in the process is adequate.

The section below describes the consideration of alternatives process carried out for the Project. In summary, in selecting the options now proposed for the Project, GW, Waka Kotahi and HCC have carried out a structured, transparent, and systematic process, and which has taken into account a wide range of potential alternatives.

1.2 Background and problem identification

Following the promenade concept articulated in 1987 and the Hutt River Floodplain Management Plan (HRFMP) in 2001, strategic investigations, scoping, scheme assessments, and business case processes were undertaken between 2013 to 2020 which identified the following key problems:

- The existing level of service for flood protection causing flood protection issues within Hutt City
- Existing transport infrastructure having a lack of resilience; and accessibility, efficiency and safety issues at the Melling Intersection on SH2, and
- Difficulty encouraging investment in the Lower Hutt city centre due in part to the above problems resulting in a lack of renewal and regeneration of Lower Hutt's city centre.

1.3 Process summary

Formal identification of the preferred options for all Project components (flood protection, Making Places urban renewal/revitalisation and the Melling Intersection Improvements) has been carried out over a number of years (since 2013) and is the subject of numerous studies. This section collates and summarises these background studies that led to the identification of the need for the Project and its progression through the iterative design process. This process has been highly iterative.

The key steps involved in the alternatives assessment and decision making processes are broadly summarised as follows:

- Review of background studies
- Identification of recommended options as part of the Project development phase
- Incorporation of the recommended options, key outcomes sought and assessed during the preliminary design phase
- Further refinement of the preferred options into the preliminary design phase, and
- Refinement of the preferred option into the consent design phase.

This process sets out the tools used to assess the options, typically being a multi criteria analysis (MCA) framework or assessment criteria application.

2. Evaluation framework and process

2.1 Introduction

MCA is a commonly used tool to guide the assessment of options for infrastructure and other projects. It is a useful tool used to compare and assess alternative proposals or options where there are multiple considerations, and where there are a range of diverse effects which can range from beneficial to potentially adverse. The range of attributes that are relevant to a decision between options can be numerous and varied, and it is important to bring the information together in a consistent, reliable and credible way.

MCA has been a key tool used to provide information and analysis about options considered throughout the development of the RiverLink Project.

The MCA processes used for the Project provided the information gathered through the options process to the relevant decision-maker: in this case, GW, Waka Kotahi and HCC as requiring authorities. That in turn enabled the requiring authorities to make decisions as to the form of their component of the RiverLink Project, in a 'joined up' manner to provide for a cohesive overall Project.

2.2 MCA assessment and evaluation methodology

The assessment methodology has incorporated:

- MCAs to assist in assessing different Project components and options (including the development of Project specific criteria)
- Value for money (construction and operational cost) consideration[2]
- Engagement with stakeholders, affected landowners and the public at various stages of assessment
- Iterative changes to the design as more detail and information was obtained from engagement and technical assessment, with those changes subject to further alternatives analysis as appropriate, and
- Monitoring of the effect of changes to the design against the Project objectives.

Overall, the methodology for all MCA processes used across key phases of the Project involved determining evaluation categories, confirming a rating system and then applying Project specific evaluation criteria and rating each option.

[2] Cost is a matter that can appropriately be considered by the requiring authority, taking into account the analysis and information on effects and outcomes provided through MCA processes.

It is noted that reports prepared prior to 2013 outlined below are summarised for background purposes only, given they developed individual Project components prior to RiverLink emerging as a combined Project. The exception to this is the HRFMP, which undertook a deliberative, robust and detailed alternatives assessment that remains valid, and the conclusions of which have been incorporated into the design of the Project.

3. Pre-project phase (1987-2013)

The concept of a river promenade, which is a key component of RiverLink, was first raised in 1987. A number of investigations, studies, reports and policy documents have supported or been specifically commissioned to understand and resolve the issues facing the city centre and through this, refined the promenade concept. This included the 1987 CBD Structure Plan, the 1999 CBD Master Plan, 2005 Hutt CBD Heart, the 2008 CBD Vision 2030 and the first CBD Making Places long term development strategy in 2009 (all prepared by HCC).

During this early pre-Project phase, the flood management planning was kicked off as well and culminated in the completion of the HRFMP in 2001, focused on flood protection, being another key component of RiverLink.

This period is referred to as the pre-Project phase because various Project elements were envisaged in broad terms, but there was no specific project under detailed consideration to enable consenting and construction processes. Importantly, the HRFMP set key 'baseline' expectations for flood protection, which then guided later Project development.

3.1 CBD Structure Plan - 1987

The HCC's CBD Structure Plan identified opportunities around connecting the city centre to the river, a riverside promenade, potential for mixed use development, a river plain as high amenity landscape, a pedestrian bridge, stronger entrances to the city centre, and a public square by the Dowse Art Museum.

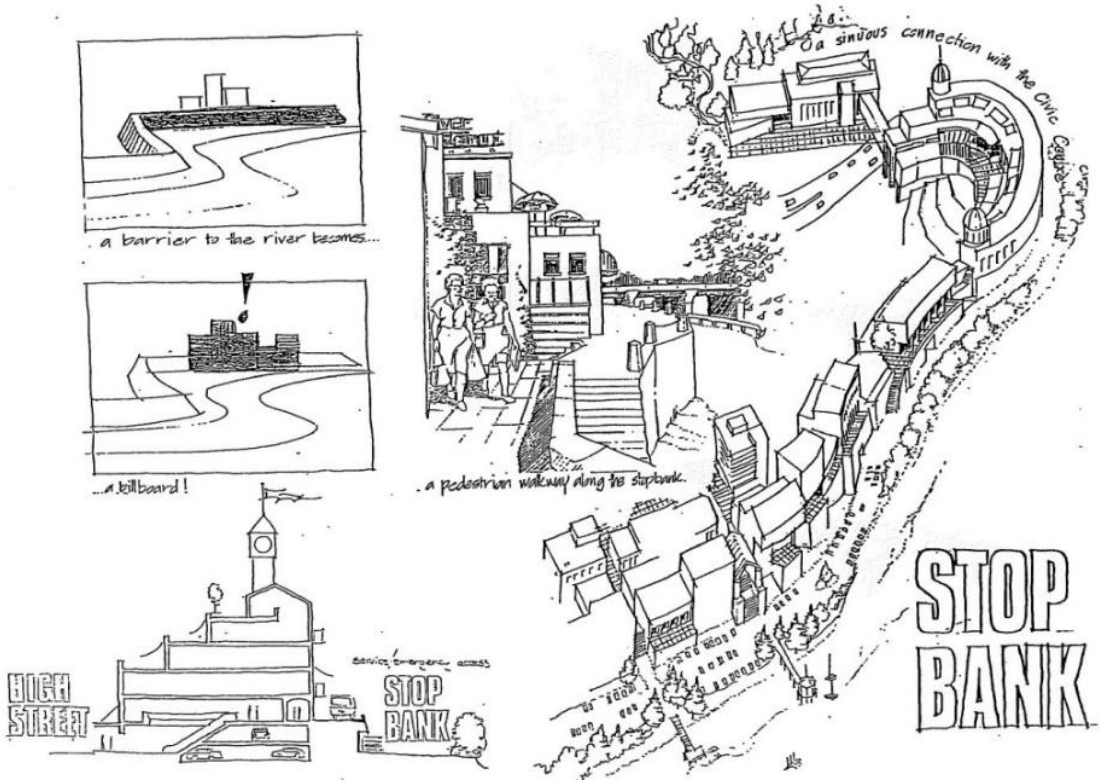


Figure 1 CBD Structure Plan 1987

3.2 CBD Master Plan - 1999

This HCC master plan developed a schedule of street upgrades to ease traffic flow and provide for pedestrian activity and increase access to the river.

3.3 Hutt River Floodplain Management Plan – 2001

The HRFMP (Greater Wellington Regional Council, 2001) was developed over the course of 10 years in conjunction with community groups and organisations in the Hutt Valley and was supported by extensive technical studies (64 reports are listed in the reference list) to improve the community's resilience to flooding. It was adopted by the HCC, Upper Hutt City Council and GW in 2001.

The development and implementation of the HRFMP occurred in five phases. Phase one, completed in November 1996, defined the flood problem, including physical, social, economic and environmental issues. Phase two involved analysing options using an MCA process. Phase three, which concluded June 2000, involved refining and finalising preferred options. Phase four involved the development, refinement following public consultation and finalising of the draft plan. GW, HCC and Upper Hutt City Council adopted the final HRFMP in August 2001. Phase five, from August 2001 onwards, involves the full implementation of the HRFMP.

The HRFMP is a foundation for implementing structural and non-structural measures and an environmental strategy for enhancing the river environment. It has provided a basis for flood improvement works, river management activities, the management of uses in the river corridor, and land use planning policy for RiverLink and the wider Hutt Valley.

The HRFMP provided a detailed assessment of the costs and risks of flooding of Te Awa Kairangi. It established that the level of protection provided by existing stopbanks was mixed; upstream of Kennedy-Good Bridge, with the exception of a few reaches, stopbanks were adequate to contain a 2800 cumec flood; however, reaches downstream of Kennedy-Good Bridge (including the RiverLink Project area) had a much lower capacity and security, with some sections of stopbank that could be breached during an event as small as a 50-year flood.

To achieve the flood protection standards of the HRFMP, a programme of physical works was planned to upgrade the stop banks, river channel and berms within defined sections of Te Awa Kairangi. The floodplain management planning process undertaken in the HRFMP, including the nature of options considered, multi criteria analysis and further evaluation undertaken, is summarised below.

3.3.1 Nature of options considered

A number of structural flood protection options were considered, such as:

- Stopbanks
- Bank edge protection and river realignment
- House raising, and
- Bridge replacement/upgrading.

Non-structural measures deal with the residual risk of flooding by improving community resilience. The non-structural options considered were:

- Land use: through policies and rules in district plans or voluntary actions that deal with constructing buildings and structures, doing earthworks and using land in a wise manner, and
- Emergency management: by preparing the community to cope with flooding.
- An environmental strategy to enhance Te Awa Kairangi's environment.

The HRFMP established an accepted level of protection (or design standard) from floods, which was a risk-based standard with varying protection standards to different areas in the floodplain, depending on how flood-prone they were. The agreed risk-based standard was called the *risk-based 2300 cumec standard* and included, amongst other things:

- A requirement to upgrade all major stopbanks (i.e. those protecting the main urban areas of Lower Hutt & Upper Hutt cities) to a 2800 cumec capacity with all remaining stopbanks to a 2300 cumec capacity
- A requirement for bank-edge and berm protection to a 2300 cumec capacity in main urban areas, with a 1900 cumec capacity for isolated and small urban areas, and
- A requirement for all new bridges and their floodways to pass a 2800 cumec flood.

3.3.2 Multi criteria analysis

Five phases were undertaken to formulate and implement the HRFMP. Phases two and three, which involved analysing options, were completed in June 2000. This included:

- Developing and evaluating design standard options
- Evaluating a broad range of flood management approaches, being environmental strategy, non-structural measures and structural measures, and
- Using social, economic and environmental criteria to evaluate them.

The preferred design standard and implementation measures were selected following public consultation.

Evaluation included initial selection of some (or a combination of) options and used technical, social and environmental databases established in the preceding phase. Factors considered included physical flood conditions, land requirements, costs, benefits and economic efficiency, visual impact, development pressure, and social / community values regarding perceived risk and level of protection.

3.3.3 Further evaluation undertaken

The preferred options were then refined and finalised. Refining the chosen options took into consideration:

- Impacts of works on the environment
- Engineering considerations, and
- Social, economic and environmental benefits.

3.3.4 Findings

GW approved the final design standard, being the risk-based 2300 cumec standard, and the following implementation measures:

- Structural measures including:
    - Upgrades to stopbanks protecting major urban areas to the 2800 cumec standard, and protecting smaller urban areas to the 2300 standard.
    - Bank-edge protection works and major river realignment in the Ava to Ewen Bridge reach.
    - An option to raise houses above the 1900 cumec flood level for residents of Bridge Road-Gemstone Drive (Upper Hutt) and Belmont (Lower Hutt).
    - When bridges reach the end of their useful life, upgrade of the new bridge to the 2800 cumec standard.

- Non-structural measures including:
  - Land use: through policies and rules in district plans or voluntary actions that deal with constructing buildings and structures, doing earthworks and using land in a wise manner.
  - Emergency management: by preparing the community to cope with flooding.
  - An Environmental Strategy that identifies opportunities to enhance Te Awa Kairangi's environment.

The HRFMP identifies a number of reports and publications and sets out what the anticipated results of the plan are in conjunction with the monitoring requirements. The HRFMP is intended to remain a living document.

The process used to reach the above approved flood protection measures was deliberative, robust and detailed. The conclusions and design standards reached in the HRFMP have informed and been incorporated into the design of the RiverLink Project.

3.4 Hutt CBD Heart - 2005

This was a further HCC master planning exercise which confirmed the symbolic importance of connecting the city centre to the River.

3.5 CBD Vision 2030 – 2008

In 2008, HCC released the "CBD Vision 2030" document which identified 6 broad themes for the development of the city centre being liveable, unique, sustainable, connected, growth and quality. This document confirmed the community's vision for the future city centre.

3.6 CBD 'Making Places' 2030 - 2009

In 2009 Council adopted CBD 'Making Places' 2030, as the long-term development strategy for the city centre. The purpose of CBD 'Making Places' 2030 was to transform the city centre by 2030 by creating the foundations for a sustainable, vibrant and buoyant future. A number of public works were identified as being required to give effect to the vision of CBD 'Making Places' 2030, including the RiverLink Project. The riverside promenade connecting the city centre to the River was identified as one of the most important public projects in Making Place as it is fundamental to achieving a strong connection between the River and the city centre.

3.7 RiverLink emerges

Around 2012 was when RiverLink evolved to be a joint Project between GW, Waka Kotahi and HCC. It included achieving flood protection, connecting the city centre to the River through urban development, and a fully integrated multi-modal transport system (that streamlines SH2 movements with good quality public transport and high quality cycling and walking networks).

4. Options considered during RiverLink project development (2013-2016)

This section discusses the options considered within background studies undertaken during the RiverLink Project development phase which commenced in 2013. It was at this time that GW, Waka Kotahi and HCC developed the integrated Project concept (i.e. started to work together to develop and deliver the three interrelated projects as one combined Project). The Project development phase concluded in 2016, since after this time options developed changed from conceptual optioneering to more detailed design options.

4.1 Hutt River City Centre Upgrade Project Options Evaluation Report

The Hutt River City Centre Upgrade Project - Options Evaluation Report (Boffa Miskell, 2015) recorded the findings of an options evaluation process for the river section between the Melling and Ewen Bridges known as the Integrated Concept Design process. This report was prepared for GW, Waka Kotahi and HCC and provided the basis for recommendations to the Hutt Valley Flood Management Subcommittee.

4.1.1 Nature of options considered

The Hutt River City Centre Upgrade Project - Options Evaluation Report examined 10 physical works options, made up of combinations of the following:

- Base flood protection options - six options were considered. In summary, these included physical works that would provide flood resilience improvements by upgrades to river channel width, berm width and stopbank height, as well as Melling Bridge height in order to match the wider corridor and flood capacity up and downstream of the City Centre Section. These physical works were considered as the 'base' physical options, as the primary purpose of these options were to upgrade the level of flood protection. Option 1 was called the maximum option as it provided for maximum flood protection, Options 2 and 3 were medium for medium flood protection, and Options 4 and 5 were minimum for minimum flood protection, and
- "Making places" options - six options were considered. In summary, these options included physical works options that would provide for the making places aims of improved investment opportunities, the development of a river promenade, park and connections, as well as transport design options that would improve the SH2 intersection performance in conjunction with a new bridge or the existing bridge at Melling.

The 10 physical works options are outlined below:

- Maximum 1A: Provides a 90m channel and 50m berm, new Melling Bridge, and capacity for a 1 in 440 year flood to the year 2105, as well as providing for apartments and commercial development to be built adjacent to the river corridor by closing Daly Street and moving traffic to High Street.
- Maximum 1B: Same as 1A except providing for apartment development while retaining Daly Street, by creating an underpass for Daly Street between the new stopbank and new development.
- Medium 2A: Provides a 90m channel, 25m berm, new Melling Bridge and capacity for a 1 in 440 year flood to the year 2105, however less flood secure than the maximum options. Provides for apartment development, maintaining Daly Street by providing an underpass between the new stopbank and new development.
- Medium 2B: Same as 2A except diverts traffic to Dudley/Rutherford Street and removes parking in the river corridor for increased development investment.
- Medium 2C: Same as 2A except diverts traffic to Dudley/Rutherford Street (and as opposed to 2B maintains parking in river corridor).
- Medium 2D: Same flood protection as 2A, but achieves this by widening the river corridor, taking out current commercial land back towards High Street and diverting traffic to Queens Drive.
- Medium 3A: Provides a 90m channel, 0-25m berm, new Melling Bridge and capacity for a 1 in 440 year flood to the year 2105. Provides moderate opportunity for apartments and commercial development abutting the river, diverts traffic to Dudley/Rutherford Street.

- Minimum 4A: Provides a 70m channel, 15m berm, new Melling Bridge and capacity for a 1 in 440 year flood to the year 2045. Provides moderate opportunity for apartments and commercial development abutting the river, diverts traffic to Dudley/Rutherford Street.
- Minimum 5A: Same as 4A except this option provides no opportunity for apartment and commercial development abutting the river, while traffic can be maintained along Daly Street.
- Minimum 5B: Provides a 70m channel, 15m berm, retains the existing Melling Bridge with a widened waterway, providing capacity for a 1 in 200 year flood. This option also provides no development opportunity.

This study also considered:

- Policy options (non-structural options) that would manage land use on the floodplain in conjunction with physical works, or instead of physical works, and
- Staging options to allow for adaptation over time to address changing climate impacts on flood frequency by upgrading when required.

The main purpose of this study was to identify recommended options that GW, Waka Kotahi and HCC could take to the community for formal consultation and feedback.

Options for achieving the Making Places and local road transport objectives were then integrated with the flood resilience 'base' options to create a set of six sub-set options.

The Making Places options were influenced by the opportunities and constraints provided in the base options. For example, in some of the base options, some local roads would become disconnected so that new local road connections would be required. These options also acknowledged the environmental enhancements (i.e. ecological, recreational, open space and amenity) that could be incorporated into the concepts, which was largely a function of the width of the river corridor that would be provided.

4.1.2 Evaluation undertaken

The following methods were used to evaluate the options combining base flood protection, making places, policy and staging options:

- The MCA method (more qualitative than quantitative) was used to allow the relative merits of the Project options to be evaluated
- Cost evaluation through the "value for money" method was used (quantitative) in addition to the MCA process to determine the relative costs of the options as well as the investment versus timing issues, and
- Adaptive pathways being an assessment of the 'use by dates' for the flood protection options when compared to providing the design standard set in the HRFMP.

MCA analysis and cost evaluation

The MCA method was used to evaluate the relative merits of the options. With inputs from the consultant experts, a set of evaluation criteria were developed to consider these options. In summary, the evaluation criteria included:

- Flood resilience
    - river corridor flow
    - channel
    - berm width
    - erosion
    - subsurface infrastructure

    - stop bank
- Movement
    - interface of local roads and SH2 efficiency and safety
    - walking distance to rail station
    - bridge resilience
    - maintaining the city west ring route
- Making places
    - realisable commercial/mixed use development opportunities at the river interface
    - river promenade with active edges
    - walking and cycling river corridor links to the city centre
- Environmental
    - minimising private property take
    - minimisation of social impacts
    - diversity of recreation activities enabled in the river corridor and adjacent spaces
    - ecological diversity on land and in-stream

The process of evaluating the options during the two workshops involved allocating a score of 1-5 for each criteria (i.e. each sub-criteria indicated above), with 1 being the worst performing option against that criteria and 5 being the best (i.e. this determined the relative performance of the options against the criteria). The aim was to use the MCA process to help to determine the relative performance of the options against the criteria. The experts with skills and experience in each of the criteria topics (flood resilience, transport movement, making places and environment) provided a score and these were discussed and tested amongst the workshop attendees. Two workshops were used to first test the workability of the topics and criteria, and to identify any gaps in information, or criteria or topics. The topics were weighted to recognise the relative significance of them, as per below:

- Flood resilience: 65%
- Movement: 5%
- Making Places: 20%
- Environment: 10%

The weightings were also 'sensitivity tested' to ensure that it was understood what the influence of the weighting was on the outcomes.

Value for money was also tested for all of the options. To give some indication of the 'value for money' for each of the options (i.e., what is the optimum point at which sufficient benefits come at an affordable price) the MCA outcome was divided by the cost, noting the calculation of Project costs was based on a very general set of concepts given the early stage of the process.

Adaptive pathways

The "adaptive pathways" evaluation was undertaken by Infometrics and PS Consulting in a separate but directly related report (Infometrics & PS Consulting, 2015). This considered which flood protection option(s) enabled the best match of investment to the uncertainties about the timing and extent of changing flood risks from climate change influences and the value in staging of the options.

The adaptive pathways method was used to determine the 'use by dates' for the flood protection options when compared to providing the design standard set in the HRFMP, this being the point at which the Level of Service provided by the flood defences will fall below the minimum standard in a given climate change scenario.

This analysis indicated that the Level of Service provided by the minimum options (works restricted to the current corridor), would fall below the HRFMP recommended standard by 2045 (assuming the bridge is replaced). Works to maintain the design standard could be carried out and would be effective, but the planning process for this work would likely have to be commenced in about 2035.

The maximum and medium flood protection options would continue to provide the required 'Level of Service' until approximately 2100. However, the maximum and medium options were recognised as being expensive, and requiring significant property purchase.

4.1.3 Findings

The Hutt River City Centre Upgrade Project - Options Evaluation Report indicated the outcome of the topic weighting and confirmed that regardless of which topics were given significance by weighting, the outcomes of the top-ranking options remained the same. The Hutt River City Centre Upgrade Project - Options Evaluation Report recommended that the Hutt Valley Flood Management Subcommittee proceed to consult the community on options 2C and 4A.

The preferred options 2C (also referred to as medium 2C option) and 4A (also referred to as minimum 4A option) are summarised below and demonstrated in Figure 2 and Figure 3.

