HUTT RIVER CITY CENTRE SECTION UPGRADE PROJECT OPTIONS EVALUATION REPORT

19 JULY 2015

Boffa Miskell

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Prepared for GWRC, HCC and NZTA by Boffa Miskell Ltd

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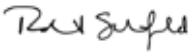
Reviewed by:	Robert Schofield, Planner Boffa Miskell Limited	
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1. Introduction

The following report presents the outcomes of the process to identify and evaluate options to upgrade the City Centre Section of the Hutt River (between Kennedy-Good and Ewen Bridges – refer Attachment 1: Figure 1). The upgrade aims to provide a combination of: (a) improved resilience to the Hutt Valley's flood protection to the Hutt River Floodplain Management Plan (HRFMP) standard[1]; (b) improved amenity for the Hutt City Centre; and (c) improved transport functionality at the intersection of Melling Link/Bridge and State Highway 2 (SH2).

The focus of this report is on the Hutt River City Centre Section between and including Melling Bridge and down to (but not including) the Ewen Bridge. The decision making process and some of the flood protection implementation in the top part of the City Centre Section upstream, between the Melling and Kennedy-Good Bridges, has already been advanced (in the Boulcott area). The stopbank and river channel alignments have been determined by earlier studies.

This report provides the basis for recommendations to the Hutt Valley Flood Management Subcommittee (HVFMS) for its decision as to the preferred options for the City Centre Section between the Melling and Ewen Bridges to proceed to public consultation for feedback.

This early stage of the consultation process asks the question as to whether the community agrees with the preferred options, or whether some other option is preferred. If the community agrees with the HVFMS preferred options then the question is what the preferences are between the two and the timing of their implementation. That feedback will inform consequent decision-making of the HVFMS as to a final option, or a package of staged options, and/or any variations on the options arising from consultation and deliberations of the HVFMS. With a final option decided the project can proceed to the next steps for funding confirmation, consenting, programming and implementation.

2. Background

2.1 Hutt River Floodplain Management Plan

The foundation policy for the management of flood risk in the Hutt Valley is the Hutt River Floodplain Management Plan (2001) (HRFMP). The HRFMP was formulated through a process of extensive community engagement and backed by a suite of technical studies. It was adopted by the constituent Councils of Hutt City Council (HCC), Upper Hutt City Council (UHCC) and Greater Wellington Regional Council (GWRC) in 2001. Since its adoption the HRFMP has been the basis for flood improvement works, river management activities, the management of uses in the river corridor, as well as land use planning policy in the Valley.

[1] The standard is for a 1 in 440 year flood

The HRFMP established an accepted level of protection from floods. With over 130,000 people living in the Valley the consequences of a large flood are significant and have been quantified at over $1 billion (not including the social and other costs associated with disruption). The extent of flooding that would occur from a breach of flood defences either side of the River is described in Attachment 1: Figures 2 and 3.

Recognising that shifting the urban development off the floodplain to the hills or elsewhere would not be viable the HRFMP strikes a balance, enabling development to continue by the provision of a sufficient standard of protection to minimise damages from floods over the long term.

The standard adopted by the HRFMP is risk based. Risk based means including some tolerance within the standard to provide for uncertainties and to recognise that risks may change over time. Accordingly, all major urban areas (of which the City Centre Section is part) are having stopbanks upgraded to contain a 2800 cumec river flow.

The 2800 cumec standard was selected for the stopbanks protecting major urban areas to respond to:

- The potential impacts of climate change[2]
- Uncertainties about flood behaviours
- Eliminating disruptions by doing the work once to a higher standard
- Costs considerations – the higher stopbanks for 2800 cumecs were not significantly more costly than the lower ones for 2300 cumecs.

To achieve the flood protection standards of the HRFMP, a programme of physical works (with a budget of $78 million as at 2001) was planned to upgrade the stop banks, river channel and berms within defined sections of the Hutt River. Several of these upgrades have been completed, including in the section from the Ewen Bridge to the Ava rail bridge and the stopbanks from Kennedy-Good Bridge downstream to Mills Street through the Boulcott area (Attachment 1: Figure 4). The HRFMP also identified a range of non-structural measures (like land use planning policy and emergency management procedures) that would work alongside the structural upgrades.

The Hutt City Centre Section stopbanks from Mills Street to Ewen Bridge (as well as channel improvements from Kennedy-Good Bridge to Melling Bridge) is the last part of the river upgrading work required to provide the protection from a flood to the Hutt City Centre and the central residential areas to the standards in the HRFMP.

2.2 Hutt City Centre Section – 2014 Integrated Concept Plan

GWRC have allocated a budget of $49.5 million[3] to undertake the upgrade to the stopbanks and river channel in the Hutt City Centre Section of the Hutt River to the HRFMP design. In considering

[2] The effects of climate change are continually being monitored and researched and the planning for these effects requires decisions to be made based on the latest understanding of the frequency and magnitude of climate change.