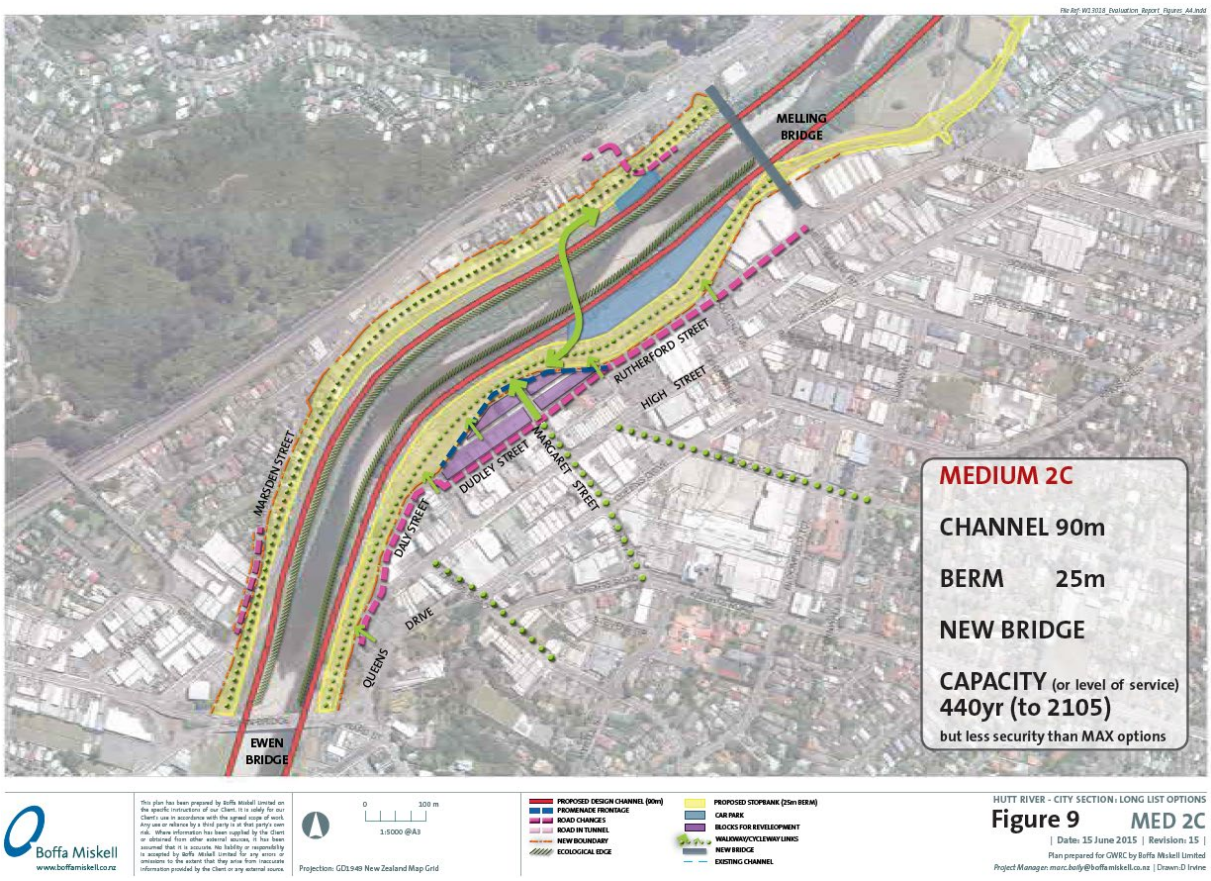


Figure 2 Option 2C, Figure 9 of the Hutt River City Centre Upgrade Project – Options Evaluation Report, 2015

In summary, Option 2C provides moderate opportunity for apartments and commercial development abutting the River. Option 2C could maintain parking in the river corridor and diverts traffic to Dudley/Rutherford Street. A new pedestrian bridge connects pedestrians and cyclists directly to the New Melling Station, refer Figure 2 above.

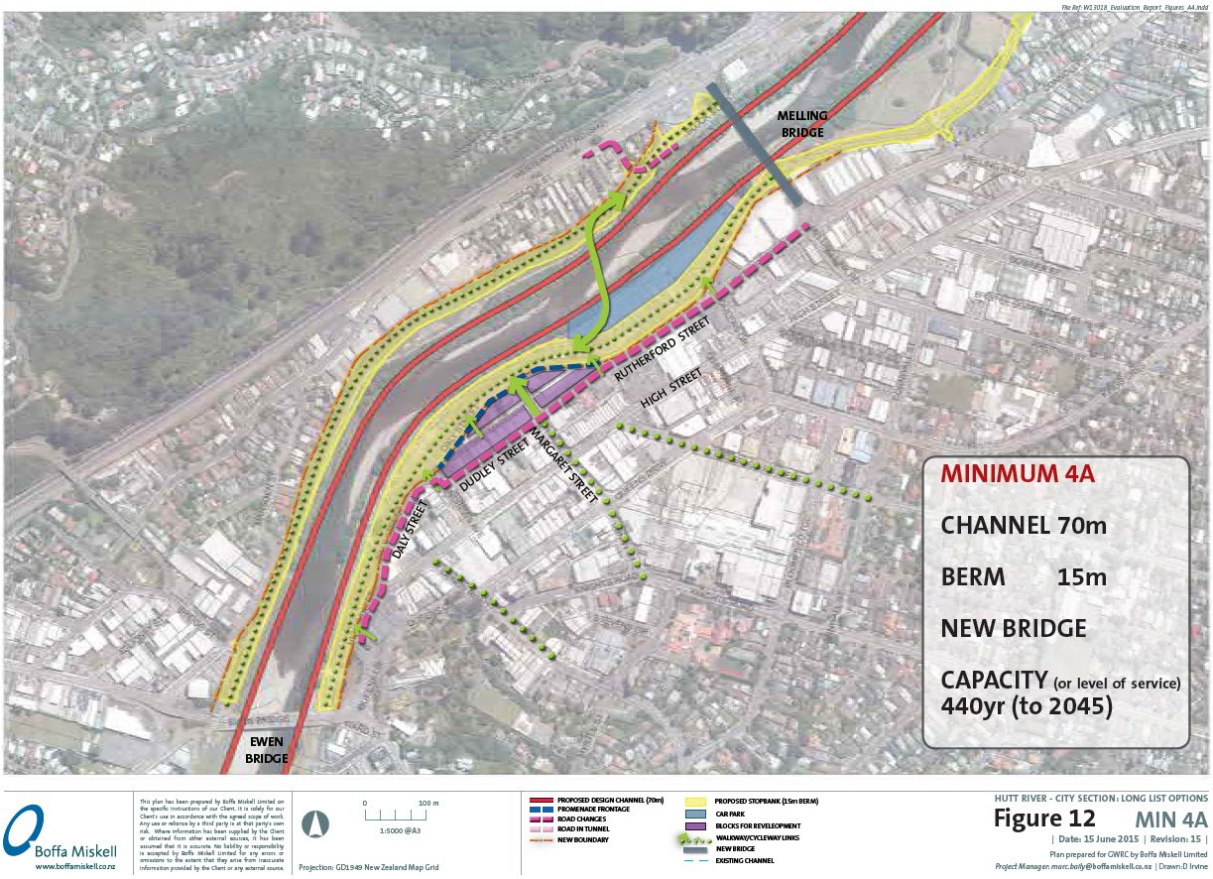


Figure 3 Option 4A, Figure 12 of the Hutt River City Centre Upgrade Project – Options Evaluation Report, 2015

Option 4A provides moderate opportunity for apartments and commercial development abutting the River, while traffic would have to be diverted to Dudley/Rutherford Street. A new pedestrian bridge connects directly to the Melling Station. This option is the same as Option 2C on the city side but does not extend west and therefore has no private property requirement, refer Figure 3 above.

The findings of the Hutt River City Centre Upgrade Project - Options Evaluation Report concluded that options 2C and 4A should proceed to consultation for the following reasons:

- Option 4A provided an improved level of flood protection for a relatively moderate level of cost. It did not require the acquisition of private property which assists to limit the cost, but also the level of social disruption. It enables investment in the city side commercial properties by providing certainty as to the edge of the river corridor and encourages development by physical works including roading changes. The negative aspects of Option 4A was that it provided little flexibility for addressing the need for managing the influences of climate change on flood frequency and magnitude. It was likely that by about 2035 the planning process would need to begin again to upgrade further. On this basis too it implied a requirement for policy that recognised that in the future, additional land may be required to widen the corridor and maintain flood protection from a 2800 cumec flood, and
- Option 2C provided a significantly improved level of flood protection which would provide a longer period of benefits in terms of resilience and long-term planning. It would not induce the same level of consideration as to land use policy responses that option 4A might as the

corridor's extent would be certain for a much longer time. The option also enabled investment in the city side commercial properties by providing certainty as to the edge of the river corridor and could enable an extent of urban amenity improvements by physical works including roading changes. The option requires the acquisition of private property on the west bank of the river which has a greater acquisition cost than option 4A and also generates a higher level of social disruption.

The other structural options (1A, 1B, 3A, 5A, 5B, 6A) were less favoured since they were either very long term options that provided a level of protection well in excess of what was required for some time, but were extremely costly due to property acquisition cost, or other options that were less expensive but provided a lesser level of flood protection over time than the community has identified it seeks.

4.2 Hutt River City Centre Upgrade Project Report to Greater Wellington Regional Council

The purpose of the Hutt River City Centre Upgrade Project Report (Atapattu, 2015a) was to advise GW Councillors about the integrated concept design options for the Hutt River City Centre Project and to seek Council approval to two options (4A and 2C outlined at section 4.1 above) for community consultation.

4.2.1 Nature of options considered

In summary, two options (Options A and B) were considered with two different implementation timeframes. These options were the previously discussed Option 4A and Option 2C described in detail in section 4.1 above. In the report, the immediate implementation of Option 2C was named Option A, and the implementation of Option 4A followed by implementation of Option 2C in 2035 was named Option B.

Option A was shown to provide the best value for money and, because of the relatively short time between completing Option 4A (programmed for 2025) and starting Option 2C (estimated to be 2035), it was more practical to simply commence now with option 2C. The proposed promenade works were to be combined with the Daly Street stopbank upgrade.

The second option (Option B) was to implement Option 4A immediately and then commence implementation of Option 2C in 2035. Option 4A had narrower channel and berm widths but the same promenade arrangements as for Option 2C so it gave certainty for the river corridor/city boundary and allowed the Making Places work to progress.

4.2.2 Findings

The above outcomes (including those outlined at section 4.1) were presented to the workshops of the Hutt Valley Flood Management Subcommittee, HCC and GW's Strategy and Policy Committee in May/June 2015 (Atapattu, 2015a). The report author recommended that GW:

- Note that the Melling Bridge needs replacement to provide the HRFMP recommended standard of protection to the Hutt city centre and the central residential areas
- Note that the Working Group will develop policy options to complement the selected physical works options to provide a high level of flood security to the Hutt city centre and the central residential area, and
- Approve Option '2C' to be called Option A and 'combined 4A progressing to 2C in 2035', called Option B, for community consultation.

4.3 Hutt City Centre Upgrade Project – River Corridor Options Report

The Hutt River City Centre Upgrade Project River Corridor Options Report (Paul & Wallace, 2015) contributes to the technical detail and identification of costs of the flood protection improvement options or the 'base flood protection options' described in section 4.1 above. In this respect, Option 1 of the Hutt River City Centre Upgrade Project Options Evaluation Report (Boffa Miskell, 2015) was also used in this report, which addressed the wider integrated opportunities to the extent that they directly related to the flood protection options considered. To clarify, this options report can be read as a background report to the Hutt River City Centre Upgrade Project Options Evaluation Report summarised at section 4.1, providing more technical detail on the flood protection options.

In summary, Option 1 of the base flood protection options as described in the Hutt River City Centre Upgrade Project Options Evaluation Report is the widest of the options, but still not as wide as the corridor upstream and downstream of the City Centre Section. It would require the largest amount of property acquisition on both the city centre side (along Daly Street and beyond) and the western side (along Pharazyn Street) of the river. This additional space enables an upgrade of channel width (90m wide), wider berms (50m wide) and higher stopbanks. This was the 'maximum' of the options in terms of corridor width and provided the greatest opportunity for adaptation over time. This option also included the replacement of Melling Bridge.

4.3.1 Nature of options considered: flood protection and the Melling Bridge

The five options proposed in The Hutt River City Centre Upgrade Project River Corridor Options Report include flood protection options in the river corridor, increasing waterway capacity at the current Melling Bridge location, with opportunities to integrate urban design development, roading and transport opportunities. This report puts various channel options and features into perspective by describing the core components of a flood protection system and how they relate to the HRFMP design standard. It brought clarity to the extent of private property acquisition and capital expenditure required and set out and evaluated the issues, benefits and disadvantages of the five base flood protection options, acknowledging the early stage of the design process. The five options considered are summarised in Table 1 below.

The Hutt River City Centre Upgrade Project River Corridor Options Report also analysed options available to stakeholders in relation to Melling Bridge, noting that with channel widening, heavy rock linings in the channel and upgraded abutments, the current Melling Bridge hydraulic capacity could be improved to 2,100 cumecs (a 125-year return period event). The report described the desired 2,800 cumec hydraulic capacity at Melling would only be obtained if a new bridge was constructed to meet the hydraulic criteria set out in the HRFMP.

The Hutt River City Centre Upgrade Project River Corridor Options Report described that the joint Project was progressing the investigation of two bridging strategies separately and that further investigation would be required to reach a decision on either of the bridge options.

In summary, the bridge options being considered were:

- Completing river channel and abutment strengthening and extending the life of Melling Bridge by around 30 years (to the end of its service life) thereby deferring construction of a new bridge, and
- Requesting funding support to replace the Melling Bridge concurrent to the flood protection works and achieve the desired level of flood protection.

Table 1 Summary of design characteristics, property requirements and capital expenditure for base flood protection options

Option[3]	Channel width (m)	Flood Defence	Minimum Berm width (m)	Private Properties Required	Channel Capacity (cumecs)		Hydraulics	Flood Security	Landscape, ecological, historical and cultural opportunities	Roading and traffic
					Upgraded Melling Bridge	New Melling Bridge				
1	90	Left and right stopbank meet 2,800 cumecs design standard	50	168	2,100	2,800	-Lowest velocities, turbulence and scour as a result of wider channel -Lowest flood levels -Up to 2.84m/s average velocity	Very High	-Wider corridor, channel and berms would allow development of these opportunities to very high standard -Making Places could be accommodated -High quality visual outcomes	-North Daly Street closed. Traffic to Melling Link via Queens Drive, Laings Road, High Street, Andrews Avenue and Dudley Street -High Street, Andrews Avenue and Margaret Street truncated at stopbank location. -Marsden St reconfigured
2	90	Left and right stopbank meet 2,800 cumecs design standard	25	76	2,100	2,800	-Lower flood levels than Options 4 and 5	High	-Wider corridor, channel and berms would allow development of	-North Daly Street closed. Traffic to Melling Link

[3] All options with the exception of Option 5 assume a full replacement of Melling Bridge, which is required to achieve the stated flood security standard. Option 5 includes an option to either replace Melling Bridge or improve channel conditions. Costs for Melling Bridge replacement have been excluded from this summary table.

Option[3]	Channel width (m)	Flood Defence	Minimum Berm width (m)	Private Properties Required	Channel Capacity (cumecs)		Hydraulics	Flood Security	Landscape, ecological, historical and cultural opportunities	Roading and traffic
					Upgraded Melling Bridge	New Melling Bridge				
							-Up to 3.4m/s average velocity		these opportunities -Making Places could be accommodated -Good potential to develop quality visual appearance	via High Street, Andrews Avenue and Dudley Street -Marsden Street realigned for 175 metres north of Bridge Street.
3	90	-Left stopbank with retaining wall at critical sections -Right bank flood wall -Meets 2,800 cumecs design standard	-25 left - Minimal right	1 (part)	2,100	2,800	Similar flood levels and velocities as Option 2	High	-Flood wall on right bank provided walking path along crest of wall. -Wall would require imaginative finishing treatment to blend into urban environment. -Flood wall does not align with HRFMP environmental policy. With high flood wall, same safety issues as a bridge	-North Daly Street closed. Traffic to Melling Link via High Street, Andrews Avenue and Dudley Street -No roading impacts on right bank.

Option[3]	Channel width (m)	Flood Defence	Minimum Berm width (m)	Private Properties Required	Channel Capacity (cumecs)		Hydraulics	Flood Security	Landscape, ecological, historical and cultural opportunities	Roading and traffic
					Upgraded Melling Bridge	New Melling Bridge				
									-Minimal right bank berm would limit amenity -Making Places could be accommodated -Left bank stopbank could be terraced and permit passive recreation and linkages to the river -Reasonable opportunities for left bank amenity planting and features in corridor -Overall corridor visual appearance average.	
4	70 (90m above Ewen Bridge and below Melling Bridge)	-Left stopbank with retaining wall at critical sections -Right bank dual stopbank/retaining wall with steeper batters (3.5:1) -Meets 2,800 cumecs design standard	15	1 (part)	2,100	2,300	-Narrow channel and corridor would result in high velocities, turbulence and scour creating	-High at 2,300 cumec flow -Low at 2,800 cumec flow	-Narrow channel and berms, smaller right bank stopbank plan area and steep batters limit development of these opportunities	-North Daly Street closed. -Traffic to Melling Link via High Street, Andrews Avenue and

Option[3]	Channel width (m)	Flood Defence	Minimum Berm width (m)	Private Properties Required	Channel Capacity (cumecs)		Hydraulics	Flood Security	Landscape, ecological, historical and cultural opportunities	Roading and traffic
					Upgraded Melling Bridge	New Melling Bridge				
							higher potential for bank edge and berm erosion -Similar hydraulic outcomes to Option 5. Flood levels in a 2800 cumec flow would be up to 350mm higher than for Option 2 -Up to 4m/s average velocity -The higher flood levels and the higher velocities reduce the level of security of the river corridor in a 2,800		-Making Places could be accommodated and left bank stopbank could be terraced to permit passive recreation and linkages to the river -No substantial opportunities for amenity planting and features in corridor -Paths on river berms and onto right bank retaining wall / stopbanks would be limited -Overall visual appearance average	Dudley Street.

Option[3]	Channel width (m)	Flood Defence	Minimum Berm width (m)	Private Properties Required	Channel Capacity (cumecs)		Hydraulics	Flood Security	Landscape, ecological, historical and cultural opportunities	Roading and traffic
					Upgraded Melling Bridge	New Melling Bridge				
							cumec flow.			
5	70 (90m above Ewen Bridge and below Melling Bridge)	Dual section (stopbank/retaining wall) flood defences, on both sides of the river over long sections	15	1 (part)	2,100	2,300	-Highest flood levels -Highest average velocities	-High at 2,300 cumec flow -Low at 2,800 cumec flow	-Narrow channel and berms, smaller stopbank plan area and steep batters would limit development of these opportunities -No substantial opportunities for amenity planting and other features in corridor. -Paths on river berms and onto right bank retaining wall / stopbanks would be limited -overall visual appearance average to low.	-Land used for parallel parking along north Daly Street would be integrated into river corridor -No other impacts.

4.3.2 Evaluation undertaken

The Hutt River City Centre Upgrade Project River Corridor Options Report also presented each of the options as they related to achievement of the flood protection objectives for the Project, noting that overall alignment with objectives would be low without replacement of the Melling Bridge.

The Hutt River City Centre Upgrade Project River Corridor Options Report does not make reference to any specific evaluation process undertaken but does note that reaching a decision on the preferred options will need to focus on cost, risk, economics, affordability and community resilience, knowledge, resilience and acceptance.

4.3.3 Findings

The Hutt River City Centre Upgrade Project River Corridor Options Report did not make any recommendations but noted that the Boffa Miskell Options Evaluation Report (see section 4.1) had recommended two of the five flood protection options for further consideration.

4.4 Melling Gateway Strategic Case

The next Project development workstream to kick off related specifically to the Waka Kotahi component of RiverLink (state highway upgrades), so that this could feed into integrated Project development and decision making which was evolving by around 2014.

The purpose of the Melling Gateway Strategic Case (GHD Limited, 2014), prepared for GW, Waka Kotahi and HCC, was to provide the senior management and governance bodies of the agencies with confidence that a co-ordinated investment in the Melling Gateway would align with their respective strategic priorities and respond to problems in an effective manner.

4.4.1 Nature of options considered

The Melling Gateway Strategic Case outlined the problems and benefits of, and strategic responses to, the Melling Gateway Project, but did not provide separate options or alternatives. Alternatives were later described and assessed during the Programme Business Case (GHD Limited, 2015) (refer to 4.5 of this appendix) and Single Stage Business Case (Stantec, 2019b) refer to 5.14 of this appendix).

Part of the Melling Gateway Strategic Case process involved defining the problem(s) through a facilitated problems workshop held with key stakeholders in July 2014.

4.4.2 Findings

The Melling Gateway Strategic Case documented four strategic responses to address the consequences of the problems confirmed through the strategic case work, in order to deliver the desired benefits, these were:

- Implement flood protection measures aligned with the HRFMP
- Optimise transport network operations with minor infrastructure improvements
- Integrate urban design plans with flood protection and transport network plans, and
- Progressively enhance the transport network with major infrastructure improvements.

In terms of funding, the Melling Gateway Strategic Case identified that each agency needed to develop separate investment activities to progress the strategic responses identified above. Significantly, the Melling Gateway Strategic Case confirmed that the agencies involved (i.e. GW, Waka Kotahi and HCC) agreed that future investment activities need to be coordinated due to the interdependence across the strategic responses.

4.5 Melling Gateway Programme Business Case

The Melling Gateway Programme Business Case (PBC) (GHD Limited, 2015) was a document jointly prepared for GW, Waka Kotahi and HCC. The purpose of the PBC was to:

- Confirm the strategic case for change
- To identify a range of options available to GW, Waka Kotahi and HCC to resolve problems, and
- Achieve Project benefits and to outline a recommended path to achieve these outcomes.

The PBC reports that GW, Waka Kotahi and HCC had been developing their respective Project elements for a number of years, either in collaboration or consultation with the other agencies. In doing so each of the agencies had been through or were in the process of planning for their respective projects and going through option development and assessment stages. The PBC further developed the Integrated Concept Design process led by GW, with support from HCC (refer to sections 4.1 and 4.2 of this Appendix) related to flood mitigation works and some of the Making Places project elements. In relation to the Melling intersection elements, the PBC noted a number of short-, medium- and long-term solutions for the intersection were investigated and a number of options that could be achieved and were supported with positive investment returns were identified. Due to the need for the removal of Melling Bridge for 5 out of the 6 flood protection options, these options were assessed in relation to staging of intersection improvements.

4.5.1 Nature of options considered

The three primary transport concepts considered were:

- Short-term intersection and network improvements with no new bridge (i.e. retaining existing Melling Bridge): Redirecting Melling Link right turn traffic via Block Road with capacity improvements on Block Road
- At-grade connection to State Highway 2 from a new bridge incorporating the redirected Melling Link right turn via Block Road (modified short-term improvements option for a new bridge, and
- Grade separated interchange with a new bridge: Melling Link on an elevated structure over SH2 with the northbound SH2 entry via a loop from Harbour View Road.

The eight programme options, described as scenarios A - H in the PBC, were developed and evaluated in two workshops attended by representatives of GW, Waka Kotahi, HCC and technical experts associated with the Integrated Concept Design process.

- Workshop 1: Scenario (option) development and preliminary assessment
- Workshop 2: Scenario confirmation and detailed assessment

The scenarios were refined during the workshops, assessed against the key success / assessment criteria identified during the Investment Logic Mapping process at the Strategic Case phase being:

1. A connected, resilient and secure floodplain
2. An integrated, resilient, safe and efficient transport network
3. A more liveable Hutt City
4. Enhanced economic growth

The PBC report emphasised that there were three key requirements that needed to be considered in addition to the assessment criteria:

- The option must achieve 1:440-year flood protection

- Traffic and transport requirements would be met in the short, medium and long-term, and
- HCC's Making Places objectives would be achieved in an acceptable timeframe.

4.5.2 Evaluation undertaken

Due to the various Project elements, there were a large number of potential options relating to staging and different packages of Project elements. Those involved recorded that the long list of eight options were suitable for assessment and provided decision makers with sufficient information and variance to adequately assess the options against the assessment criteria. The eight options assessed and their suitability for shortlisting is shown in Table 2.

Table 2 Programme Business Case long list of options and suitability for shortlisting

Option	Description	Shortlisted	Reason
Scenario A: Do Minimum - minimal flood protection and staged network operation improvements	• No new stopbanks works • Network operation/intersection improvements – Interim improvements completed in 2016/17 – Grade Separated Interchange completed by 2029/30 • Connectivity improvements for pedestrians and cyclists on new Melling Bridge, and • Making Places - stopbanks integration works.	No	Not recommended for short-listing as it did not meet the agreed flood protection levels identified in the Hutt River Flood Management Plan.
Scenario B: Partial flood protection and staged network operation improvements	• Channel widening under existing bridge in 2017 • No new stopbanks works • Network operation / intersection improvements – Interim improvements completed in 2016/17 – New Melling Gateway Bridge completed by 2029/30 – Grade separated interchange completed by 2029/30 • Connectivity improvements for pedestrians and cyclist on new Melling Bridge; and • Making Places – stopbanks and new Melling Bridge integration works.	No	Not recommended for short-listing because a significant flood risk would exist until the bridge was replaced in approximately 2029 and so full flood protection would not be achieved.
Scenario C: Delayed full flood protection and delayed transport network improvements	• Flood Protection: – Widening beneath existing bridge completed in 2017 – New Melling Gateway Bridge completed by 2029/30 – Stopbanks between Melling and Ewen Bridges completed by 2029 including land acquisitions • Network operation / intersection improvements – Interim improvements completed in 2016/17 – New Melling Gateway Bridge completed by 2029/30 – Grade Separated Interchange completed by 2029/30 • Connectivity improvements for pedestrians and cyclist on new Melling Bridge, and	No	This option was not recommended for short-listing because a significant flood risk would exist until the bridge is replaced in approximately 2029.