[3] 2015-2025 GWRC Proposed Long Term Council Plan.

the design of the upgrade, two other public project initiatives were identified that had overlapping interests in the same section:

(a) proposed transportation improvements by New Zealand Transport Agency (NZTA) at the intersection of the Melling Bridge and SH2; and

(b) proposed amenity improvements by HCC as part of a 2009 urban design strategy for the Hutt City Centre (called 'Making Places') that encourages investment and public use through a suite of public and private initiatives, such as improved connections to and along the River and a riverside promenade and park with associated residential and commercial developments adjacent to the River.

GWRC prepared a report (City Centre Section Scoping Report – Hutt River Floodplain Management Plan) in 2013 which established that there was benefit in taking an integrated approach to the design of the City Centre Section of the Hutt River to take advantage of the overlapping interests of the public projects. The HVFMS confirmed (June 2013) an integrated approach process should be progressed and a management structure was set up (September 2013) which includes a Working Group (of officers from HCC, GWRC and NZTA, and consultants as required), a Management Group (senior officers), and with governance provided by the HVFMS.

The process of developing an integrated design advanced with the development of design objectives (approved by the HVFMS March 2014) followed by the stopbank and river channel widening engineering design, and Making Places urban and landscape design. As part of the design process, the hydrological performance of the proposed river channel, stopbanks and obstructions such as bridges, was reviewed including the use of computer modelling to predict that performance.

When factoring into the model the most recent knowledge[4] on potential climate change influences on flood frequency, as well as the more up-to-date data on the River profile, including the constraints generated by the existing Melling Bridge, it was determined that the agreed HRFMP protection from flooding (containment of a 2800 cumec river flow) could not be achieved within the current stopbank footprint. The narrowness of the City Centre Section of the river corridor, relative to the much wider corridor[5] upstream and downstream of this section, creates a constrained passage for floodwaters to move through. The HRFMP design relied on maintaining the existing relatively narrow river corridor width and widening as far as possible the river channel and increasing stopbank heights within that corridor. It was therefore determined to consider alternative options and their possible staging over time, for providing the standard of protection sought by the HRFMP through the City Centre Section.

[4] The International Panel on Climate Change Report and New Zealand context (Chapter 25, 2014) has guided (with advice from Andy Reisinger, Coordinating Lead Author) a range of scenarios to model river flows – a 'high' carbon use future where more extreme events can be expected through to a 'low' carbon future where events can be expected to be more moderate albeit not getting any less moderate than they are now.

[5] River corridor means the width from one side to the other (stopbanks, berms, water, car parking areas etc) – typically defined by the outside edge of the stopbanks. The width of river channel up and downstream of the City Centre Section is significantly greater providing greater flexibility for changes.

2.3 Melling to Kennedy Good Bridge

The City Centre Section works have been partly implemented in the Boulcott area where the stopbanks have been upgraded – this work was completed in 2013. Downstream of the Boulcott works further stopbank upgrades are required along with river channel widening. Part of the upgrades include realigning the stopbank at Mills Street to release a constriction in the floodway width. This requires the acquisition and removal of several residential properties. The decisions have been made on the stopbank realignment in this Mills Street area and GWRC has progressed with the acquisition of some of the required properties.

The river channel alignment through this section has been determined. However, no additional land between Melling and Kennedy-Good Bridges beyond the current corridor (apart from that at Mills Street) is required so channel widening and stopbank upgrades can occur within the current river land. This directs the main flood planning focus at this time to the options that will provide for the constriction in corridor width in the area between the Melling Bridge and the Ewen Bridge.

3. Alternative Options

The process and programme for developing, evaluating, consulting on and deciding on alternative options for the City Centre Section between the Melling and Ewen Bridges was presented to the HVFMS in December 2014. This report now sets out the findings of that options evaluation process.

In identifying the potential principal alternative physical works proposals for achieving flood protection in this section of the Hutt River, as well as the other design objectives, a combination of option components was considered. These are considered as a combination because the various 'base' flood resilience options can have Making Places options and transport options or policy options applied in various combinations. The options are made up of combinations of the following components:

a) Physical works options that would provide flood resilience improvements by upgrades to river channel width[6], berm width[7] and stopbank height[8], as well as Melling Bridge height in order to match the wider corridor and flood capacity up and downstream of the City Centre Section. Together these can result in significant improvements to the capacity of the river corridor to contain large flood events. These physical works are considered as the 'base' physical options, as the primary purpose of the work is to upgrade the level of flood protection. It is noted that some of the options considered cannot provide the HRFMP standard over time due to potential climate change influences.

[6] Channel width is the measurement from side to side of the river channel measured from the top of the batter slope as it meets the berm.
[7] Berm width is the generally flat area that is between the river channel and the inside toe of the stopbank.
[8] Stopbanks are typically designed to have a slope of 3.5 to 1. The current stopbanks will need to be increased in height by 1m.

b) Physical works options that would provide 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. A "Better Business Case" approach (NZTA model) to determine the optimal *timing* of the replacement of the Melling Bridge (in conjunction with any intersection improvements, other transport benefits, urban design gateway benefits and consequent flood protection improvements) is occurring in a parallel process.
c) Policy options (i.e. non-structural options) that would manage land use on the floodplain in conjunction with physical works, or instead of physical works.
d) Staging options to allow for adaptation over time to address changing climate impacts on flood frequency by upgrading when required.