Option	Description	Shortlisted	Reason
	• Making Places – Stopbanks and new Melling Bridge integration works.		
Scenario D: Interim transport network improvements and all major elements in the medium term	• Flood protection – New Melling Gateway Bridge completed by 2023/24 – Stopbanks between Melling and Ewen Bridges completed by 2029 including land acquisitions • Network operation / intersection improvements – Interim improvements completed in 2016/17 – New Melling Gateway Bridge completed by 2023/24 – Grade separated interchange completed by 2023/24 • Connectivity improvements for pedestrians and cyclist on new Melling Bridge and potentially a footbridge across Te Awa Kairangi, and • Making Places – stopbanks and new Melling Bridge integration works.	Yes	Recommended for short-listing because the flood risk is mitigated in the medium term as well as transport network improvements and a return on investment from the interim transport intersection improvements.
Scenario E: No interim transport network improvements and all major elements ASAP	• Flood Protection: – New Melling Gateway Bridge completed by 2019/20 – Stopbanks between Melling and Ewen bridges completed by 2026/27 including land acquisitions • Network operation / intersection improvements: – New Melling Gateway Bridge completed by 2019/20 – Grade separated interchange completed by 2019/20 • Connectivity improvements for pedestrians and cyclist on new Melling Bridge and potentially a footbridge across Te Awa Kairangi, and • Making Places – stopbanks and new Melling Bridge integration works.	Yes	Recommended for short-listing because the full flood mitigation could be achieved in the medium term as well as providing vastly improved connections with State Highway 2. This option had a risk that a coordinated consenting process for all of the works may result in a delay to the delivery of the transport improvements and thus not resolve the issues being experienced at the

Option	Description	Shortlisted	Reason
			State Highway 2 and Melling Link interchange.
Scenario F: Interim transport network improvements, all flood mitigation works in the medium term and delayed Grade Separated Interchange	• Flood protection – New Melling Gateway Bridge completed by 2021/22 – Stopbanks between Melling and Ewen bridges completed by 2026/27 including land acquisitions • Network operation / intersection improvements – Interim improvements completed in 2016/17 – New Melling Gateway Bridge completed by 2021/22 – Grade separated interchange completed by 2028/29 • Connectivity improvements for pedestrians and cyclist on new Melling Bridge and potentially a footbridge across Te Awa Kairangi, and • Making Places – stopbanks and new Melling Bridge integration works.	No	Not recommended for short-listing due to the additional cost to construct the Grade Separated Interchange at State Highway 2 after the completion of the new Melling Bridge; this may also result in significant Level of Service impacts and closure of the bridge for an extended period.
Scenario G: Interim transport network improvements and staged (east then west) flood protection elements and delayed Grade Separated Interchange	• Flood protection – New Melling Gateway Bridge completed by 2021/22 – Stopbanks between Melling and Ewen bridges completed by 2029/30 including land acquisitions • Network operation / intersection improvements – Interim improvements completed in 2016/17 – New Melling Gateway Bridge completed by 2021/22 – Grade separated interchange completed by 2029/20 • Connectivity improvements for pedestrians and cyclist on new Melling Bridge and potentially a footbridge across Te Awa Kairangi; and • Making Places – stopbanks and new Melling Bridge integration works.	No	Not recommended for short-listing due to the additional cost to construct the Grade Separated Interchange at State Highway 2 after the completion of the new Melling Bridge; this may also result in significant Level of Service impacts and closure of the bridge for an extended period.
Scenario H: Interim	• Flood protection – New Melling Gateway Bridge completed by 2026/27	Yes	Recommended for short-listing because the flood risk

Option	Description	Shortlisted	Reason
transport network improvements, delayed flood protection elements and delayed Grade Separated Interchange	– Stopbanks between Melling and Ewen bridges completed by 2030/31 including land acquisitions • Network operation / intersection improvements – Interim improvements completed in 2016/17 – New Melling Gateway Bridge completed by 2026/27 – Grade separated interchange completed by 2026/27 • Connectivity improvements for pedestrians and cyclist on new Melling Bridge and potentially a footbridge across Te Awa Kairangi; and • Making Places – stopbanks and new Melling Bridge integration works.		would be mitigated in the medium term as well as transport network improvements and a return on investment from the interim transport intersection improvements. Whilst flood risk remains this option enabled programme partners to confirm funding, acquire properties and plan effectively for the program of works.

Following evaluation of the short list, the PBC summarised the recommended Scenario E programme against achievement of programme assessment criteria (and by extension the three key problems outlined in the PBC). The findings of this evaluation are summarised in Table 3 below.

Table 3 Comparison of recommended programme against do minimum response

Assessment criteria	Do minimum	Recommended programme (Scenario E)
A connected, resilient and secure floodplain.	Only partial protection against flood risk.	Achieved full flood protection over the medium term (10-15 years).
An integrated, resilient, safe and efficient transport network.	Improved efficiency of transport networks in short term only. Would not achieve required resilience levels.	Achieved long term transport objectives, meeting required levels of integration, resilience, safety and efficiency.
A more liveable Hutt City	.	Provided long term infrastructure to protect the community from major flood events.
Enhanced economic growth.	Minimal support for economic growth.	Provided enabling infrastructure for the city centre redevelopment.

4.5.3 Findings

The PBC concluded that Scenario E provided significant benefits above the existing situation and against many of the other options considered. This was because the programme was achievable for GW, Waka Kotahi and HCC and reflected a collaborative approach to the planning and delivery of the various programme improvements.

4.6 Community feedback on Integrated Concept Design Options September 2015

The Community Feedback on Integrated Concept Design Options is a report prepared by GW to provide an overview on the community feedback received on the Integrated Concept Design options for the Hutt River City Centre Upgrade Project for consideration by the Hutt Valley Flood Management Subcommittee (Atapattu, 2015b). The Integrated Concept Design options are discussed in more detail in sections 4.1 and 4.2 of this appendix.

4.6.1 Nature of options considered

Two options (Option A and Option B: refer to section 4.2 of this appendix) were released for public consultation in July 2015 and feedback from the community was also sought in September 2015.

Options A and B both include building the flood defences on a widened river corridor between Ewen and Melling Bridges and at Mills Street to provide and maintain the HRFMP recommended 440-year flood standard over a long period of time with allowances for the predicted climate change impacts on the flood frequencies.

Option A is a one step process where the flood defence on the wider corridor would be completed in one step. Option B is a staged approach, where the flood defences on the City

Centre side would be constructed to the final standard but the stopbanks and channel widening on the Marsden Street side would be initially constructed within the existing corridor and widened at a later date.

4.6.2 Evaluation undertaken

A total of 279 written responses were received in addition to oral community feedback received by officers at meetings and displays.

Some of the community feedback received in favour of Option A referred to cost efficiencies. The costs were then compared between Option A and B. A comparison of current and discounted total Project costs was undertaken between the two options. A sensitivity check was also undertaken on the discounted costs to address the scenario that predicted climate change might not occur for another 10 years. In terms of discounted costs this showed that Option B costs were higher than Option A, except where land purchase is postponed to 2030s (or 2040s for completion by 2055). The discounted costs were also checked for a different discount rate and the results were similar.

4.6.3 Findings

The written feedback was compiled and analysed and generally confirmed that Option A was the clear preference over Option B. Option A was supported by 74% of the respondents, with 16% of the respondents supporting Option B. Four percent of the respondents suggested other options. These suggestions included an option for taking buildings on Daly Street to widen the river corridor and further raising stopbank levels and gravel extraction. The additional suggestions were largely contained within the options consulted on already.

The feedback results also indicated clear support for the promenade concept, parking spaces and the proposed pedestrian/cycleway bridge. These components were common to both Options A and B. However, some re-work of the works in the river corridor would be necessary under Option B, the two-step process.

Option A was the option endorsed by the (GW and HCC) Hutt Valley Flood Management Subcommittee.

5. Options assessed during preliminary design phase (2017-2019)

This section discusses the options and background reports which were used to develop the preliminary design for the RiverLink Project, during the preliminary design phase. Fourteen reference documents are discussed or referred to in this section in conjunction with the community feedback and consultation received.

It was in this stage that the broad conceptual Project components established above were developed in further detail to prepare preliminary designs for each component (i.e. broadly confirm river channel and stopbank design, state highway interchange design and new Melling Bridge alignment, and urban development interface with the river). This stage concluded once preliminary designs were established for each Project component and before consent design commenced.

5.1 Riverside Promenade Business Case – Building the Future

The Riverside Promenade Business Case – Building the Future (Hutt City Council, 2020) aimed to provide a better understanding of the economic impacts of developing the promenade to support decision making regarding the preferred option for the design and development of the promenade to achieve desired outcomes.

5.1.1 Nature of options considered

A summary of the promenade development options considered within the Riverside Promenade Business Case is presented in Table 4 below.

Table 4 Promenade development options

Option	Description
Counterfactual	The Counterfactual Option was the least amount of development possible and limited the work to construction of a retaining wall at the exterior side of the stopbank in Stage 1 and 2. This would guarantee that HCC would have the option to develop a service tunnel connecting the stopbank to the adjacent properties (to be called "the tunnel" hereinafter) at a later date. The only impact considered in this option was its construction impact as there was no financial return to HCC as a result of building the retaining wall. This option was named Counterfactual because of the low likelihood of HCC and the community supporting the building of such a retaining wall without further improvements of the stopbank, connections and nearby streets because there were no benefits associated with the retaining wall on its own.
Stage 1	Stage 1 reflected the promenade being constructed adjacent to the stopbank between Margaret St. and Andrew's Ave. Stage 1 was the most complex and costly stage due to its significance and connection with key promenade features. The Daly Street tunnel, two large ramps towards the city, changes to the configuration of Dudley Street, and improved intersections and walkways towards the centre of the city were included in the proposed Stage 1 preliminary design. Stage 1 was close to existing central city development and a good walking distance from Queensgate shopping centre. Improved connection between the promenade and these established points of interest was seen as likely to encourage private sector development.
Stage 2	Stage 2 reflected the area further south of Stage 1 towards Ewen Bridge. This was to be a wider and longer area. The total cost was significantly less than Stage 1 because there were none of the expensive features of Stage 1, such as the service tunnel or large ramps. However more investment in pavement, design features, public art and safety aspects was required as a result of the larger footprint.
Stage 3	Stage 3 presented the area from Margaret Street north to Melling Bridge. The cost estimation for Stage 3 only covered stopbank improvements. The report noted the urban design team was working with GW to evaluate the possibility of using a portion of current riverbank to expand the promenade and offer a more exciting Stage 3. Stage 3 construction would be likely to start a few years after the Stage 2 due to budget constraints and development limitations. The economic impacts of Stage 3 have therefore been assessed on the basis that Stages 1 and 2 have been completed.
Stage 2X	Stage 2X reflects extending the Stage 1 tunnel into Stage 2 which would connect all Daly Street buildings to the promenade. As the exact location and size of the tunnel and its upper and lower ends were yet to be determined at the time of the report uncertainty around the estimated cost of this stage was higher than the other parts of the Project.
Stage 1 and 2 concurrently	This option presented the promotion of private sector activity through development of Stage 1 and 2 at the same time. For the purposes of the evaluation the development cost of doing the two stages concurrently was not estimated to be significantly different than doing the stages one after the other.

Option	Description
Pedestrian and cycle bridge	The promenade at its most comprehensive included providing pedestrians and cyclists with an improved access to the existing public transit facility at Melling Station. The report noted the location of the pedestrian bridge was indicative as the optimum shape and location of the pedestrian and cycling bridge would be dependent on the location of a new Melling Station and changes to the Melling Bridge and new Melling interchange. As a result the report noted pedestrian and cycle bridge cost estimates were based on limited information due to these unknowns.

5.1.2 Evaluation undertaken

The report used both qualitative and quantitative methods to determine the benefits and the preferred design and configuration of the promenade. The qualitative and quantitative assessment methods are described below.

Qualitative methods

- A workshop open to the public, and
- A survey through "Citizen's Panel"; this included a survey on the value residents across the city placed on the proposed promenade, and whether, and to what extent, they would be willing to pay for the promenade development. The results suggested that the Project was strongly supported by residents and that they understood the benefits of the Project.

The results of the qualitative surveys were used to inform the quantitative results associated with the development of the promenade such as return on investment.

Quantitative methods

The quantitative benefits were reviewed through an economic impact assessment that explored the costs and benefits of various options. The purpose of the assessment was to identify the optimum scale of the promenade development and the required level of investment from HCC.

An economic impact assessment of each of the seven options described above and how they impacted potential future private developments was undertaken. The assessment included the analysis of:

- Residential and commercial development
- Construction impact
- New jobs created
- Property value increases due to improved amenity
- New residents' expenditure, and
- Visitors' expenditure.

The results were modelled on the basis of medium growth, aspirational growth and low growth scenarios. The Riverside Promenade Business Case report concluded that the highest direct and total impact, compared to the capital expenditure, would come from implementing Stage 1 and 2 concurrently because of the high construction expenditure; the significant majority of this expenditure was for Stage 1 construction. However, on the other side of the equation, construction of Stage 1 and 2 concurrently was assessed to also result in the greatest amount of economic stimulation and creation of new residences and jobs. The creation of Stages 1 and 2 concurrently also had the greatest positive impact on property values when compared to Stages 1 and 2 being constructed separately. The Riverside Promenade Business Case report ultimately assessed developing Stage 1 and 2 concurrently as the option with the highest return on investment for HCC.

5.1.3 Findings

The Riverside Promenade Business Case report concluded that, if Stages 1 and 2 were completed at the same time, impacts on investment could be more pronounced as it would be unlikely that the small area in Stage 1 would (on its own) attract a significant number of visitors or investors because of the inconveniences that potential construction in the future Stage 2 would create. The impact of staggered construction on logistics (separate contractors at different Project stages), and neighbours and nearby businesses through disruption from construction activity at two (or more) different stages was also acknowledged.

In conclusion, the report summarised that given the budget limitations of HCC for the promenade project, HCC should focus on concentrating efforts on construction of Stages 1, 2 and the pedestrian and cycling bridge. This conclusion was supported by the results of the economic impact assessment and the survey results. The opportunity for extending the development into Stage 3 was recommended for consideration in the future.

5.2 RiverLink Daly Street Interface Structures Design Statement

The RiverLink Daly St Interface Structures Design Statement (Beca Limited, 2017) described the options considered for construction of the structures that would interface with Daly Street and the river corridor.

The RiverLink Daly St Interface Structures Design Statement describes the Daly Street interface structure would be constructed along the edge of the new stop bank between the junctions of Daly Street with High Street and Margaret Street. The report estimated that the interface would comprise a new 390 m long wall structure to support the eastern edge of the stop bank to allow a service lane to be accommodated between the stop bank and adjacent development. The report assumed that a promenade would be provided along the top of the stop bank which would extend to the adjacent development on an elevated structure that spanned over the service lane.

5.2.1 Nature of options considered

The RiverLink Daly St Interface Structures Design Statement presented four design concepts that were considered for the interface structures. These included:

- Option 1 - a Mechanically Stabilised Earth (MSE) retaining wall supporting a precast slab over the service road and supported by a beam and piled column arrangement adjacent to the development. Ground improvement would be required below the MSE wall to limit vertical and lateral movements due to liquefaction of the soil
- Option 2 - a MSE retaining wall with wrap-around geogrid and separate precast facing panels supporting a precast slab over the service road and supported by a beam and piled column arrangement adjacent to the development. The MSE wall would be allowed to move under seismic loads below the slab to reduce the amount of ground improvement required
- Option 3 - a piled box culvert structure forming the service road, and
- Option 4 - a contiguous pile concrete wall with soil anchors to the gravels below and supporting a precast slab over the service road and supported by a beam and column arrangement adjacent to the development. Precast facing panels would be provided to the piled wall.

The RiverLink Daly St Interface Structures Design Statement described an additional option, raising the stop bank level by 900 mm to achieve the required vertical clearance at the service tunnel, which had been considered but rejected early in the design process as it would increase the visual impact, land requirements and cost of the stop bank.

Because the position and type of development that may occur on the land to the east of Daly Street was not known, the report assumed that the adjacent development would be independent of the interface structure and that any development would be designed to take account of the interface structures.

5.2.2 Evaluation undertaken

The selection of an option for the Daly Street interface structure took account of the following factors:

- Structural performance including seismic resilience
- Indicative cost
- Effect on adjacent development, and
- Buildability in relation to the stop-banks.

5.2.3 Findings

Assessment of the factors identified indicated that Option 1 was the preferred option for the preliminary design stage due to its structural performance and minimal impact on the proposed adjacent development on Daly Street. The RiverLink Daly St Interface Structures Design Statement noted Option 2 could also be feasible subject to a more detailed assessment of the expected ground movements if no ground improvement was provided below the MSE wall, although it would be likely that these movements would be excessive and would affect the adjacent development. Options 3 and 4 were not preferred because of their high cost and constructability concerns.

The RiverLink Daly St Interface Structures Design Statement noted other options from a value engineering process that could also be investigated further in the next design phase. These were:

- Reducing the width of the service lane to that required only for visual inspection of the MSE wall with any future repairs being carried out from promenade level, and
- Constructing the stop banks without the MSE wall and promenade structure as a first stage with the promenade being constructed later as part of the adjacent development. The promenade would then be supported on piles through the stop bank so that the MSE wall and service lane would not be required.

A cross-section of the preferred option (Option 1) was provided in the RiverLink Daly St Interface Structures Design Statement. This plan showed an indicative arrangement of the preferred MSE wall and promenade structure.

5.3 RiverLink Project and Hutt City Council Stormwater, Wastewater and Water Services Preliminary Design Report

The RiverLink Project and HCC Stormwater, Wastewater and Water Services Preliminary Design Report (GHD Limited, 2017) assessed the impact the relocation of the stopbanks into areas of legal road along Daly Street, lower High Street, Marsden Street and Mills Street and the implications that would have on the existing HCC services in these streets (including those managed by Wellington Water Ltd on behalf of HCC).

5.3.1 Nature of options considered

The report also investigated opportunities for efficiencies to upgrade existing services and infrastructure where required because of growth predictions or assets that were approaching end of service life. The RiverLink Project and HCC Stormwater, Wastewater and Water Services Preliminary Design Report discussed in further detail options at four locations (Marsden Street, High Street, Rutherford Street and Melling Road).

5.3.2 Evaluation undertaken

This RiverLink Project and Hutt City Council Stormwater, Wastewater and Water Services Preliminary Design Report summarised the investigations carried out, the impacts and possible upgrading of the services, and noted issues that would need to be addressed as part of the final design process.

The report identified that the stopbank footprint would require consideration of relocation of existing pump stations and associated infrastructure at the following locations:

- Marsden Street
- Daly Street (Margaret Street to Andrews Avenue) closure
- Daly Street (Andrews Avenue to High Street) closure, and
- Mills Street termination point.

Possible new pump stations sites were also indicated at the following locations:

- Marsden Street (Outlet 23)
- Southern end of High Street (Outlet 24)
- Rutherford Street (Outlet 35), and
- Melling Road (Outlet 40).

5.3.3 Findings

The RiverLink Project and Hutt City Council Stormwater, Wastewater and Water Services Preliminary Design Report states that for all potential future pump stations a preliminary assessment was carried out to determine likely footprints, pump selection/arrangements and pump outlet pipe discharge diameters, but that further detailed analysis during the detailed design stage would be required to determine all requirements for the pump stations.

5.4 RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report

The RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report (Boffa Miskell Limited, 2018), prepared for GW, Waka Kotahi and HCC, presented the preliminary design for the landscape works as part of RiverLink. It built on the agreed river channel design and focused on the interface between the river corridor and the urban environment of Lower Hutt city centre. The report addressed three key design elements, as summarised in Table 5 below.

Table 5 Design elements

Design element	Description
Landscape Design	Vegetation, River Corridor Access, Recreation, Paths, River Edge, Land Form, Art, Furniture, Signage + Lighting
Ecology	Wetlands, Terrestrial Habitat, and Aquatic Habitat
Urban Design	City Edge Promenade + Park, Street Spaces, Pedestrian/Cycle Bridge, Interfaces and Westside.

5.4.1 Nature of options considered

The RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report presented an indicative design for landscape architecture, urban design and ecology for the flood protection and Making Places elements of the RiverLink Project. It recorded the design parameters, design context and influences (including strategic documents and policy) and options considered for some discrete Project elements including:

- Connection options
- Pedestrian bridge options, and
- Options for future development of residual land on Pharazyn Street.

For some of the design elements, the report did not document the iterations considered in the design process.

Connection options

The report presented several design approaches considered to determine the preliminary design for access to the river, especially from the main city interfaces of Andrews Street and Margaret Street where the majority of people were expected to gain access to the river edge. The interface connection structures considered were stairs, ramps or stairs, mechanical accesses such a s lifts and escalators and stop bank cut throughs.

Pedestrian bridge

The RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report described that many potential options for the structural design of a pedestrian bridge were explored over the course of the Project. The key design parameters considered were flood capacity, ability to connect to the promenade with minimal additional ramping and cost, and the user experience of the pedestrian bridge – the visual and experiential quality and appropriateness of the bridge to the river context. In summary, the bridge options considered were:

- A single span variable depth arch bridge
- A three span variable depth bridge
- A four span bridge or variable constant depth
- An asymmetric two span bridge
- A three span suspension bridge
- A four span truss bridge, and
- A single span arch bridge

Development of residual land on Pharazyn Street side

The RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report described there could be opportunities to sell (recognising any constraints of the Public Works Act) the land on the Pharazyn Street of the river post-construction of RiverLink. In addition to the property acquired for the Project, the report described land which is currently Pharazyn Street legal road could be added to the residual land to create a development block.

The report presented a sketch of two potential options for the development block, these had variations in apartment and carpark numbers.

The report also presented that a parking building to provide 110 car parks across three-storeys had been considered as an option to supplement any parking short-falls.

5.4.2 Evaluation undertaken

The RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report outlined that using a simple un-weighted MCA process the design team selected a preferred option for the pedestrian bridge to take forward to further concept design. The criteria adopted in the MCA were:

- Pedestrian bridge experience for users – views of the river and linear park
- Flood capacity – impact on the waterway capacity
- Accessibility/levels – at each of the bridge, height above stop-bank and ramps required
- Cost - based on relative order of cost for each option, and
- Formal appropriateness – suitability for the location.

5.4.3 Further evaluation

Out of the seven options identified for the pedestrian bridge four options were identified by the design team as appropriate for further examination. These were:

- Option 2 - A three span bridge of variable depth and two piers located outside the main river channel
- Option 3 - A four span bridge of variable or constant depth with two piers located outside the main river channel and one within it
- Option 4 - An asymmetric two span cable stay bridge with a single column located on the west side of the river channel with a 50m high back-leaning mast which would support the deck weight without back cables being required, and
- Option 5 - A three span suspension bridge with V-shaped piers located outside the main river channel.

5.4.4 Findings

The RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report concluded that following evaluation the design team found Option 3, the four-span bridge, to be the most appropriate pedestrian bridge option for this environment. There was no decision as to the retention or type of development of the west side land on Pharazyn Street at the time of the report.

The RiverLink Preliminary Design Landscape Architecture, Urban Design and Ecological Design Technical Report did not make any recommendations or draw any conclusions as to the most appropriate city side connection option.

5.5 Preliminary Concept Design Technical Report RiverLink Transport Assessment

The RiverLink Preliminary Concept Design Transport Assessment (GHD Limited, 2018), prepared for GW, summarised the transport implications as a result of RiverLink stopbank improvements.

The purpose of the RiverLink Preliminary Concept Design Transport Assessment was to:

- Assess the potential Daly Street closure scenarios resulting from stopbank improvements and the impacts and opportunities on the road network
- Assess implementation of the Eastern Access Route as a mitigation measure, and
- Assess and develop concepts for mitigating the potential impacts on Marsden Street from stopbank alignment options.

5.5.1 Nature of options considered

The RiverLink Preliminary Concept Design Transport Assessment considered options in relation to two components, the Hutt city centre transport network on the eastern side of the river and the local road network on the western side of the river.

5.5.2 Hutt city centre network – eastern side of river

The implications of either partially or completely closing Daly Street as a western access route (changing function to a service lane), were assessed. The following options for the configuration of Daly Street were considered:

- Southbound one-way service lane
- Northbound one-way service lane
- Two-way service lane, and
- Complete closure of Daly Street.

Concept mitigation options to cater for redistributed traffic movements around the network and potential road space reductions along Daly Street were considered for potential Daly Street closures. All concepts considered Dudley Street reconfigured to two-way to discourage use of High Street. The options considered included:

- Consideration of reconfiguring Dudley Street to a two-way corridor in combination with lower High Street alterations
- Provision of the “eastern access route” and improved connection from Ewen Bridge to Marsden Street, and
- Retention of Marsden Street to encourage use as an alternative route in the form of a “western ring route”.

5.5.3 Local road network – western side of river

RiverLink was also expected to require a larger stopbank footprint on the western side of the river, so this increased stopbank footprint would affect Marsden Street, requiring either closure or realignment (with associated property acquisition). The following options for the configuration of Marsden Street were considered:

- Retain existing configuration (realigned)
- One-way service lane, southbound
- One-way service lane, northbound
- Two-way service lane
- Two-way relocated road, and
- Closure of Marsden Street (southern section).

5.5.4 Evaluation undertaken

In order to assess the impacts and opportunities of the options for traffic under the Project, three stages of modelling were undertaken, these are summarised below.

Stage A investigated reducing conflict between through traffic and the high activity land use in the Lower Hutt city centre. Stage A modelling considered the resulting traffic redistribution from closure of Daly Street required for the stopbank footprint.

Stage B investigated the effects of relocation of traffic that was previously using the Daly Street corridor to access the Lower Hutt city centre, and how the parallel routes could potentially facilitate these movements. Two alternative Melling bridge locations were considered, either connecting at Queens Drive or connecting at Melling Link (near the existing location).

Stage C investigated the impacts identified in prior stages and the influence of the inclusion of the historic proposals for the "eastern access route" as a mitigation measure. These were considered with connections to the existing bridge location at Melling Link or at Queens Drive.

5.5.5 Further evaluation

The report noted an increased stopbank footprint on the eastern side of the river would affect the form and function of the city centre local road network. It stated that complete closure of Daly Street was the most likely outcome, given the stopbank footprint would need to extend into the road corridor, and that modelling demonstrated partially closing Daly Street would result in similar impacts. The implications of closing Daly Street as a "western access route" (changing function to a service lane), were assessed and determined there would be redistribution of through traffic to High Street and to the western side of Te Awa Kairangi (Pharazyn Street and Marsden Street). The RiverLink Preliminary Concept Design Transport Assessment report described that considering HCC aspirations to retain High Street for amenity and 'sense of place' function, redistribution of through traffic via High Street was not an appropriate outcome.

The report recommended consideration at future stages to the:

- Form and function of lower (southern) High Street between Daly Street and Andrews Avenue
- Dudley Street two-way configuration in combination with streetscape aspirations
- Andrews Avenue intersection configuration to encourage Dudley Street over High Street, and
- Eastern access route connection with the Melling Bridge location confirmation.

Supported by high-level redistribution modelling and consideration of alternative Marsden Street options, the report recommended that Marsden Street be maintained as a two-way road with similar configuration. The combination of the closure of Daly Street and Marsden Street indicated a significant redistribution of traffic to Pharazyn Street and through the city centre along High Street – both of which were considered undesirable alternative routes. With the local road network implications in the city centre, retention of Marsden Street was considered critical to retain a functional "western ring route". The retention of Marsden Street was also considered necessary to mitigate the loss of the Daly Street "western access route". This recommendation has been followed through to consent design, which proposes a reconfigured two-way Marsden Street.

The report noted further consideration would need to be given to:

- The constrained area near the Marsden Street and Bridge Street intersection
- Appropriate realignment and design criteria for Marsden Street, and
- Opportunities to improve the connection from Ewen Bridge to Marsden Street.

5.5.6 Findings

The report concluded that modelling of the different scenarios or options demonstrated:

- If Marsden Street was closed to accommodate the new stopbank footprint (in absence of a realigned road), traffic would redistribute to the eastern side of the river through the city centre
- If Daly Street was fully or partially closed (and Marsden Street retained), traffic would transfer to the western side of the river

- If both Marsden and Daly Street were closed, then overall there was predicted to be an increase in traffic on the eastern side of the river through the city centre
- The effects of closing Daly Street could be partly mitigated through the provision of two-way movements on Dudley Street
- If Daly Street was fully closed, making Dudley Street two way would partially mitigate the effects, however the flow on southern High Street would increase to a level that would require the street layout to be amended. The intersection of Andrews Avenue and High Street would also potentially need reconfiguration to encourage use of Andrews Avenue over High Street
- Altering the intersection control on the "eastern access route" would not mitigate the effects of a Daly Street closure alone

5.6 RiverLink Preliminary Design Report for Stopbanks

The RiverLink Preliminary Design Technical Report for Stopbanks (Opus Limited, 2018) records indicative earthworks quantities and sources, and the design parameters considered when designing the stopbanks. The report also includes preliminary design of retaining walls (excluding the proposed MSE retaining wall and service tunnel at Daly Street described in section 5.2 above), at locations where there would be space constraints, and ramps that provide access over the stopbanks between the city and the river.

The report describes that retaining walls would be required where the stopbank footprint would be restricted due to space constraints. This was expected to be where the stopbanks abutted residential properties and roads to avoid or otherwise minimise the encroachment of stopbank batters on private property and local roads. Services relocation was also addressed within the report.

5.6.1 Nature of options considered

The RiverLink Preliminary Design Technical Report for Stopbanks identified several retaining wall options which would be suitable for reinforcing the RiverLink stopbanks.

The following wall options were considered:

- Option 1: MSE with a vegetated wall face which employs geosynthetic (geogrid or geotextile) reinforcement connected to a prefabricated steel mesh to create a reinforced soil mass
- Option 2: MSE wall with a hard face (such as rock fill, gabion or concrete panels)
- Option 3: Timber pole wall, and
- Option 4: Reinforced concrete wall.

5.6.2 Evaluation undertaken

An assessment of the advantages and disadvantages of the retaining wall options is presented in Table 6 below.

Table 6 Advantages and disadvantages of retaining wall options

Option	Advantages	Disadvantages
Option 1: MSE wall with vegetated face	• Wall is flexible and can accommodate some seismic displacement. • Simple to construct	• Mowing will be required for the sub-vertical green vegetated facing. • Wire mesh is susceptible to corrosion.

Option	Advantages	Disadvantages
	• The rocks used for the facing are natural to the environment. • Less labour-intensive than MSE wall with hard facing.	• Some deformations and bulging of wall face may show a few years after construction. • Requires base width relative to wall height.
Option 2: MSE wall with hard face	• Wall is flexible and can accommodate some seismic displacement. • Low maintenance – no mowing required. • Simple to construct. • The rocks used for the facing are natural to the environment.	• Some deformations and bulging of wall face may show a few years after construction. • Requires base width relative to wall height. • Wire mesh is susceptible to corrosion. • Rock-filled facing is labour intensive.
Option 3: Timber pole wall	• Stiff wall system allows some displacement. • Intermediate performance between flexible and rigid wall. • Quick and easy to construct. • No long-term settlement / bulging and corrosion issues as for MSE walls. • Low maintenance. • Timber is natural to the environment.	• Durability – the design life of timber pole wall is typically 50 years, compared to the 100-year design life of the new stopbank. • Cantilever pole wall is limited to low wall height. • May require tieback anchors for wall heights more than 2m. • Requires substantial pile embedment if poor material is encountered.
Option 4: Reinforced concrete wall	• Durable in many environments. • Undergo less lateral displacement. • Less maintenance. • Concrete can meet aesthetic requirements.	• Semi-rigid wall which performs not as good as the other wall types in an earthquake. • Costs more than other walls. • Deep foundation support or ground improvement may be necessary if founded on weak or marginal soils.

5.6.3 Further evaluation

Only one option was considered in relation to the relocation of network utility services as a result of the stopbank design. Cost estimates were calculated from estimates provided by the individual service providers. Assumptions, risk and actions were also applied to cost estimates. Cost savings were also explored with relocating the utility services within the same trench and the effect of this on the overall cost.

5.6.4 Findings

No preferred wall was selected at this time, rather, the report noted that site investigations and geotechnical assessment should be carried out at each wall site during the detailed design stage and the most appropriate type of wall could be determined at this time. The RiverLink

Preliminary Design Technical Report for Stopbanks concluded that locating all the services into a single trench has the potential to reduce the costs by 50%.

5.7 DamWatch RiverLink Riverworks Preliminary Design Report

The RiverLink Riverworks Preliminary Design Report (Damwatch Engineering Limited, 2018), prepared for GW, pulled together the evaluation of a number of different technical assessments and reports to present a preliminary design for the river works and river channel design elements of RiverLink. The RiverLink Riverworks Preliminary Design Report included consideration of the following specialist fields and reports:

- River channel design - carried out by G & E Williams Consultants and is recorded in the River Channel Design Assessment of Options and Preliminary Design Report (G & E Williams Consultants and Christensen Consulting Limited, 2018)
- Sediment transport modelling - carried out by DHI (Graham Mackie) in the RiverLink, Riverworks Preliminary Design, Modelling Bed Level Changes of the Hutt River report (DHI Limited, 2017a)
- Hydraulic modelling - carried out by DHI (Philip Wallace) in the RiverLink, Riverworks Preliminary Design, Hydraulic Modelling report (DHI Limited, 2017b), and
- Channel alignment selection - a MCA process was adopted to select a preferred channel alignment from two options developed in the river channel design. The alignment selection process was designed by Damwatch and facilitated by GW, on behalf of RiverLink. This is recorded in the Riverworks Preliminary Design, Channel Alignment, Options 1 and 2 Selection Process (Polvere, 2018).

The most relevant reports discussed in the RiverLink, Riverworks Preliminary Design Report, prepared by Damwatch considered the analysis of options, and subsequently presented to stakeholders were:

- RiverLink Project, River Channel Design, Assessment of Options and Preliminary Design Report (G & E Williams Consultants and Christensen Consulting Limited, 2018), and
- RiverLink, River Channel Design, Channel Alignment, Options 1 and 2: MCA Selection Process (Polvere, 2018)

The RiverLink Project, River Channel Design Assessment of Options and Preliminary Design Report is discussed further in section 5.8 of this appendix and the RiverLink, River Channel Design, Channel Alignment, Options 1 and 2: MCA Selection Process report is discussed in section 5.9 of this appendix.

5.8 River Channel Design Assessment of Options and Preliminary Design Report

The River Channel Design Assessment of Options and Preliminary Design Report (G & E Williams Consultants and Christensen Consulting Limited, 2018) included an evaluation of the preferred Option A channel design (see section 4.6) and an analysis of potential options for the channel configuration within the preferred 90 m design channel.

5.8.1 Nature of options considered

Two channel options included different active channel widths and bed levels, which represented the range of channel variability achievable within the defined corridor of the Project, were drawn up:

- Option 1, called the “Consistent” river channel, had a channel width of 90 m from Ewen Bridge upstream to Kennedy-Good Bridge. On each bank a narrow 5 m lower berm was included within a 25 m berm to reduce the height of edge protection rock linings and to give

some flow separation and landscape diversity across the berm. Upstream of Transpower a lower 10 m wide berm accommodated an edge vegetation buffer.

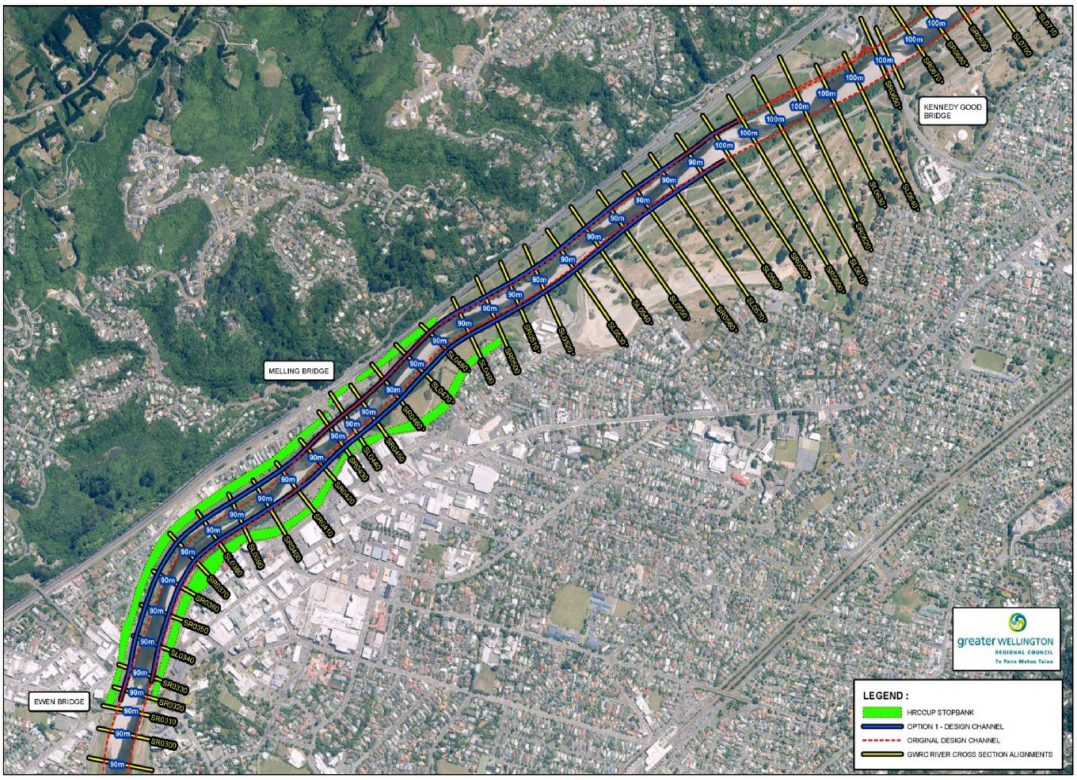


Figure 4 Option 1 Alignment (Consistent Channel)

- Option 2, called the “Variable” river channel, comprised a 70 m wide active channel from Ewen Bridge to above Melling Bridge. On each bank there was a wider low berm within the 90 m channel limits and then the 25 m berms. Above Melling there was a long 800 m transition in channel width, from 90 m to 100 m, up to the Transpower site. From Transpower to Kennedy-Good Bridge there was a 100 m design channel as proposed in the HRFMP.

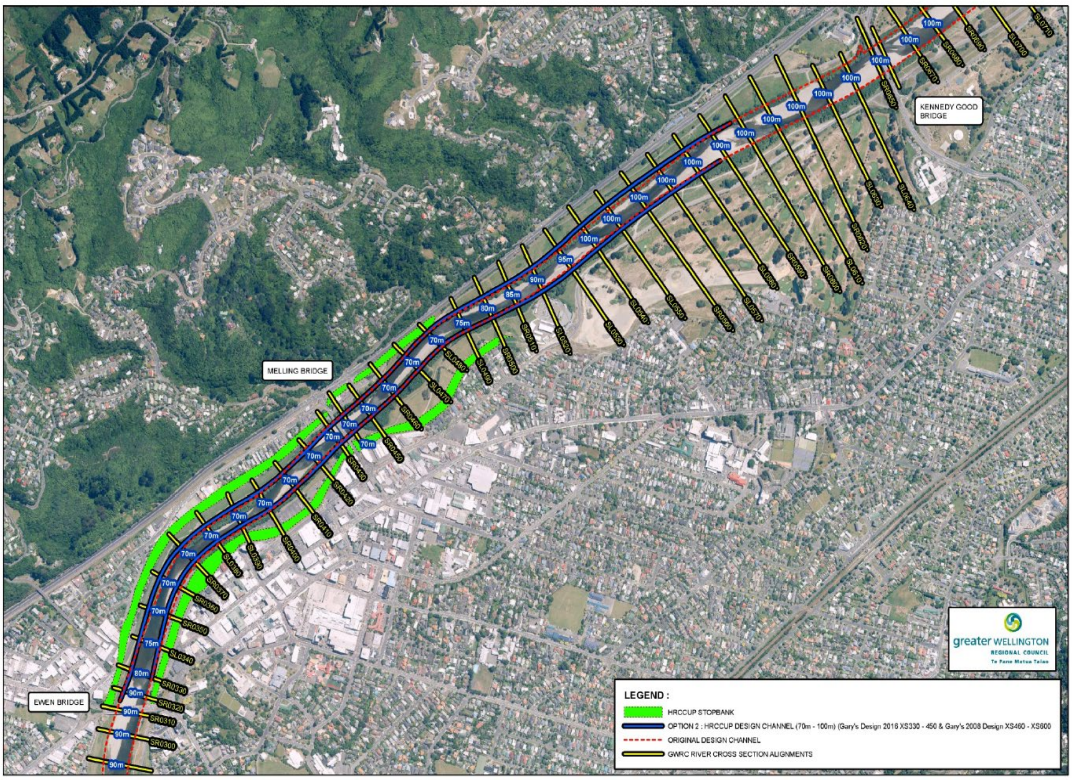


Figure 5 Option 2 Alignment (Variable Channel)

Within these options were two sub-options for consideration:

- Keeping the bed level at the current level (2014), and
- Restoring the bed level to the modelled 1998 bed level.

5.8.2 Evaluation undertaken

The report analysed the options from a technical perspective and used this to inform a separate evaluation process (the MCA described next in the RiverLink River Channel Design Channel Alignment Options 1 and 2: MCA Selection Process (Polvere, 2018) in section 5.9 below).

5.8.3 Findings

In summary, the technical analysis found the following:

- there was very little space for any variations in alignment or meander pattern within a Consistent channel width (Option 1). The channel would be very straight, with only a slightly curving pattern to the gravel beaches or bars within the channel
- there were more possibilities with the 70 m Variable channel (Option 2), however any pattern that retained an appropriate curvature and wavelength required substantial alterations to the existing channel
- keeping the bed level at its current level was recommended because it provided lower, more resilient river channel banks with the additional capacity provided by slightly higher stopbanks considered to be a better solution. Lowering the river bed to the HRFMP design levels would also involve disruptive and high ecological impact “wet” gravel extraction operation
- the Variable channel (Option 2) would be easier to manage through small to medium flood events, and likely have better pre-flood conditions before a major event

- the Variable option (Option 2) would have shorter rock works of less height than the Consistent option, but they would be thicker meaning the residual risks of failure (of the flood defences) would be lower, and
- there were only small differences in berm velocities across the two options.

The report determined that a variable channel width, with a 70 m active channel up to Melling and then a long transition to a 100 m channel between Transpower and Kennedy-Good Bridge was preferable to a constant 90 m active channel throughout. This was because a narrower 70 m active channel up to Melling provided higher sediment transport capacity and it would be more likely that gravel would be transferred through to below Ewen Bridge rather than depositing through the City Centre.

The report recommended that preliminary design of the river channel should be based on the Variable option (Option 2) with the existing (2014) bed levels and that channel design would need to be further refined, taking into account the inter-connections that arise from the various elements of the Project.

5.9 RiverLink River Channel Design Channel Alignment: Options 1 and 2 Selection Process

The Riverworks Preliminary Design Channel Alignment: Options 1 and 2 Selection Process (Polvere, 2018) records the broader evaluation of the options for the river corridor, being the Variable (Option 2) or Consistent (Option 1) design channel described in the report described in section 5.8 above.

5.9.1 Nature of options considered

This report recorded the MCA process to assess the two channel alignments and selection of the preferred option. The report noted that the selection process did not account for any implications arising from the Melling Bridge replacement or the proposed pedestrian and cycle bridge because details for these Project components were unknown when the report was finalised.

5.9.2 Evaluation undertaken

The objectives used for the evaluation of each channel alignment option were as follows:

- Flood Resilience: Hutt Valley people (current and future generations) and properties have protection to the level set out in the HRFMP
- Mana Whenua: Enhance Mana Whenua values along the river corridor
- Environment: Social, recreational and ecological values are enhanced along the river corridor, and
- Sustainability: The design enables a staged implementation process and ensures affordable outcomes in terms of ability to implement and maintain.

Each objective was defined by developing criteria and sub-criteria and included analysis from the relevant technical experts. The report acknowledged Mana Whenua representatives were not available to participate in the selection process but that inputs from Mana Whenua would be provided through discussions and workshops held separately with Mana Whenua representatives.

The process looked at the opportunities each channel alignment provided and identified where there were potential issues with an option. The selection process was spread over three workshops. A summary of each workshop is provided in Table 7 below.

Table 7 Design channel options MCA workshops

Date	Workshop	Description
1 September 2016	Workshop 1	Technical experts considered the Project objectives applicable to the river works selection process then developed associated attributes (i.e. criteria, sub-criteria) to be used for appraisal.
19 October 2016	Workshop 2	An initial evaluation of the river alignment options by the technical experts and GW Flood Protection operations team. The experts with skills and experience in each of the objectives provided an initial score and explanation, this was discussed and debated with workshop attendees to develop an agreed score or reference.
26 October 2016	Workshop 3	Review of completed Workshop 2 evaluation by GW Flood Protection with input from technical experts.

The appraisal of the river alignment options was completed through the second and third workshops. A score of one to five was given for each sub-criterion, with one being the lowest rating and five being the highest. The aim was to determine the relative fit of the opportunities available for each option against the sub-criteria. The evaluation during the workshop process involved the following:

- An “importance” weighting was applied to each objective
- The channel alignment performance was scored based on an assessment of the attributes
- A weighting was applied to each sub-criterion based on the impacts of the design, or the opportunity provided, and
- A sensitivity exercise was undertaken by varying the importance weighting of each objective. This provided an understanding of the level of influence any given objective had on the final selected channel alignment.

The importance of each design objective was identified based on the level of consideration required for the design of the channel alignment. The importance accorded to each of the objectives was:

- Flood resilience 80 %
- Mana Whenua 5 %
- Environment 10 % (amenity and recreation 5% and ecological 5%), and
- Sustainability 5 %.

5.9.3 Findings

The appraisal of the two river alignment options identified that the Variable river channel option was the highest scoring and most favourable option for meeting the objectives and attributes identified.

The Variable channel alignment was found to best meet the objectives and associated attributes. Sensitivity testing confirmed that the Variable channel alignment preference was not dependent on the importance of any objective.

The report concluded the Variable channel alignment was selected and subsequently progressed.

5.10 Melling Intersection Improvements Indicative Business Case (IBC)

The Melling Intersection Improvements Indicative Business Case (IBC) (NZ Transport Agency, 2017) outlines the optioneering process undertaken from October to December 2016. Following completion of the draft IBC, the Transport Agency's Value Assurance Committee directed the team who drafted the report to progress and develop a Single Stage Detailed Business Case (SSBC) for approval. The work carried out in the IBC was carried forward into the further alternatives assessment process outlined below.

5.10.1 Nature of options considered

Options to solve the transport issues were identified in long list workshop with GW, Waka Kotahi and HCC by reviewing options from previous reports as well as searching for new options not previously considered. This process resulted in a long list of 43 options.

Key principles were developed as part of the IBC to assist in understanding the scope of the options and serving as part of the sifting of options. The key principles were:

- Traffic to connect into edge of Lower Hutt City Centre - not the core or further away
- All routes for all modes should be legible and all existing connectivity should be retained
- There should be full pedestrian and cycle connectivity, taking desire lines into account
- Retain the ability to extend the Melling rail line further north should the need arise in the future
- Allow for the flood protection works which were being designed for a 1 in 440-year event, and
- Maintain Melling as the Gateway to the Lower Hutt City Centre with the bridge to connect into road network adjacent to Te Awa Kairangi.

Of the 43 options developed, 13 were shortlisted and 30 were discarded because of their inability to contribute to the investment objectives or misalignment with the key principles developed.

Table 8 below summarises the discarded options at a high level.

Table 8 summarises the discarded options.

Option	Reasons for excluding from shortlist
At-grade intersection options for SH2/Melling where they are the "final" options	No meaningful contribution to safety, access travel choices or reliability. Retains Block Road and flooding issues.
Grade separated options from previous studies	Whilst multiple were retained, many did not appropriately consider pedestrians and cyclists and to accommodate them would result in either an unsafe or illegible active network.

Option	Reasons for excluding from shortlist
Options with SH2 going over local roads	Discarded due to geometry and constructability. Current local roads are above the current level of SH2 such that switching the levels of these could have significant impacts on the footprint and result in a poor layout for local roads.
Options with bridge location north of Melling Link and South of Queens Drive	Bridge locations to the north did not provide for HCC's desire for the interchange to be a gateway into Hutt City Centre. Bridge locations to the south would direct too much traffic into the city centre.
Options retaining the current Melling Bridge	The current Melling Bridge is a significant capacity constraint on both the floodway (due to the bridge's height above Te Awa Kairangi) and the road network (since lanes provided constrain capacity) and so these options were discarded.

5.10.2 Evaluation undertaken

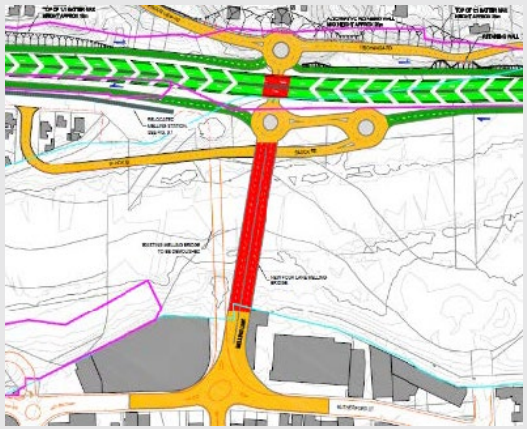
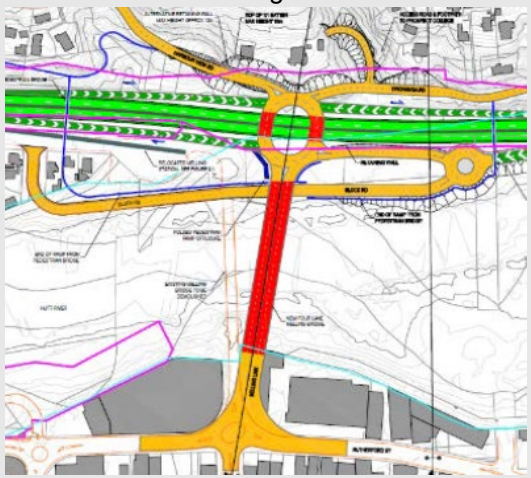
Three MCA workshops were held to further evaluate the initial shortlist of 13 options. The MCA workshops assisted in the evaluation and identification of the preferred option. A five point scoring system was used for each MCA.

The first MCA considered the shortlist of 13 options. The following criteria were adopted to evaluate the options at the workshop:

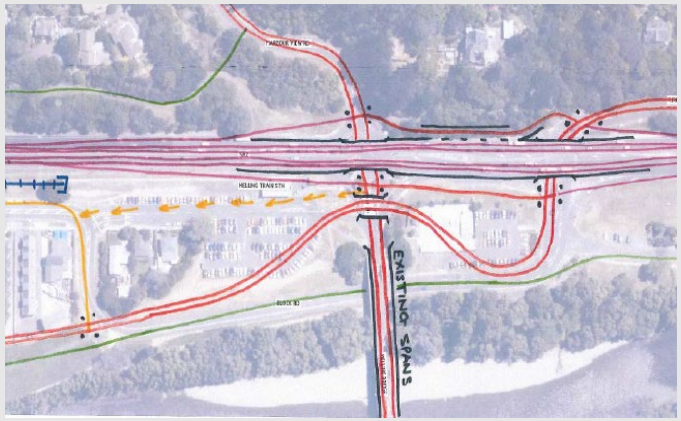
- Transport benefits
- Fit with local road system
- Utility for non-motorised travel modes
- Railway/bus system utility
- Impacts on tangata whenua values
- Visual and landscape impacts
- Natural hazards management fit
- Impact on adjacent land uses
- Urban design opportunities
- Consentability
- Engineering degree of difficulty
- Cost

Table 9 below summarises the assessment of the 13 options at the first MCA.

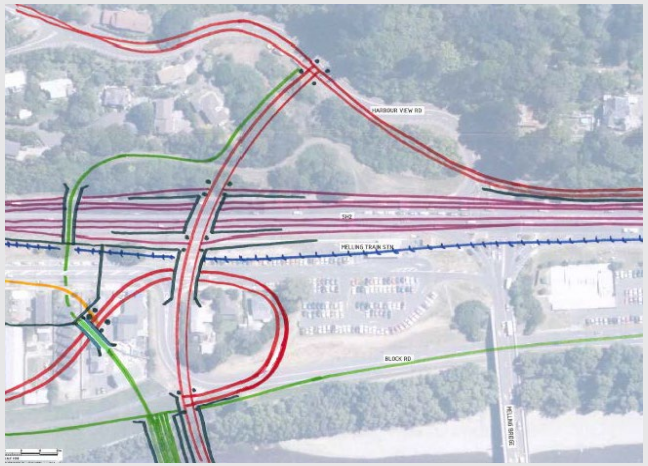
Table 9 MCA – summary assessment of 13 options

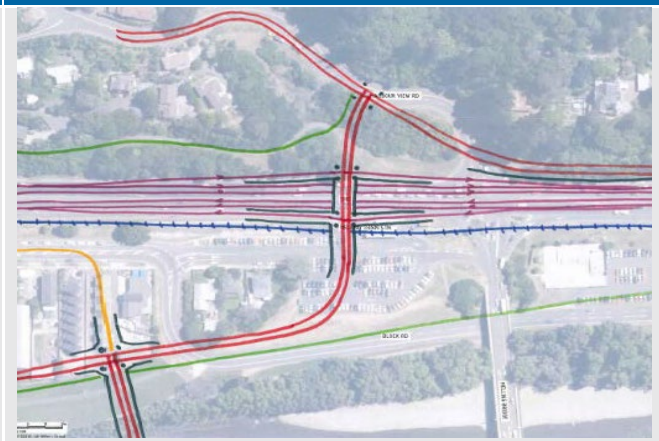
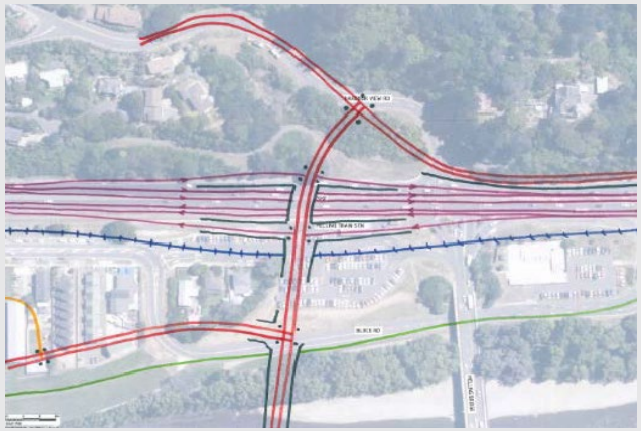
Option No.	Description and figure	Assessment
Discarded Options (i.e. discarded before further assessment for other options below)	Dumbbell Interchange 	**Discarded** due to geometric difficulties and safety concerns with the 5-arm roundabout on the west side of SH2.
	Roundabout Interchange 	**Discarded** due to serious safety issues associated with the 7-arm roundabouts.
1	At-grade intersection improvements on both sides of Te Awa Kairangi, including signalised intersections at High Street and	**Not moved forward.** Main reasons for rejection include a lack of transport benefits, lack of improvements to walking

Option No.	Description and figure	Assessment
	Rutherford Street, and retaining Melling Bridge in current form and level 	and cycling, lack of improvement for public transport, no improvement to flood risk and no opportunities to improve the gateway to Hutt City.
2	Par-clo interchange replacing Melling Bridge and providing an overpass to Harbour View and Tirohanga 	**Not moved forward.** Option scored averagely across the MCA criteria. Need for pedestrians and cyclists to traverse the road network was a concern, as was the ability to easily connect to the railway station in its present location.
3	Par-clo interchange with skewed Melling link, otherwise similar to Option 2	**Not moved forward.** Scored similarly to Option 2 but worse with regard to landscape impacts and engineering degree of difficulty due to skewed bridge.

Option No.	Description and figure	Assessment
		
4	Split diamond interchange with service roads, taking SH2 over a new direct connection to Harbour View and Tirohanga, with local roads beneath. 	**Not moved forward.** Lack of improvements to flood capacity due to retention of Melling Bridge and constructability problems with raising the highway over local roads.
5	Split diamond interchange with service roads – similar to option 4, however SH2 remains at-grade with local roads above, and Melling bridge is replaced.	**Not moved forward.** There were concerns with the impact on the local road network, primarily as Pharazyn Street was not well connected to the city centre.

Option No.	Description and figure	Assessment
		
6	Diamond interchange with traffic signals and new “green link” over Te Awa Kairangi to connect to PT interchange and to Harbour View Road 	**Yes, moved forward for further investigation.**
7	Grade separated roundabout interchange with new green links and separate connection for Pharazyn & Tirohanga	**Yes, moved forward for further investigation.** Although this option did not score highly, it was retained as a roundabout would be consistent with the interchanges north and south along SH2.

Option No.	Description and figure	Assessment
		
8	Diamond interchange with connection to Tirohanga on western side, and a new green link adjacent to a new Melling bridge relocated further south 	**Not moved forward.** No particular issues, however other options scored better.
9	Diamond interchange with indirect connection to relocated Melling Link and new green link at southern end of Melling Station	**Yes, moved forward for further investigation.**

Option No.	Description and figure	Assessment
		
10	Diamond interchange with direct connection to Melling Link and new green link at southern end of Melling Station 	**Incorporate into Option 9**
11	Diamond interchange (incorporating non-conventional side of road) with indirect connection to Melling Link and new green link at southern end of Melling Station.	**Yes, moved forward for further investigation.**

Option No.	Description and figure	Assessment
		

5.10.3 Findings

Of the 13 short list options, four of those options were identified for further investigation – Options 6, 7, 9 and 11 (with Option 10 being merged into Option 9).

5.11 Melling Link – Further Options Report

The Melling Link – Further Options Report (Options Report) (Stantec, 2018) describes the investigations undertaken to assess the feasibility of the four options identified through the IBC process described above in section 5.10 of this appendix.

This report also summarises the assessment process to shortlist the options for investigation through a Single Stage Business Case (SSBC).

The feasibility investigations focused on three areas:

1. A concept level road safety audit of the four shortlisted IBC options
2. Additional traffic modelling of the options, and
3. Further topographical survey investigations to confirm the existing LIDAR information.

The Melling Link Further Options Report then summarises the above IBC shortlisting process and presents the shortlist of options recommenced for public consultation.

Nature of options considered

The four preferred options from the IBC are presented below in Figure 6, Figure 7, Figure 8 and Figure 9 (sourced from the Melling Link – Further Options Report).

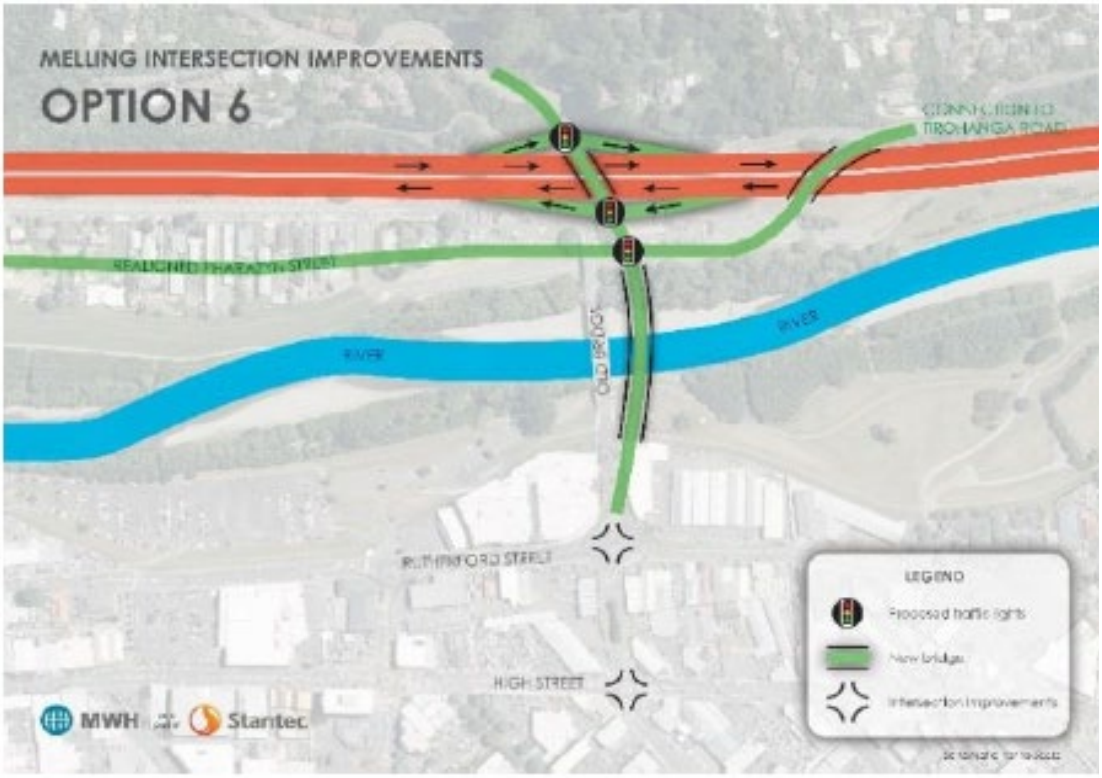


Figure 6 Option 6: Diamond Interchange with direct connection into Melling Link and Tirohanga Road connection at Pharazyn Road

Figure 7 Option 7: Signalised Roundabout Interchange with direct connection into Melling Link and Tirohanga Road connection at Pharazyn Road

Figure 8 Option 9: Diamond Interchange with connection into Queens Drive and Tirohanga Road connection to Harbour View Road

Figure 9 Option 11: Diverging Diamond Interchange with dog-leg connection into Queens Drive and Tirohanga Road connection at Pharazyn

5.11.1 Evaluation undertaken

Further evaluation was undertaken in the form of a road safety audit, traffic modelling and further topographical investigations. This further investigation was generally based on the four options identified as part of the IBC (options 6, 7, 9 and 11).

In addition to the road safety audit traffic modelling was also undertaken. The traffic modelling introduced three further options (6A, 9A, and 11A), demonstrated in Figure 10, Figure 11 and Figure 12 below.

Figure 10 Option 6A: Same as Option 6 however Tirohanga Road is connected to Harbour View Road rather than Pharazyn Street.

Figure 11 Option 9A: Same as Option 9 however instead of a straight connection to Queens Drive, a dog-leg connection is proposed.

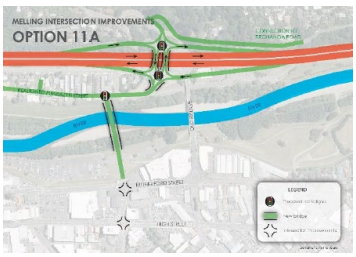


Figure 12 Option 11A: Same as Option 11 however Tirohanga Road is connected to Harbour View Road rather than Pharazyn Street.

A further topographical survey of the escarpment between Harbour View Road and Tirohanga Road was undertaken to determine constructability of a Tirohanga to Harbour View connection. It was found that such a connection would be difficult, however was not considered prohibitive.

5.11.2 Further evaluation undertaken and options

After the assessment of the road safety audit, traffic modelling and further topographic investigations, a number of further options and sub-options had been identified. Rather than undertaking a further evaluation of an extended range of options and sub-options, it was decided to evaluate a number of key Project components. Following this evaluation of the key Project components, the shortlist of options for development in the SSBC were formed. The Project components evaluated are described below.

- Interchange form:
  - Roundabout
  - Signalised Roundabout
  - Diamond
  - Diverging Diamond
  - Large gyratory
- Tirohanga Link:
  - Tirohanga to Harbour View
  - Tirohanga to Pharazyn
- Linkage to Hutt City:
  - Bridge at Melling Link
  - Bridge at Queen Street
- Connection between Hutt City and Interchange:
  - Dog Leg to separate the interchange from Pharazyn Street intersection
  - No Dog Leg

GW, Waka Kotahi and HCC reviewed the key Project components at an option assessment workshop attended by key stakeholders from GW, Waka Kotahi and HCC on 16 February 2018 against similar criteria as used for the IBC MCA process, i.e.:

- Transport benefits;
- Fit with the local road system;
- Utility for non-motorised travel modes;
- Railway/bus system utility;
- Natural hazards management;
- Urban Design;
- Opportunities;
- Engineering degree of difficulty;
- Ability to be staged;
- Additional safety benefits; and
- Cost

A five-step scoring approach, ranging from “- -”, through 0, to “++” was used in the assessment.

Tirohanga Link

Two options were further evaluated for connecting Tirohanga Road into the road network at this location. The first was constructing a new link parallel to SH2 to connect Tirohanga Road into

Harbour View Road (refer Figure 13). The second was construction a new bridge over SH2 to connect Tirohanga Road into the interchange opposite Pharazyn Street (refer Figure 14).

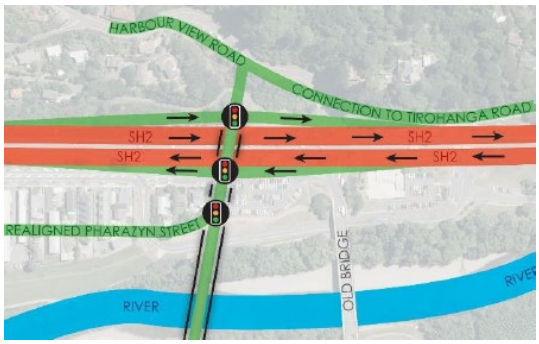


Figure 13 Tirohanga to Harbour View Road

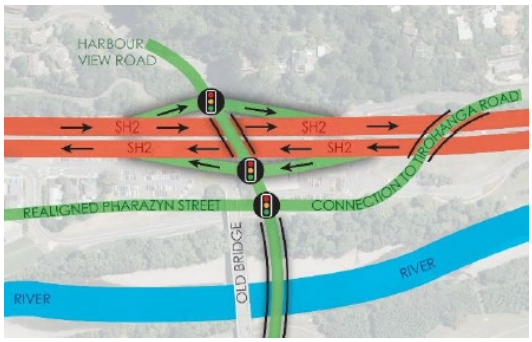


Figure 14 Tirohanga to Pharazyn Street

Linkage to Hutt City

There were two options for connecting the interchange across the river into the road network on the east of Te Awa Kairangi, Melling Link and Queens Drive (refer Figure 15 and Figure 16 below).

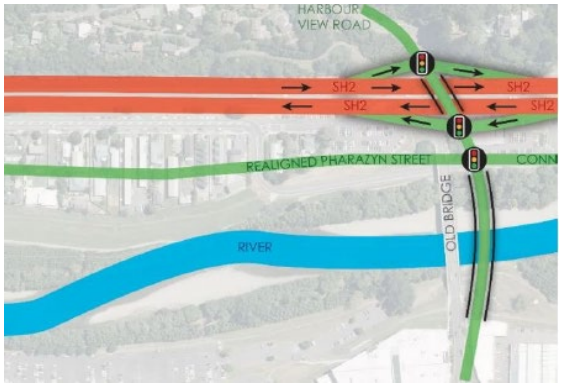


Figure 15 Melling link

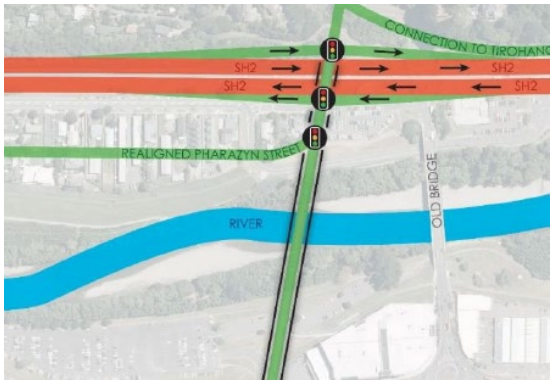


Figure 16 Queens Drive

Connection between Hutt City and Interchange

There were two options (direct connection Figure 17 and a dog leg connection Figure 18) to connect the interchange to the river bridge.

Figure 17 Direct connection

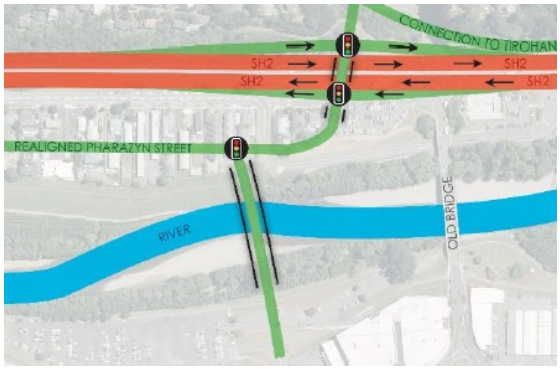


Figure 18 Dog Leg Connection

Assessment of Interchange Form

Four interchange options were considered in the IBC and an additional idea was raised by the road safety audit team. Five options were considered at this stage, as demonstrated in the figures below, these options were Roundabout (non-signalised) (Figure 19), Signalised Roundabout (at least the two off ramps and the Melling Link approach signalised) (Figure 20), Diamond (Figure 22), Diverging Diamond (Figure 23) and Large Gyratory (i.e. extra-large roundabout with 3 lane circulating carriageway that enabled all approach roads to connect to a single gyratory system((Figure 21).

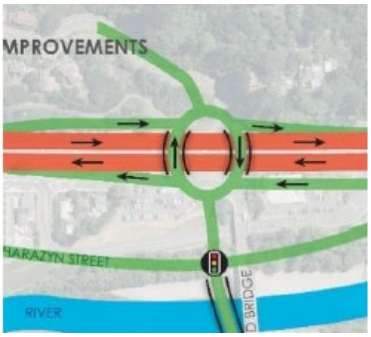


Figure 19 Roundabout

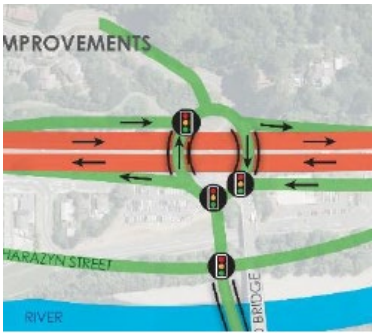


Figure 20 Signalised Roundabout

Figure 21 Large Gyratory

Figure 22 Diamond

Figure 23 Diverging Diamond

5.11.3 Findings

The findings of the further evaluation undertaken through the road safety audit and traffic modelling relative to each of the options are set out below in Table 10.

Table 10 Road safety audit and traffic modelling findings

Option	Road safety audit findings	Traffic modelling
6	The safety audit team considered this option was "*the least safe system compliant option*", due to; • three signalised intersections close together, • a complex intersection at Tirohanga Road/Pharazyn Street/Melling Link, and • a curved approach to the interchange from the east.	Significant congestion in Lower Hutt city centre for outbound movements on Pharazyn Street, and on the Melling Interchange off ramps. There were also safety concerns with this layout due to the spacing between signalised intersections. As such it was considered undesirable as a Project option.

Option	Road safety audit findings	Traffic modelling
6A	Not separately audited	Some improvements over Option 6, however issues remain with queue lengths for northbound movements on Melling Bridge, and on Pharazyn Street.
7	Option 7 was the "*only option to utilise a roundabout, which is the most safe system compliant form of intersection control since it reduces the number of conflicts, simplifies road user decision making and minimises impact angle in the event of a crash*."	Shows congestion within Lower Hutt city centre resulting from northbound queues extending back from the interchange, and queuing for outbound movements on Pharazyn Street, however neither are as poor as Option 6. Melling off ramps perform well.
9	Even though Option 9 is similar to Option 6, the safety audit team considered that the following features improve safety compared to Option 6: 1. The intersection arrangement to the east of the SH2 over bridge is less complex making it easier to co-ordinate and with fewer conflicts. 2. The alignment from the east is straight so that drivers will have a view of what is happening ahead of them. 3. The realignment of Harbour View Road allows a safer intersection to be constructed for the Harbour View Road-Tirohanga Road link. 4. There is more direct desire line connectivity possible for pedestrians and cyclists.	Performs better than Option 6 but still has significant queueing on Pharazyn Street and northbound on the Melling Bridge.
9A	Not separately audited.	Provides for improved operation compared to Option 9, through greater separation between Pharazyn Street intersection and the interchange.
11	The safety audit team considered there would be major safety issues with Option 11, and with the Tirohanga connection into Harbour View. However in the design team's opinion, many of the safety issues associated with these aspects can be avoided or mitigated through intelligent design.	Best performing of the Project options modelled, with no significant queueing at key intersections.
11A	Not separately audited.	Introduces some issues with the performance of Pharazyn Street with additional traffic having to go through the interchange to access Tirohanga Street.

The conclusions and findings for each option and which options were selected to proceed further are summarised in Table 11.

Table 11 Key Project components selected to progress for further investigation

Component	Options	Key Project components chosen for further investigation
Tirohanga Road Link	Harbour View Road vs. Pharazyn Street	**Harbour View Road** connection that abuts the escarpment is superior in terms of efficiency, and provides excellent safety and visibility. The Pharazyn Street link would require construction into the floodplain.
Linkage to Hutt City	Queens Drive vs. Melling Link	**Both options**. Queens Drive scored similar or better against all considerations, however there was a desire from Waka Kotahi to consider options connecting to the existing Melling Link.
Connection between Hutt City and interchange	Dog-leg vs. No dog-leg	**Both options**. There were strong contrasting positives and negatives for each option, therefore both should go forward for further investigation.
Interchange form	Roundabout vs. signalised roundabout vs. large gyratory vs. diamond interchange vs. diverging diamond interchange	**Diamond interchange**. The diverging diamond also scored well but was discounted by Waka Kotahi due to safety concerns.

Melling Link Options

Subsequent to the options workshop, the design team considered a variation on Option 9 that had the diamond interchange in the same place, but with the bridge over Te Awa Kairangi realigned to feed into Melling Link (closer to the existing Melling Bridge). This variation had significant advantages over Option 6 in that it had a lesser impact on the floodway, would be easier to construct, and could have the ability to be staged. The Melling Link - Further Options report therefore recommended this option (referred to as Option 9B) to be used during consultation as the likely form of an interchange to connect into Melling Link.

Recommended Options

Based on the further investigations described above, three options were recommended for further development during the SSBC phase. These options were:

- Option 9: Diamond Interchange with direct connection to Queens Drive, refer Figure 24;
- Option 9A: Diamond Interchange with dog leg connection to Queens Drive; refer Figure 25; and
- Option 9B: Diamond Interchange with direct connection to Melling Link, refer Figure 26.

Importantly, all options provide a link from Tirohanga Road to Harbour View Road. Options 9 and 9A connect to Queens Drive while 9B connects to Melling Link. Option 9A provides a dog leg while Options 9 and 9B provide a direct link, and all options incorporate a diamond interchange form. These options are therefore consistent with and carry forward the recommendations of the above findings.

The Melling Link option would not be progressed with a dog leg connection due to constrained environment and the locations of Melling Link, Pharazyn Street and the proposed location of the interchange. The Melling Link – Further Options report recommended progressing the concept design of Options 9, 9A and 9B for assessment and consideration through public consultation.

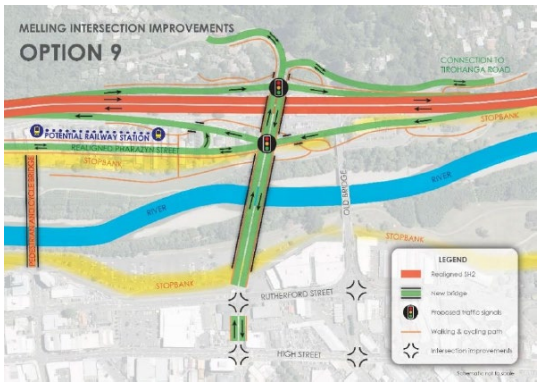


Figure 24: Option 9

Figure 25 Option 9A

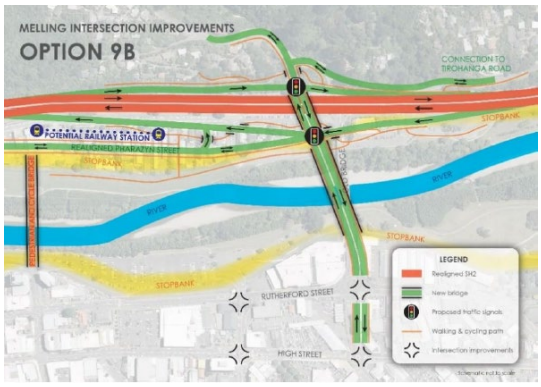


Figure 26 Option 9B

5.12 Public Consultation – May-June 2018

The three shortlisted options as identified in the Melling Link – Further Options Report (9, 9A and 9B) were presented to the community for feedback during May-June 2018. Of the 382 responses received, 189 identified a preferred option. The most popular option was a direct connection to Queens Drive (Option 9), receiving support from 46% of those who identified a preferred option, followed by an indirect connection to Queens Drive (Option 9A) (31%) and a connection to Melling Link (Option 9B) (23%). Respondents said they preferred the direct connection to Queens Drive because it has fewer traffic lights, was easy to navigate, had better access to the city centre and minimises disruption during construction.

5.13 Melling Intersection Improvements MCA Workshop (June 2018) Report

A third MCA workshop was held in June 2018 to consider the final three options (9, 9A and 9B), with the intent of confirming a recommended option (Stantec, 2019a). Technical specialists undertook preliminary investigations and led discussions on each criterion at the workshop. The outcome of this workshop is documented in the MCA Workshop Report.

5.13.1 Nature of options considered

The following three options were considered during this MCA workshop:

- Melling Link (Option 9B)
- Queens Direct (Option 9)
- Queens Indirect (Option 9A)

These options are outlined in section 5.11 above.

5.13.2 Evaluation undertaken

Initially ten criteria were proposed generally based on the earlier Melling assessments, however, during the workshop, the criterion of 'urban design and recreational opportunities' was modified to extract recreational considerations into a new category labelled as 'recreational functional amenity'. Each option received a score from 1-5 for each criterion. The eleven criteria evaluated were as follows:

- Transport benefits
- Fit with local road system
- Visual and landscape impacts, which also included biophysical considerations of earthworks, ecology and natural character
- Natural hazards management fit
- Land use effects
- Urban design opportunities
- Consentability
- Engineering degree of difficulty
- Ability to be Staged
- Cost
- Recreational functional amenity

The MCA criteria for this workshop (referred in this report as "Workshop 3") were amended (as compared to the criteria for the MCA at section 5.11) to remove "utility for non-motorised travel modes" (consideration of how well the Project can provide for walking, cycling, and any other modes) and "railway/bus system utility" (consideration of opportunities for rail and bus system integration and facilities such as park and ride, and potential for their future expansion or extension). These criteria were excluded, as there was unlikely to be any significant difference between options at this level of assessment. Project traffic safety benefits were incorporated into the 'transport benefits' criterion for Workshop 3.

There were six weighting systems applied to the MCA scores. None of the weighting systems are constrained in terms of an overall weighting, so no 'trade-offs' were made. The systems used were as follows;

- Workshop - based on raw values of the attendees.

- Alternative Workshop Weighting –visual and landscape, recreational functional amenity and urban design opportunities reduced to 1/3 of their weighting as could otherwise dominate scoring.
- RMA Balanced – This weighting aimed to reflect the aspects that contribute to the overall evaluation of the Project under the RMA.
- Environment – This weighting system emphasised the physical environment.
- Community – This weighting system emphasised the aspects likely to be most important to the community and was informed, in part, by consultation comments.
- Economic – This weighting system placed full weight on the criteria with a significant economic component.

5.13.3 Findings

In summary:

- **Transport benefits:** Modelled travel time for 2031 showed that all options would provide a significant travel time improvement. All options would significantly improve safety on SH2, by separating local and state highway traffic streams. Queens Indirect (Option 9A) had a better bus route alignment and would provide a more direct connection for active modes to the Melling Station. Queens Indirect (Option 9A) was therefore the most favoured option.
- **Fit with local road system:** The options connecting to Queens Drive were preferred, since they provide better connectivity to HCC's Eastern Access Route, and since they provide a more direct public transport connection to the city centre than the Melling Link option. Queens Direct (Option 9) was preferred over Queens Indirect (Option 9A) as it was considered to provide a more legible connection to the local road network, particularly Pharazyn Street. Queens Direct (Option 9) was the most favoured option.
- **Visual and landscape impacts:** Queens Indirect (Option 9A) was considered the worst option, since it requires the road to run along the top of the western stopbank which would result in significant visual impacts. Melling Link (Option 9B) was slightly favoured over Queens Drive, since there was already a bridge in this location, which would be familiar to residents compared to a new bridge at Queens Drive. Melling Link (Option 9B) or Queens Direct (Option 9) were the most favoured options.
- **Recreational functional amenity:** The Queens Direct (Option 9) and Queens Indirect (Option 9A) options would result in shading and noise issues for the existing recreation area used as an off-street carpark and weekend markets. By connecting at the Melling Link, these concerns were avoided. Melling Link (Option 9B) was the most favoured option.
- **Natural hazards management fit:** Melling Link would lock in the existing river channel constraints for the next 100 years. By relocating the bridge to Queens Drive, the opportunity is created to provide additional future flood protection. Of the Queens Drive options, the Queens Indirect option (Option 9A) was less desirable if constructed as presented, since the location would fix in place an undesirable berm fill obstruction. The seismic, landslide and tsunami hazards were predicted to be similar for all three options. Queens Direct (Option 9) was the most favourable option.
- **Land use effects:** All three options had impacts on land parcels on the city centre side of the river, as either Queens Drive needs widening or Melling Link needs realignment. The Queens Indirect (Option 9A) option would require a 5m lift of Rutherford Street, while the Queens Direct option would require a 2-3m lift of Rutherford Street. There was agreement that all temporary adverse effects should be discounted given the time scale of a 100-year project, and so did not have any effect on the overall land use scores. It was proposed that this criterion may justify only a low weight due to the uncertainty of adverse effects vs

opportunities. Queens Direct (Option 9) was the most favourable option by a narrow margin.

- **Urban design opportunities**: The Melling Link option did not create the gateway effect into the city centre desired by HCC, whereas the Queens Drive options do. The Queens Indirect option (Option 9A) was less desirable due to the dog-leg approach from SH2. The Queens Direct (Option 9) option was most preferred, however would require further urban design development around how the new Rutherford Street level would work with the existing city centre blocks. Queens Direct (Option 9) was the most favourable option.
- **Consentability:** The key consideration of the RMA was section 6 Matters of National Importance – in this case section 6(h): the management of significant risks from natural hazards was the focus. Melling Link (Option 9B) did not perform well against this criterion as it did not improve the existing river/bridge constraint at this location created by the width of the river channel at this point. Apart from this, all other matters were considered similar in nature. Queens Indirect (Option 9A) or Queens Direct (Option 9) were considered the most favourable options.
- **Engineering degree of difficulty:** The Melling Link option (Option 9B) provides the largest engineering challenge, as a segment of the existing bridge needs to be removed to enable completion of construction of the new bridge. The Queens Indirect option (Option 9A) is also challenging as it has significant interaction with stopbanks, and requires a 5m lift to Rutherford Street. The Queens Direct (Option 9) option has the least impact on the stopbanks, involves a lower lift of Rutherford Street, and predominantly avoids existing traffic. This option is the least complex to design overall. Queens Direct (Option 9) is the most favourable option.
- **Ability to be staged:** With all options, the bridge and SH2 interchange would need to be built after the stopbanks. Constructing the bridge before the interchange is feasible, as the rearrangement of the road connections between the new bridge, SH2 and local roads can be made but staging would have some disbenefits. Queens Indirect (Option 9A) or Queens Direct (Option 9) is the most favoured option.
- **Cost:** All options had similar cost estimates, likely to be within 20% of each other. Queens Indirect is expected to be the most expensive, since it is the longest bridge and had likely additional cost of construction associated with the stopbanks. Melling Link (Option 9B) or Queens Direct (Option 9) were the most favoured option.

Workshop participants also applied sensitivity testing to the assessment, using a variety of weighting options for the criteria. Regardless of the different weighting scenarios, a clear order of preference emerged, with Queens Direct (Option 9) the most favoured, followed by Queens Indirect (Option 9A) and Melling Link (Option 9B).

This MCA workshop report concluded that the Queens Direct option (Option 9) performed the best considering the wide range of criteria through the MCA process, and recommended that this option be presented to Waka Kotahi for their consideration alongside other aspects when deciding on a recommended option to present to their Board.

5.14 Melling Transport Improvements Single Stage Business Case

The Melling Transport Improvements Single Stage Business Case (SSBC) (Stantec, 2019b) revisited the case for change, and explained the process used to progress from an options long list to a recommended option, including the results of technical assessment and consultation/engagement activities The SSBC summarises the optioneering and multi-criteria assessments outlined above in sections 5.11 and 5.13 of this appendix.

The SSBC identifies that the recommended option of Queens Direct (Option 9) was endorsed by the Transport Agency Board at its December 2018 meeting.

5.14.1 Option development

Figure 27 below demonstrates the progression of Queens Direct Option 9 development of the Melling transport improvements as the preferred option.

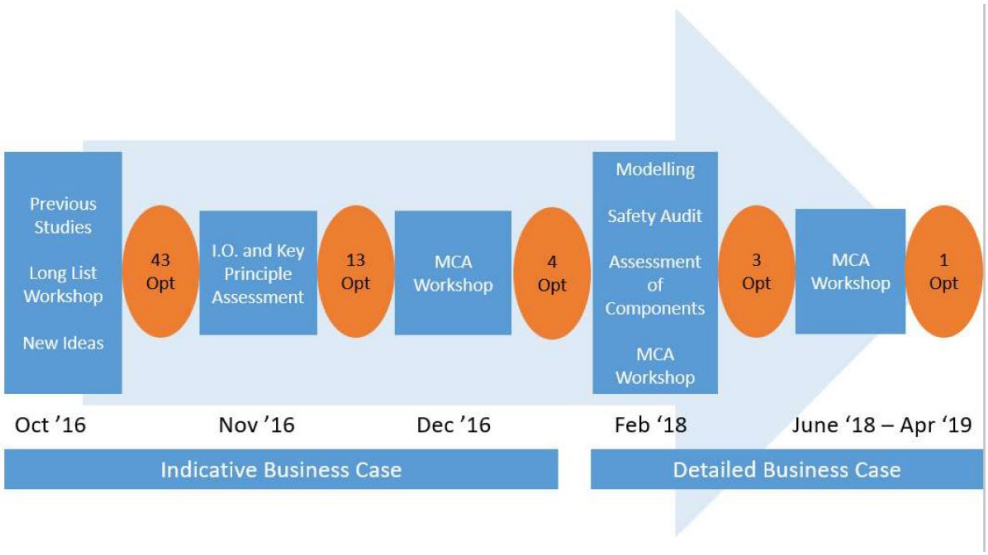


Figure 27 Queens Direct Option 9 development through the Business Case process (sourced from the SSBC)

5.14.2 Findings

Queens Direct (Option 9) outperformed both other short-listed options, was preferred by the community during consultation, and is the most compliant geometric design solution in terms of height and dimensions given the general layout of the adjoining road network.

The key benefits of the Queens Direct option (Option 9) over the alternative options considered include:

- **Resilience:** The bridge in this location (connecting directly to Queens Drive from the SH2/Harbour View Road intersection), combined with the new stopbanks, will reduce the risk of flooding in Lower Hutt and Melling.
- **Safety:** The grade separated interchange will be safer for all users.
- **Transport choice:** Access for pedestrians, cyclists and public transport will be improved, the Melling Station will be moved closer to the city centre, and better park and ride facilities will be provided.
- **Readability:** Provides an alignment into Hutt City that is direct, easy to understand and easy to sign.
- **Land use integration:** A Queens Drive connection promotes a more compact city centre and enables a gateway into the Hutt City Centre.
- **Land use:** The layout minimises the area of land required for infrastructure, maximises future development potential for the area of Pharazyn Street, and reduces the need for additional work on or over the stopbanks and in the floodplain.
- **Reliability:** A new interchange and river bridge will reduce congestion in peak travel times, and enable through traffic to use SH2 rather than using local roads, improving conditions in the city centre.

5.14.3 Melling Station Location Options Assessment

Appendix J of the SSBC includes a Melling Station Location Options Assessment. This assessment considered two possible station locations, indicated in Figure 28.

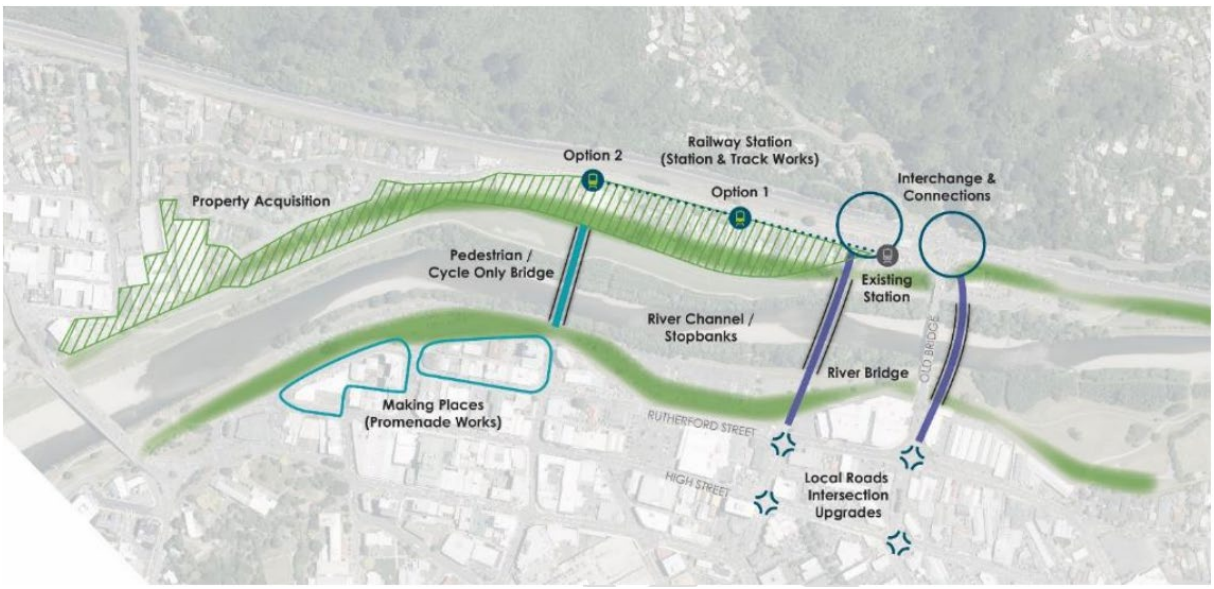


Figure 28 Melling Station location options (source: Appendix J of SSBC)

Option 1 would locate the New Melling Station 250m south of the existing Melling Station. This is the minimum amount by which the station location could be adjusted to accommodate the interchange footprint. Option 2 would locate the New Melling Station 500m south of the existing station, directly opposite the proposed pedestrian bridge into the Lower Hutt city centre.

The following assessment was made against the two options:

- **Walking:** Both options increase the walking distance from Western Hills and Boulcott to the New Melling Station. Both options, but particularly Option 2, bring Queensgate, the Dowse Art Museum and High Street to around a 10 minute walk or less.
- **Park and ride:** Both location options facilitate park and ride spaces and neither option significantly increases travel time by car.
- **Bus:** Both options show negligible difference for existing bus users accessing Melling Station from Belmont (the only current service). Walking time from the station to Queensgate bus hub would be reduced from 14 minutes to 9 minutes for Option 1, and 7 minutes for Option 2.
- **Rail:** Rail patronage changes purely resulting from the station location adjustment are expected to be minimal, however there is significant potential for increased patronage when the station location adjustment is combined with future development in the Lower Hutt city centre and expansion of rail services (e.g. weekend and evenings).

The rail location options assessment cited public consultation for RiverLink that occurred in June 2017. Fifty individuals responded to the question about where the New Melling Station should be located, with the following results:

- 48%: Opposite city centre/Margaret Street
- 18%: Unsure, it depends on other factors such as – the intersection, car park facilities, access
- 16%: Move it north
- 12%: Don’t move it

- 6%: Move it to the city

The Station Location Options Assessment concluded that on balance, the differences between the two options were minimal, with both having beneficial aspects.

6. Options assessed during consent design (late 2019-2021)

This section discusses the further refinement of the preliminary design options outlined above that were taken through to the design development for the NoR and resource consent applications.

6.1 RiverLink Te Awa Kairangi - Pedestrian and Cycle Bridge. Concept Design Report

The RiverLink Te Awa Kairangi - Pedestrian and Cycle Bridge Concept Design Report (Isthmus Limited, 2019), prepared for GW, Waka Kotahi and HCC, builds on the work undertaken by Boffa Miskell on the pedestrian bridge structure design described in section 5.4 where Option 3, a four span bridge, was determined to be the preferred option.

6.1.1 Nature of options considered

The RiverLink Te Awa Kairangi - Pedestrian and Cycle Bridge Concept Design Report recorded the options considered for the design of the pedestrian and cycle bridge, focused on physical form and appearance perspective.

Three options considered are depicted below in Figure 29, Figure 30 and Figure 31.

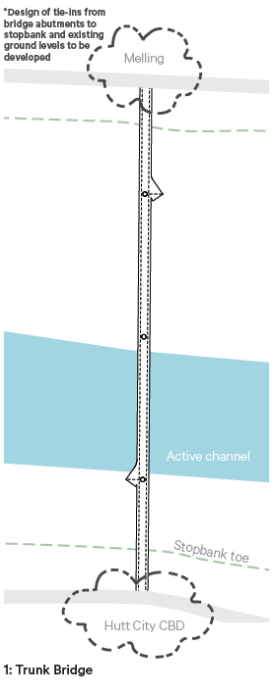


Figure 29 Option 1 Trunk Bridge

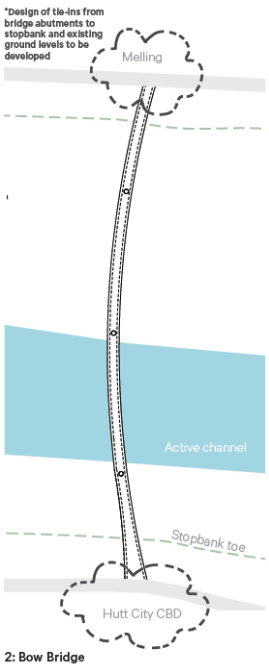


Figure 30 Option 2: Bow Bridge

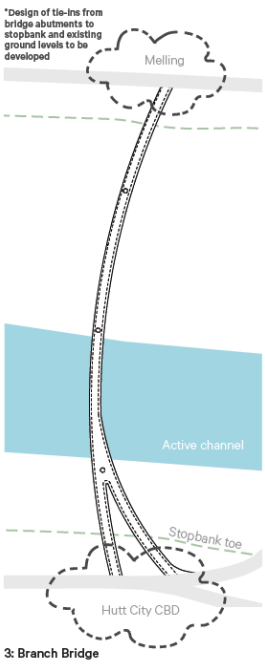


Figure 31 Option 3: Branch Bridge

6.1.2 Evaluation undertaken

The bridge concept options were evaluated by the design team using the criteria set out in Table 12 below.

Table 12 Evaluation Criteria applied in the RiverLink Te Awa Kairangi - Pedestrian and Cycle Bridge

Evaluation Criteria	
Resilience	Performance in flood event Performance in seismic event Environmental resilience Repair and maintenance
Consentability	Environmental effects - impact on the waterway, aquifer and surrounding environment Ability to consent
Cost	Bridge structure Ground improvements Economic benefit (tourist attraction)
Constructability	Ease of construction and impacts on time and staging Durability and ease of maintenance Life-cycle Quality risks
Awa	Iwi values - recognition of Te Awa Kairangi as sacred by tangata whenua and the importance of its protection 'Life of the river' - improving the life of the river (habitat, ecology, river life) Acknowledgement of history
Experience	Pedestrian and cyclist experience of using the bridge Experience/perception of the bridge from within the River Park and tops of the stopbanks. 'Sense of arrival' in Hutt City - gateway / iconic Connectivity Accessibility Comfort - shelter from the wind Lighting experience (day vs night) Story telling / wayfinding

6.1.3 Findings

The report concluded that Option 1, the Trunk Bridge (Figure 29), was the preferred design solution. The option was preferred as a whole, it performed best against the assessment criteria. All options scored positively and similarly against the Consentability and Awa criteria, but Option 1 was scored the best against the cost related matters, and also achieved better Resilience scores than the other two options. Option 3: Branch bridge scored better against the Experience criteria, but the remainder of that Option's scores were lower than Option 1's. Option 1 was consequently preferred by the Isthmus report.

6.2 RiverLink City Edge Multi Criteria Analysis Report

The RiverLink City Edge Multi Criteria Analysis report (GHD Limited, 2021a), prepared for GW, Waka Kotahi and HCC, summarised the outputs from multiple MCAs undertaken on six options for the 'City Edge' future urban development design concept for the eastern side of the river, in the vicinity of the Lower Hutt city centre. The report considered the need for underlying infrastructure (including building platforms), services, and the connection of future buildings with the stopbank (and integration into the Lower Hutt city centre). At that time, the possibility of including some building development within the current applications was considered. However, as such developments are unlikely to be constructed by HCC, and as the District Plan is now under a full replacement review, it was considered more appropriate for such developments to be provided for through a combination of the integration works now sought in the application along with the new planning framework to be provided in the new District Plan. The report described that several MCA workshops were held to confirm the Project objectives, option assessment criteria and the options to be assessed, and to evaluate the options.

6.2.1 Nature of options considered

The six options evaluated through the City Edge MCA are summarised in Table 13 below.

Table 13 Summary of the City Edge MCA options

Option	Description	Features
Option 1: Existing city edge with raised stopbanks	Employed a bare minimum approach with the least impact on the road reserve	• No property acquisition required • New stopbanks constructed, incorporating tall retaining walls (between 2-5m high) • Impact on road reserve minimised
Option 2: Existing buildings with wider stopbank	Mitigated the effect of the retaining wall heights by extending the stopbanks into the road reserve.	• No property acquisition required • New stopbanks constructed incorporating lower retaining wall sections (on average 2.5m high) • Daly Street would become a narrow shared space
Option 3: Southbank Park and urban regeneration.	Further acquisition of Daly Street properties and the development or regeneration of existing buildings along Dudley Street to create a new Southbank Park would be required.	• Major property acquisition required • New sloping stopbanks need to be constructed • New river edge public space • New laneway • Opportunity for existing buildings to be adapted and re-purposed

Option	Description	Features
		• No major retaining walls
Option 4: Integrated development	Gradual transition from the city centre to the top of the stopbank to form a new promenade and an integrated development. Dudley Street properties would be developed and / or regenerated.	• Major property acquisition required • New integrated development in place of existing Daly Street buildings • New public space and promenade on top of stopbank • Opportunity for existing buildings to be adapted and re-purposed • No major retaining walls • New access points created with a new lane way
Option 5: New development with wider stopbanks.	The acquisition of Daly Street properties to form a newly built city edge.	• Medium property acquisition required • New development in place of existing buildings, but in a manner not connected to flood protection infrastructure • New stopbanks constructed • New access points created • New laneway • Lower retaining wall
Option 6: Preliminary Design 2018.	The promenade design as referenced in the HCC Making Places programme (discussed in section 3.6 above) and in the Preliminary Design Report 2018 (discussed in section 5.6 above)	• Medium property acquisition required • Comprehensive development that integrates building with stopbank structure • Mixed-use • Promenade at top of stopbank • Service tunnel under promenade • Mechanically stabilised earth (MSE) retaining wall along Daly Street

6.2.2 Evaluation undertaken

The above options were evaluated against the criteria that were established in the first MCA workshop. In summary the criteria consisted of:

- Urban design – assessment against the urban design principles set out in the Central City Transformation Plan CCTP;
- Te Mana o te Wai[4];
- Development feasibility and economics;
- Cost and implementation;
- Flood resilience;

[4] As defined in the NPSFM 2020, Te Mana o te Wai *"is a concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai. Te Mana o te Wai is about restoring and preserving the balance between the water, the wider environment, and the community."*

- Transport; and
- Environmental and social.

6.2.3 Findings

Summary of overall performance of each option

Options 1 and 2 scored very poorly against achieving the goals of the CCTP, and the goals of Te Mana o te Wai because both options feature tall retaining walls and limited access paths which reduce the access and connections between the city and the river. Both options would have poor environmental / social outcomes relating to visual amenity and natural character and were considered to have no economic development potential. Options 1 and 2 were not recommended for further consideration.

Option 3 was considered to achieve the CCTP, transport and Te Mana o te Wai objectives, and was the highest performing option in the environmental and social criteria. Option 3 would create strong visual and physical connection between the city and the river and has good flood resilience adaptability compared to the existing environment.

Option 3 would not provide for any additional direct economic development opportunity but in comparison to other options would be a low cost option to construct. Option 3 was expected to indirectly generate revenue potential for owners of the properties adjoining the new proposed river park, but this redevelopment revenue was not factored into the development feasibility assessment completed for this MCA.

Option 4 would achieve the goals of the CCTP, in particular the integration and connection between the city and river. Option 4's green space and the transition between the river and city mean it would have the second best environmental and social outcomes (behind Option 3). Option 4 was favoured by workshop participants because it was seen as an option that offered some of the benefits of Option 6, without such expensive integrated and risky construction and staging requirements.

However, Option 4 was one of the worst performers with regard to flood resilience due to the number of interfaces between structures, and although it has less risk than Option 6 to construct, it was still one of the highest risk and cost options to build.

Option 5 was seen as an 'average' option, which would not deliver the desired Project objectives in the strong way Options 3, 4 or 6 were expected to. Option 5 had poorer environmental and social outcomes, and it had one of the worst capital cost and implementation scores.

In Option 5's favour, it had positive flood resilience scores, and the best (comparative) economic development feasibility, being significantly better than Options 3, 4 and 6. Because of this Option 5 was considered to be worth further investigation, to identify how these outcomes could be taken forward into a new design option, while retaining the more positive environmental and CCTP objective outcomes achieved by Options 3 and 4.

Option 6 was identified as an option to continue investigating in Workshop 2 due to the option achieving well on the CCTP and transport objectives and having components which could be integrated into future design options (effective staging). However, it performs significantly worse than all other options, with regard to implementation, and the Project objective of flood resilience and had comparatively poor environmental / social outcomes. Option 6 was also the most expensive option to construct. This investment was not expected to be recouped.

Conclusions

It was recommended that none of the options in their entirety be progressed and that a new option (or options) be developed having regard to and incorporating the strengths of Option 3 (Southbank park urban regeneration), Option 4 (Integrated development), Option 5 (New

development with wider stopbanks) and Option 6 (Preliminary Design 2018). Key themes to take forward were recorded as being:

- The inclusion of both areas of public open space and buildings in the City Edge area, with the provision of more river – city connection;
- Low level buildings (not exceeding 3 storeys) to achieve a financially feasible development, in recognition of the findings arising that buildings over 3-4 stories require significantly greater ground improvement works due to the ground conditions;
- Not structurally integrating buildings with flood protection structures to provide for easy staging of investment and development, and to avoid compromising flood resilience and increased construction and maintenance risk. The integration of some form of a promenade would provide positive outcomes for pedestrians;
- Avoidance of structures like the tunnel for Daly Street due to increased costs, personal safety concerns, and the lack of flood and seismic resilience associated with this feature; and
- Minimising MSE retaining walls where possible.

6.3 City Edge MCA Analysis Addendum

The City Edge MCA Analysis Addendum (GHD Limited, 2021b) was prepared for GW, Waka Kotahi and HCC following completion of the previous MCA. Its purpose was the assessment of a new City Edge option (Option 7) that was developed to create an option that integrated the preferred/key themes or design elements identified in the City Edge MCA. The features of Option 7 are described in Figure 32.

Option 7 features
• A promenade boardwalk connecting a new 4-storey development in northern Daly Street to the top of the stopbank, • 4-5m high retaining wall near the pedestrian bridge but otherwise either low (2-3m) or no retaining walls along Daly Street • New access points between the River and the city centre including a new laneway between the Civic Precinct and the riverside • New development in place of existing buildings and explicit provision made for under building carparking • Medium levels of property acquisition required

Figure 32: Option 7 features

For consistency with the assessment undertaken for the original six options, Option 7 was to be assessed against the full suite of MCA criteria used for the original MCA described in section 6.2.

The assessment was partially complete, when the assessment was put on hold due to broader RiverLink scope issues relating to the position and height of the stopbanks. These issues had the potential to affect the design of the City Edge options, so no assessment work could be done until the matters were resolved.

The broader RiverLink scope issues were resolved through the Scope Resolution Phase described below in section 6.4, which then resulted in the alternatives assessment process at six specific locations as summarised in section 6.5 below.

Three of the six locations addressed in the work described in section 6.5 below encompassed the geographic City Edge area, and the scope of the assessment criteria included the main issues being considered through the City Edge MCA process, including:

- stopbank design including retaining walls and interface with development;
- road layout and access to the pedestrian bridge;
- private land impacts and development potential; and
- maintenance requirements.

It was determined that the assessment of alternatives for the six locations sufficiently incorporated the key issues from the City Edge MCA process (including the elements previously incorporated into Option 7) so the City Edge options were consequently determined through the assessment process described in section 6.5.

6.4 Scope resolution phase

The completion of flood modelling in July 2020 resulted in adjustments to the stopbank heights which had consequential effects on number of the Project assumptions and requirements which also had the potential to affect the overall scope of some previously designed RiverLink Project elements.

As a result, workshops were held to define the issues and GW, Waka Kotahi and HCC requirements at 14 locations within the Project area that were affected by the stopbank changes, with an end goal of reaching agreement as to the requirements at each of the 14 locations. After several workshops changes were made to the location of the stopbanks, the river channel alignment and the location and design of the new Melling Station and park and ride.

The result of this work was unanimous agreement by GW, Waka Kotahi and HCC on Project design at eight of the 14 locations, and the identification of six sites / areas where an assessment of alternatives was necessary to identify the "best for RiverLink" design for that location. This assessment is set out below in section 6.5 below.

6.5 Assessment of Alternatives 1 – 6 Assessment Report

As a result of the scope resolution phase, six specific Project locations were identified as requiring specific testing through an assessment of alternatives process. For each of the six Project locations, the design team created several potential design solutions and then assessed the performance of the options developed. These were referred to as Assessment of Alternatives 1 – 6 (AoA 1-6).

The AoA 1-6 Assessment Report (GHD Limited, 2020a) documents the assessment of alternatives at six locations within the Project area as a result of the scope resolution phase. Three of the AoA's are within the area known as the 'City Edge' which was subject to an earlier assessment of alternatives process which was addressed above in sections 6.2 and 6.4. The majority of matters assessed in the City Edge MCA process were carried through into the AoA 1-6 Assessment Report. The preferred alternatives were carried through to the Draft Indicative Design for Design Freeze 1. The concept of design freezes is explained at section 6.7.

The locations of the six AoA's are:

- AoA1 – Marsden Street;
- AoA2 – South Daly Street;
- AoA3 – North Daly Street City Edge;
- AoA4 – Chamber of Commerce & Auto Point House;
- AoA5 – Melling Bridge / Rutherford Street; and
- AoA6 – River Design Upstream of Melling.

6.5.1 Nature of options considered

In summary, 26 options were considered across the six locations, the general components of the options evaluated are summarised in Table 14 below.

Table 14 AoA options and summary of description

Option #	Summary of options
AoA 1 - location and alignment of Marsden Street - 3 options assessed This assessment considered different alignment options for Marsden Street to allow sufficient space for the new stopbank location, the impacts on the wider transport network, the scale of property acquisitions and integration into the wider urban environment.	
Option A	Realignment of Marsden Street adjacent to stopbank Incorporates a 1 m high retaining wall for a length of approximately 150 m. Requires no additional property acquisition beyond what was already identified as required for the Project
Option B	Realignment of Marsden Street away from stopbank Requires additional property purchases, however some residual land available for future development.
Option C	Realignment of Marsden Street away from stopbank, and changes to intersection with Bridge Street Requires more substantial property purchases; however, more residual land available for future development.
AoA 2 – southern configuration of Daly Street – 5 options assessed The assessment considered how the stopbank can be accommodated into south Daly Street, which includes consideration of the stopbank / city interface, the need for retaining walls, road layout, the scale of property acquisition required, and the potential for development.	
Option A	Daly Street reduced to one lane (southbound or northbound). Requires significant retaining structures up to 4.7 m high in the stopbank for 302m length. No requirement for property purchase along Daly Street south

Option #	Summary of options
Option B	Daly Street South is removed and replaced with a one-way service lane between High Street and Andrews Avenue. Requires property purchases to accommodate stopbank and enable future urban development. Requires retaining walls – one at the southern end of High Street with a length of 86m up to 2.5m high, and another 54m long and 2m high at the end of Andrews Avenue.
Option C	Daly Street South is removed and replaced with a one- way service lane between High Street and Andrews Avenue. Also provision of a new intersection at High Street/Queens Drive enabling all turning movements. Requires property purchases to accommodate stopbank and enable future urban development. Requires retaining walls – one of 34m length and 1.5m height at the southern end of High Street, and one of 54m length and 2m height at the end of Andrews Avenue.
Option D	Daly Street is removed and a new left-in left-out intersection at High Street/Queens Drive is developed Requires property purchases to accommodate stopbank and enable future urban development. Requires retaining walls – one of 34m length and 1.5m height at the southern end of High Street, and one of 14m length and maximum 1m height at the end of Andrews Avenue.
Option E	Daly Street is removed, and High Street is amended to southbound only, with a left-out intersection onto Queens Drive. Requires property purchases to accommodate stopbank and enable future urban development. Requires low retaining walls of 26 m length and maximum 1m height at the southern end of High Street and 14m length and 1m height at the end of Andrews Avenue.
AoA 3 central Daly Street configuration – 3 options assessed The assessment considered options to integrate the stopbank with future urban development, which included consideration the stopbank / city interface, the need for retaining walls, stopbank resilience, and the potential for development.	
Option A	8m wide stopbank crest and 5m accessway for maintenance

Option #	Summary of options
	Full height MSE wall (approx. 5m) with the potential to widen to a promenade by constructing a lid (bridging slab) over the maintenance accessway between the MSE wall and the proposed development area. This would provide a future promenade if desired
Option B	4m wide stopbank crest and 2m accessway for maintenance, resulting in a more restricted maintenance access but larger development footprint than Option A. The potential future promenade will also be narrower than Option A. Full height MSE wall (approx. 5m) with the potential to widen to a promenade by constructing a lid (bridging slab) over the maintenance accessway between the MSE wall and the proposed development area. This would provide a future promenade if desired
Option C	4m wide stopbank crest, with sloped land to provide maintenance access and a low 2m retaining wall to enable some development within the toe of the natural stopbank. Points of access, (regular bridging), rather than a continuous promenade, could be provided to first floor level cantilevered balconies of any future buildings.
AoA 4 - northern Daly Street configuration – 4 options assessed This assessment addressed how to fit the stopbank, the existing and future urban development, the pedestrian bridge and the access to the pedestrian within a constrained space, and considered the property acquisition requirements.	
Option A	No property purchases required and no impact on the Chamber of Commerce building and 20 Daly Street. Requires a low localised retaining wall (45m length, less than 1m high) within the stopbank adjacent to the Chamber of Commerce building. Stair and ramped pedestrian access off bridge down stopbank, and no cycle connection directly into the Lower Hutt city centre from the pedestrian/cycle bridge.
Option B	Partial property purchase of 20 Daly Street (up to 20m length), to achieve natural stopbank toe with 5m buffer and allows space for the cycle ramp Requires low localised retaining walls within the stopbank adjacent to the Chamber of Commerce building (45m 18 | AoA Report for RiverLink length, less than 1m high) and adjacent to 20 Daly Street (17m length, less than 1m high).

Option #	Summary of options
	Stair and ramped pedestrian access off bridge down stopbank. Cycle ramp providing direct access to the Lower Hutt city centre from the pedestrian/cycle bridge
Option C	Purchase of 20 Daly Street to accommodate a more generous cycle ramp that lands on Margaret Street. Stair and ramped pedestrian access off bridge down stopbank. Requires low localised retaining walls within the stopbank adjacent to the Chamber of Commerce building (45m length, less than 1m high) and adjacent to 20 Daly Street (17m length, less than 1m high)
Option D	Acquisition and demolition of the Chamber of Commerce building. Redevelopment of the site which provides the opportunity to integrate the pedestrian/cycle bridge landing and a cycle ramp with future urban development on the site. Requires a low localised retaining wall within the stopbank adjacent to 20 Daly Street (51m length, less than 1m high).
AoA 5 – Melling Bridge landing into Rutherford Street – 7 options assessed This assessment considered options to connect the new Melling interchange and bridge into Rutherford Street / Queens Drive while also considering road geometry, stopbank design requirements, property impacts and landscape / urban renewal	
Option A1	Moves Queens Drive centreline to the south and affects property on both sides of the road but with greater impact to the properties on the southern side of Queens Drive. Limits demolition of existing buildings through using retaining walls adjacent to the road boundary.
Option A2	Moves Queens Drive Centreline to the south and affects property on both sides of the road but with greater impact to the properties on the southern side of Queens Drive. Has greater impact on property through the formation of a natural earth batter interface between the new and existing ground profile.
Option B1	Aligns Queens Drive centreline close to the existing (slightly to the north) and effects property on both sides of Queens Drive, more significantly to the north.

Option #	Summary of options
	Limits demolition of existing buildings through using retaining walls adjacent to the road boundary.
Option B1.5	Aligns Queens Drive centreline close to the existing (slightly to the north) and is a hybrid of Options B1 and B2 which proposes a batter slope to the southern side of Queens Drive affecting property. Proposes a retaining wall to the northern side of Queens Drive such that the Brockelsby Roofing building can be retained. Wishart and Work & Income buildings will be removed.
Option B2	Aligns Queens Drive centreline close to the existing (slightly to the north) and has greater impact on property through the formation of a natural earth batter interface between the new and existing ground profile. Affects property on the northern side of Queens Drive more significantly than Option A1/A2, continues to affect property on the southern side of Queens Drive.
Option C1	Moves the Queens Drive centreline north which affects property on the northern side of Queens Drive more significantly than property to the south. Brocklesby, Wishart and W&I require demolition but demolition of Hotsprings Spas is avoided through using retaining walls which results in awkward skewed road intersection at High St / Queens Drive. Severely impacts property access on the northern side of Rutherford St including to the Harvey Norman building carpark.
Option C2	Moves the Queens Drive centreline north and has greater impact on property through the formation of a natural earth batter interface between the new and existing ground profile. Brocklesby, Wishart and W&I require demolition, but it affects property on the northern side of Queens Drive more significantly with some effect on property on the southern side of Queens Drive as well as access impacts on northern side of Rutherford St including to the Harvey Norman building carpark

Option #	Summary of options
AoA 6 – Active River Channel Design between Harcourt Werry Drive and Kennedy Good Bridge – 4 options assessed This assessment considers options for the design and management of the active river channel to manage in-channel erosion/food resilience, including consideration of ecological outcomes, buffer types, river and berm channel widths, maintenance and construction requirements	
Option A	100m wide naturally meandering channel with managed willow and native flexible edge No groynes but debris fences required while the 20m deep willow planting on the lower berms establish. Willows will be interspersed with native vegetation and will require regular, on-going maintenance to re-establish planting lost to erosion
Option B	90m wide channel which has fixed edges, and is relatively constrained creating unnatural channel meanders. Rock groynes along the lower berms every 50m on both river banks, and 10m deep native riparian shrub and groundcover on the lower berm. The maintenance regime will include replacement of the groynes and significant in-channel works following flood events
Option C	95m wide channel with a semi-fixed edge. The channel movement is fully constrained by groynes, fixing channel alignment and beaches in place. Rock groynes along the lower berms every 50m with 10m deep native riparian shrub and groundcover on the lower berm. The maintenance regime will require repair to groynes and management of vegetation. Regular interventions will be required in the active channel to maintain the meander pattern
Option D	90m wide channel with a fixed edge, and partially constrained channel. Wider channel and semi-fixed edge allow a more natural meander. Rock groynes along the lower berms every 50m on the TLB with 10m deep native riparian shrub and groundcover on the lower berm. On the TRB, no groynes, and 20m deep willow planting. A combination of maintenance regimes will be required to respond to the different treatments on TRB and TLB and will include in-channel works.

6.5.2 Evaluation undertaken

Each option for each of the six AoA's was evaluated against the criteria detailed in Figure 33: Matters of assessment unless it was identified as irrelevant. For example, the assessment of AoA-6 – Active river channel design was not assessed against transport related criteria, as there were no transport effects and therefore this matter was not a differentiator between the AoA-6 options.

Matters of assessment	Summary of items assessed through the supporting criterion
Flood protection	Achieving the RiverLink objective of increased flood protection, and the ability to withstand and recover from a flood or seismic event
Transport	Achieving the RiverLink objective of improved safety, resilience and efficiency of local roads and SH2 and improved accessibility between transport modes
Urban renewal and revitalisation	Achieving the RiverLink urban renewal and revitalisation objectives including connection between the city and river, enhanced amenity and connections and opportunities to attract people to the river
Te Mana o te Wai	How the mana and mauri of Te Awa Kairangi and its people between Ewen Bridge and Kennedy Good Bridge through design and the practice of kaitiakitanga can be enhanced
Environmental	Environmental effects including construction effects and effects on ecology, river recreation, amenity, stormwater, geo-morphology and natural processes
Property	The need and risk / complexity of acquiring property and the potential for redevelopment
Implementability	Estimated capital costs and maintenance requirements

Figure 33: Matters of assessment

The options were considered against the environment as it is today. This means the 'base case' or 'do nothing' option was the continued reliance on the existing environment for each option, rather than a comparison between the options. The assessment of likely capital cost excluded the property and acquisition costs (which are reflected in the property criteria). The capital cost therefore is an indication of the scale of likely civil works costs only, and also excluded any future building development costs).

6.5.3 Findings

Table 15 below sets out the preferred option and reason for each AoA option being recommended:

Table 15 Preferred Option for each AoA

AoA No	Preferred Option and Description	Reason
AoA -1 Marsden Street	**Option A** includes: - -Realignment of Marsden Street adjacent to stopbank. - -Incorporates a 1 m high retaining wall for a length of approximately 150 m. - - Requires no additional property acquisition beyond what was already identified as required for the Project before the AoA process	All options achieved the RiverLink Project objectives, however Option A was recommended because it was identified as having the fewest adverse effects and lowest cost whilst still contributing to the desired Project outcomes.
AoA – 2 Southern Configuration of Daly Street	**Option D AND Option E** To be built, both options require: - The acquisition and removal of buildings to build the stopbank and enable future urban development (there is no difference between the two options with regard to property acquisition) - The removal of Daly Street - Both require retaining walls at the southern end of High Street and at the end of Andrews Avenue, but Option D's High Street retaining wall is 8m longer, and 0.5m higher - Option D retains High Street as two way, with provision of a new left-in left-out intersection at High Street/Queens Drive while Option E reduces High Street to southbound only, with a left-out intersection onto Queens Drive.	Both Options D and E were recommended to be taken forward and developed further in the next stage of design because the respective option's impacts on the transport network would be more clearly understood at this stage, which will allow the better-performing option to be identified and chosen.
AoA – 3 Central Daly Street Configuration	**Option C** includes: - -4m wide stopbank crest, with sloped land to provide maintenance access and a low 2m retaining wall to enable some development within the toe of the natural stopbank. - -Points of access, (regular bridging), rather than a continuous promenade, could be provided to first floor level	Option C was recommended to be taken forward as it most effectively balanced the competing desire outcomes of resilience and urban renewal / amenity, while not foreclosing any future development opportunities. It was therefore the recommended option.

AoA No	Preferred Option and Description	Reason
	cantilevered balconies of any future buildings.	
AoA – 4 Northern Daly Street configuration	**Option B** includes: -Partial property purchase of 20 Daly Street (up to 20m length), to achieve natural stopbank toe with 5m buffer and allows space for the cycle ramp; -Requires low localised retaining walls within the stopbank adjacent to the Chamber of Commerce building (45m length, less than 1m high) and adjacent to 20 Daly Street (17m length, less than 1m high). -Stair and ramped pedestrian access off bridge down stopbank. -Cycle ramp providing direct access to the Lower Hutt city centre from the pedestrian/cycle bridge.	As Option B achieved the desired transport and amenity outcomes, was more efficient in terms of cost and land (because it was cheaper and required less private land), and did not preclude future private and/or public redevelopment of adjacent sites, it was the recommended option for AoA 4.
AoA – 5 Melling Bridge landing into Rutherford Street	**Option B1.5** includes: -Aligns Queens Drive centreline close to the existing (slightly to the north). -Is a hybrid of Options B1 and B2 which proposes a batter slope to the southern side of Queens Drive affecting property, and proposes a retaining wall to the northern side of Queens Drive such that the Brockelsby Roofing building can be retained. -Wishart and Work & Income buildings will be removed.	Since Option B1.5 provided a compromise between Options B1 and B2 it provided for a less adverse urban renewal outcome than Option B1, and avoided the significant complexity and risk associated with the acquisition of the Brockelsby Roofing site required by Option B2, Option B1.5 was the recommended option.
AoA – 6 Active River Channel Design between Harcourt Werry Drive and Kennedy-Good Bridge	**Option A** includes: - Managed willow and native bio-engineered, 'flexible' edge. -100m active river channel width. -Flexible channel and edge conditions. -Lower berm/buffer zone condition: 20m depth of managed willows on the TLB and the TRB, with native tree species in blocks minimum 5-15m wide at 60-120m	Subject to the adoption of an adaptive management approach, Option A was the recommended option because it achieves flood resilience outcomes and allows for natural river processes, and does not foreclose the pursuit of any alternative options in future if required.

AoA No	Preferred Option and Description	Reason
	intervals, all underplanted with native riparian shrub and groundcover species. -No groynes. -Requires debris fences Wood and rope) while willow plantings are establishing (approximately 5 year timeframe). -Meander: wider channel and flexible edge condition enables a more natural river dynamic, including channel movement/meander and sediment transport. - Maintenance: Vegetation buffers require ongoing maintenance, with vegetation re-establishment (replanting and layering) as erosion losses occur with channel movements. Likely to be low level and localised, but relatively regular. Annual programme of tree works is required to ensure the buffer is effective.	

All of the preferred or recommended options for each of the six AoA's were carried through into the consent design.

6.6 SH2 Pedestrian Overbridge Memo

As part of the consent design work, a possible pedestrian bridge over SH2 connecting to the proposed pedestrian /cycle bridge was considered. The option of a pedestrian bridge over SH2 was addressed within the SSBC (Stantec, 2019b), specifically Appendix I. Appendix I found that due to the steep and undulating nature of the topography of the western hill suburbs, fewer people walked to Melling Station from the adjacent hill suburbs than from the valley floor, and more people drove to the Melling Station from the hill suburbs than from the valley floor. Various options were considered in the SSBC for a new potential pedestrian overbridge over SH2, connecting the new Melling Station to the Western Hill suburbs of Harbour View.

Further investigations were undertaken during the consent design phase, which built on the investigations contained within Appendix I to the SSBC. These further investigations and findings are documented in a document titled SH2 Pedestrian Overbridge Memo, prepared by GHD, dated 24 July 2020 (GHD Limited, 2020b).

6.6.1 Nature of options considered

The initial feasibility assessment in the SSBC considered five options:

- Do nothing (i.e. existing network)
- Option 1: a new interchange and bridge over Te Awa Kairangi into Queens Drive (green in Figure 34 below). This option also included a footbridge over Te Awa Kairangi connecting to Margaret Street (blue in Figure 34)
- Option 2: a new pedestrian bridge over SH2 connecting into Harbour View at Gaskill Grove (red in Figure 34)
- Option 3: a footpath extension added to City View Grove (yellow in Figure 34)
- Option 3A: an alternative connection to City View Grove (yellow dashed line in Figure 34).

Out of the five options (including do nothing), options 2, 3 and 3A were considered relevant and progressed further as they incorporated a pedestrian bridge over SH2.

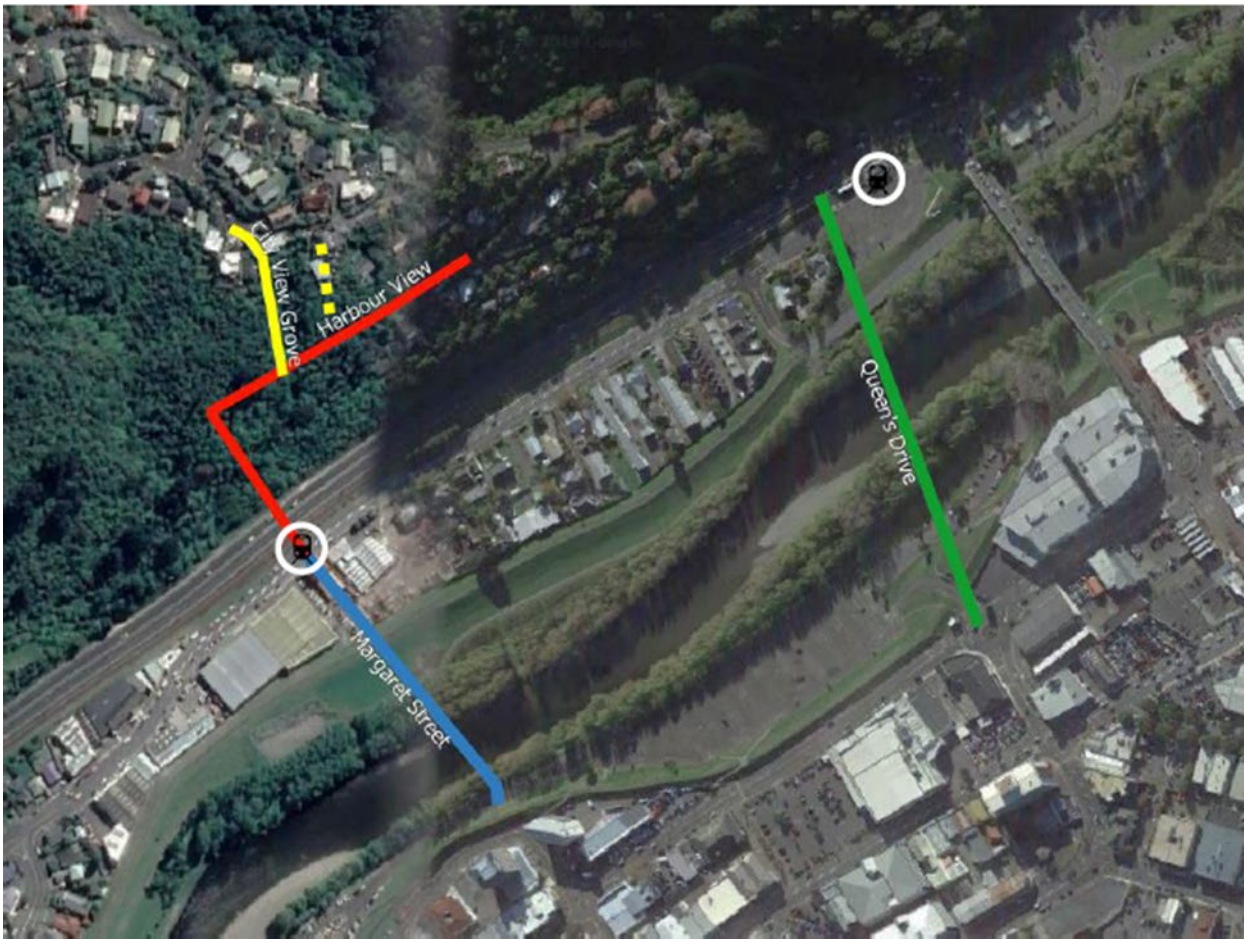


Figure 34 Pedestrian Overbridge SSBC Options

6.6.2 Evaluation undertaken

For the SH2 Pedestrian Overbridge Memo, a walking catchment assessment was undertaken and found that due to the location of the new Melling Station, all options would increase the walking distance from Harbour View. In addition, all of the options considered in the SSBC required stairs to achieve the proposed grades. A separate accessible ramp was not considered or proposed. The SSBC options therefore all precluded disabled access, therefore as they did not include a separate accessible ramp these options were discarded and not assessed further.

As part of the further evaluation undertaken, GHD prepared a further detailed option (refer Figure 35) during consent phase to further understand the gradient required to be achieved on an overbridge connecting Gaskill Grove to Melling Station. An option incorporating stairs in addition to an accessible ramp was also considered.

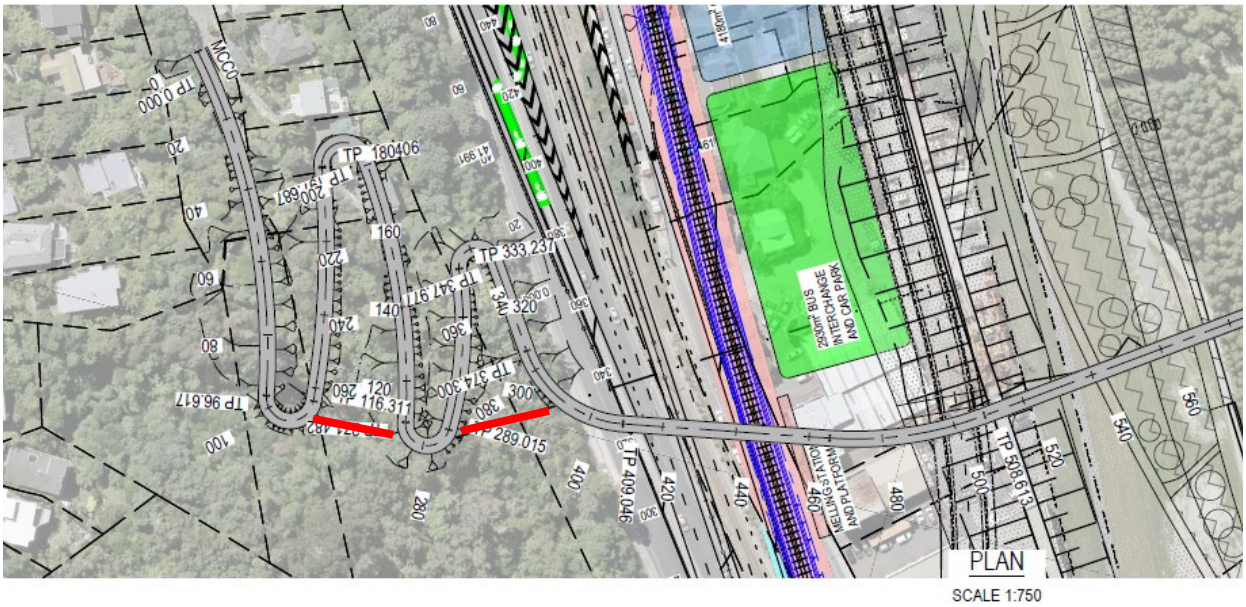


Figure 35: GHD overbridge sketch design (red indicates possible stair option

In summary, the existing and potential future pedestrian routes from Harbour View Road to Melling Station are identified in Figure 36.

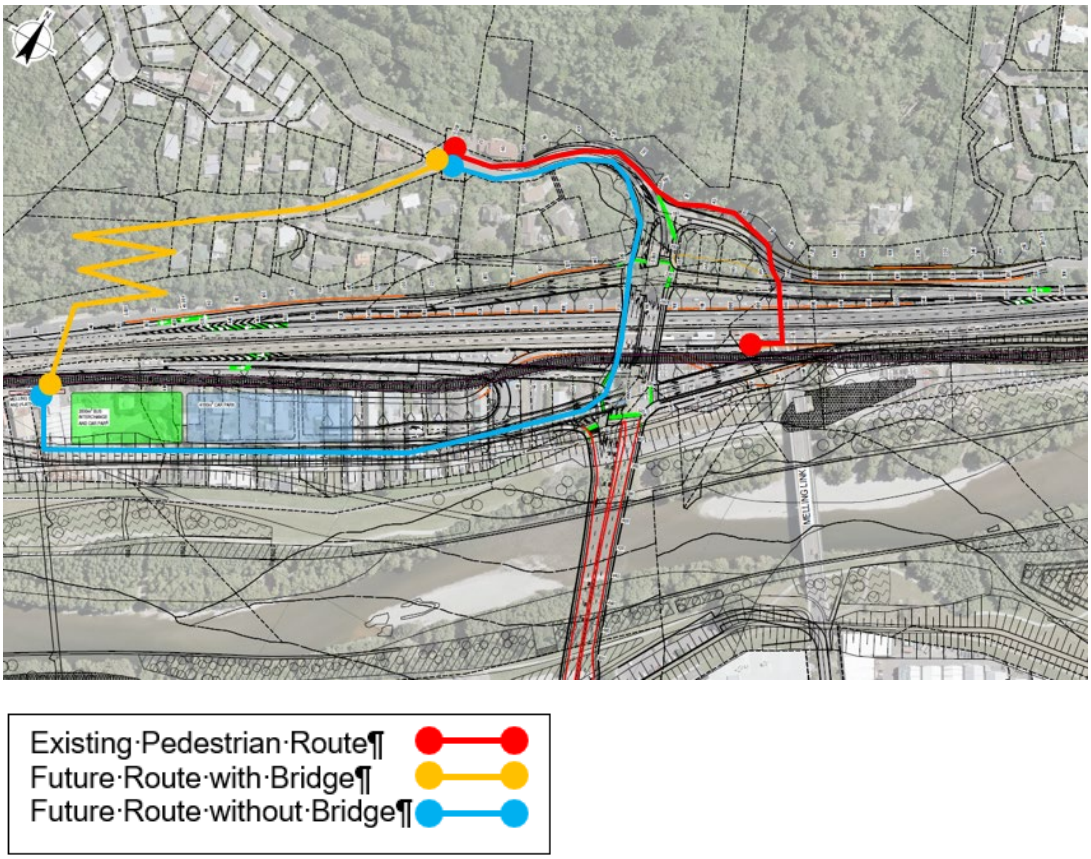


Figure 36 existing and potential future pedestrian routes

6.6.3 Findings

The investigations and further evaluation found that approximately 20 households are brought within an 800m catchment (i.e. walking distance) of the new Melling Station as a result of an SH2 pedestrian over bridge and therefore it only provides very small benefit. Other residents further afield in Harbour View are considered unlikely to utilise a new pedestrian bridge, given the steep gradient in the western hills. Given the small catchment and steep gradient necessary for the bridge, compared to the otherwise significant benefits to cycle and pedestrian links at the Melling interchange as a result of the RiverLink Project, a pedestrian overbridge connecting Melling Station to Harbour View is not considered to be warranted so was not included in the consent design for RiverLink.

6.7 Further consent design refinements

As part of design work undertaken to complete the consent design for the Project, further refinements were made to the design that involved a consideration of alternatives. These further refinements and alternatives considered are outlined below.

6.7.1 Cycleway / shared path design

During preliminary consent design, three broad options for cycling / shared path infrastructure provision were developed and assessed. There were elements within these options that had crossover, i.e. were the same for different options:

Option 1:

- Shared path minimum 4.5m width along west side of Pharazyn Street to Bridge Street.
- Shared paths of minimum 3m and 4.5m widths along the stopbank and riverbank respectively on both sides of the river.
- Shared path pedestrian and cycle bridge across the river.
- Separated one-way cycleway on each side of the new Melling Bridge
- Shoulder on State highway 2 northbound up to the existing interchange – utilising exit ramps to connect to bridges over SH 2 and the river
- Shoulder on State highway 2 southbound with underpasses to remove conflict at exit and entry ramp gore areas.

Option 2:

- Separate bi-directional cycleway along west side of Pharazyn Street to Bridge Street.
- Shared paths of minimum 3m and 4.5m widths along the stopbank and riverbank respectively on the TLB.
- A combination of shared and segregated paths along the stopbank and riverbank on the TRB.
- Segregated pedestrian and cycle bridge across the river.
- Separated one-way cycleway on each side of the new Melling Bridge
- Shoulder on State highway 2 northbound up to the existing interchange – utilising exit ramps to connect to bridges over SH 2 and the river
- Shoulder on State highway 2 southbound with underpasses to remove conflict at exit and entry ramp gore areas.

Option 3:

- Separated bi-directional cycleway along east side of Marsden Street from Bridge Street to new Melling Bridge.
- Shared path of minimum 4.5m and 3m widths along the stopbank and riverbank respectively on the TLB.
- Shared path of minimum 4.5m along the riverbank transitioning to the stopbank on the TRB.
- Shared path pedestrian and cycle bridge across the river.
- Separated bi-directional cycleway on southern side of new Melling Bridge
- Shoulder on State highway 2 northbound up to the existing interchange – utilising exit ramps to connect to bridges over SH 2 and the river

- Shoulder on State highway 2 southbound with underpasses to remove conflict at exit and entry ramp gore areas.

These options were discussed with cycle advocacy and interest groups from across Wellington and the Hutt valley as well as HCC walking and cycling representatives. Through these discussions a hybrid version of Option 2 was selected as the preferred option to develop for the consent design. The elements of this preferred option are:

- Separated bi-directional cycleway along the railway corridor from Parliament Street to the New Melling Station
- Shared path of minimum 4.5m and 3m widths along the stopbank and riverbank respectively on the TLB.
- Shared path of minimum 4.5m along the riverbank transitioning to the stopbank on the TRB.
- Shared path pedestrian and cycle bridge across the river.
- Separated bi-directional cycleway on southern side of new Melling Bridge
- Shoulder on State highway 2 northbound up to the existing interchange – utilising exit ramps to connect to bridges over SH 2 and the river
- Shoulder on State highway 2 southbound with underpasses to remove conflict at exit and entry ramp gore areas.

The initial amendment to Option 2 was a shift in the location of the Pharazyn St path to the eastern side of the road and the connection to the stopbank.

As this design was further developed and the effects of it were understood, the impact of parking on Pharazyn Street and safety of the path with the number of residential accessways across it became apparent. The preferred solution was to extend the Pito-one to Melling separated bi-directional cycleway along the railway corridor from Parliament Street to the New Melling Station.

6.7.2 Rail station and carpark

Due to the spatial requirements for the state highway, entry and exit ramp geometry, flood protection works in the river, and minimum rail corridor requirements, there are limited options for locating the New Melling Station. The remaining space in this (Melling) area has been fully utilised for the station, bus and car connections, car park layout and stormwater treatment. The proposed location of the New Melling Station is a natural fit with the overall Riverlink Project, and in terms of providing improved connectivity to Lower Hutt city centre.

6.7.3 Pedestrian and cycling bridge western abutment

Two options were considered for the interface with the realigned Pharazyn Street was considered for the western abutment of the pedestrian and cycle bridge; the bridge landing at the top of the stopbank level, or continuation of the pedestrian bridge to incorporate an overbridge over Pharazyn Street.

The Pharazyn Street overbridge option was discounted due to geometry, i.e. the height required to cross over Pharazyn Street resulted in a very high bridge structure with long ramps connecting to the stopbank and the Melling Station. The visual impact and undesirability from a user perspective

were further reasons to discount this option. Therefore, the preferred option was to land the western end of the bridge at the top of the stopbank, which is at the same level as the new Pharazyn Street.

6.7.4 SH2 over bridge culvert impacts

The new SH2 interchange overbridge and associated on and off ramps will require the relocation (reconstruction) of the existing culvert under Harbour View Road. This will result in the loss of a 25m section of natural waterway between the highway and the existing Harbour View Road culvert. This 25m section of waterway cannot be retained as part of the new works as it is the location of the new SH2 overbridge abutments and off ramp for the new interchange. Relocation of the abutment to retain the section of stream was not practically achievable due to roading geometry requirements without a major increase in earthworks and associated loss of bush and possible impact on adjacent flowpaths. A number of alternative solutions were considered for management of the tributary flows. These alternatives and the reason that they were not considered feasible are identified below:

- Installing a culvert along the alignment of the current channel and culvert beneath the abutment: This option was discounted as the abutment works require major ground improvement which prevent a culvert being installed in this location.
- Installing a culvert and outlet on the northern side of the abutment: This option would have required the culvert to go through the abutment and the associated ground improvement similar to the option above and was therefore not considered further.
- Installing channel on the south side of the interchange: The adjacent topography is very steep and would have required additional land acquisition, significant additional excavation and clearance of established bush. A channel in this location would be significantly steeper than the current channel and likely to require engineered energy dissipation or bed reinforcement and the downstream section of culvert between the channel and the River would be steeper preventing fish passage.
- Installing a culvert on the south side of the interchange but daylighting a section/ providing a new section of channel between SH2 and the river: There are no suitable locations where this could be achieved in the vicinity of the current alignment.

The waterway cannot be reinstated within the immediate vicinity, due to the topographical and spatial constraints. While reinstating the waterway under the over bridge abutment may be technically possible, such an undertaking would result in a very significant structure at significant expense, therefore this is considered to be unfeasible.

None of the alternative options identified allowed retaining or re-establishment of a channel similar in nature to the existing and the option to culvert the flow and daylight an alternative section of culvert in the Tirohanga Stream to re-establish an open channel similar in nature and of similar or greater length was adopted.

6.7.5 Design freezes

The development of consent design plans adopted a methodology of design freezes to allow for specialist input into the design. There were three design stages: Design Freeze 1 (DF1), Design Freeze 2 (DF2) and Final Consent Design. The DF1 plans were prepared based on the outcomes

of the various alternatives and optioneering processes outlined above. These DF1 plans were provided to the specialist technical assessors to prepare their draft technical assessments. DF2 plans were then prepared, incorporating amendments to the DF1 plans based on comments and mitigation recommendations provided by the technical specialists. Following final reviews, the DF2 plans were updated to reflect the final consent design.

7. Conclusion

Given the RiverLink Project development has spanned a number of years there have been a number of assessments undertaken with regards to the assessment of alternative options, for the overall Project and its individual components. The Project has adapted over time to the different objectives of the three requiring authorities and in response to feedback from environmental specialists, the public and key stakeholders.

The alternatives assessment has been robust and thorough in terms of its requirements of section 171(1) and Clause 4 of Schedule 6 of the RMA. Robust evaluation frameworks have been followed throughout the development of the alternative design options, with MCA being a key tool employed to carry out analysis and provide information in respect of alternatives considered to GW, Waka Kotahi and HCC.

Following that detailed consideration of alternatives, the consent design will provide a large number of benefits, and deliver three long awaited projects under the umbrella of a single integrated design solution. The alternatives process (and outcomes) has been cognisant of environmental, social and cultural constraints; an overall positive outcome will be achieved.