The options components under (a) to (d) above have been considered as combinations to ensure that the benefits of an integrated concept design process are maximised (refer section 2.2 above). A diagram which describes these option component overlaps is provided in Attachment 2. These options components are described further below.

3.1 Physical Works Options – Flood Resilience

There are a range of options for addressing the need for improved flood resilience to meet the 2800 cumec standard as set by the HRFMP. To be effective, the options all need to reduce the constraints of the narrower section of the river between Melling and Ewen Bridges (including the constraint of the Melling Bridge which is too low to allow large quantities of flood water to pass). It is one of the policies (Policy 15) of the HRFMP that, when owners decide to replace them, then the Hutt River bridges should be built to pass a 2800 cumec river flow.

An important consideration in determining the physical options has been the context within which the options have to be derived to satisfy the HRFMP standards. Effectively the only options for the river's City Centre Section that can realistically achieve the standard must connect between the upgraded and wider section upstream and the upgraded and wider section downstream. To do this the flood resilience options are all focussed around widening the river corridor to a greater or lesser extent.

The effectiveness of flood protection works into the future[9] will depend on the extent to which the corridor allows for adaptation of responses so the 2800 cumec standard can continue to be met as weather events become more extreme or frequent. Note that to provide a range of options there are some which include a lesser level of protection than the HRFMP established in the event that this is accepted by the community as its preference (such as for reasons of affordability). However, any of these lesser options may need stronger land use policy to reduce the risk of damage from flooding.

The principal structural options for improving flood resilience have been grouped into 3 types – maximum, medium and minimum option - the calibration of which relates to corridor widths and the

[9] Further discussion on adaptation is set out in 3.4 of this report.

extent of physical change. It is noted that the 'maximum' option is not the maximum the corridor could be, but the maximum of the options identified. These are illustrated in Attachment 1: Figures 5 – 15, and summarised in Table 1 below:

- Maximum Option 1

  The maximum option is the widest of the options, but still is 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 heightened stopbanks. This is the 'maximum' of the options in terms of corridor width and provides the greatest opportunity for adaptation over time. This option also includes the replacement of Melling Bridge.

- Medium Option 2
  The medium option generates a wider corridor, but still is less of a match with the corridor up and downstream of the City Centre Section in terms of berm widths. The medium option widens the river corridor on one side or the other (but not both) which, like the maximum options, would require some (but not as much) property to be acquired. This enables an upgrade which includes river channel widening (90m wide), wider berms (25m wide) and heightened stopbanks. This option also includes the replacement of Melling Bridge.

- Medium Option 3
  The medium Option 3 achieves a wider river corridor by building a 4m high floodwall on the back boundary of properties along Pharazyn Street. The wall effectively reduces the space required for a stopbank and consequently means no private property on the west side would be required. The upgrade would include widening of the river channel (90m wide) but there is no berm on the west side against the floodwall. On the city side the stopbank would be heightened and berm on the city side would be widened (25m berm). This option also includes the replacement of Melling Bridge.

- Minimum Option 4
  The minimum Option 4 widens the river corridor marginally by taking up road reserve space on Daly Street. The corridor remains the same on the western (Pharazyn Street) side and no private property there would need to be acquired. This option only allows for a 70m wide channel, berms of 15m wide, stopbanks heightening and Melling Bridge replacement.

- Minimum Option 5
  This option has no widening of the river corridor and, as far as possible within the constraints, widens the river channel (70m wide), berms (15m wide) and stopbanks heightening. The Melling Bridge would not be replaced[10].

[10] Note that when Option 5 is expanded to the Making Places and Transport Options (Table 2) then one of the Options (5A) does include a replacement bridge and this would meet the HRFMP standard in 2015, but not by 2045.

- Status Quo - Option 6
  This is the status quo or 'do nothing' option, whereby the current poor level of protection remains. The Melling Bridge would not be replaced.

Table 1: Summary of Base Flood Resilience Options								
Option	Type	Private Property Take[11]	Melling Bridge Replace	HRFMP Standard 2800 cumec in 2015	HRFMP Standard 2800 cumec in 2045	Channel Width (m)	Berm Width (m)	Adaptation Flexibility within Option Corridor
1	Maximum	Extensive	Yes	Yes	Yes	90	50	Maximum
2	Medium	Moderate	Yes	Yes	Yes	90	25	Medium
3	Medium	Minimal	Yes	Yes	Yes	90	0 west	Nil[12]
4	Minimum	Minimal	Yes	Yes[13]	No	70	15	Minimal
5	Minimum	Minimal	Yes	No[14]	No	70	15	Minimal
6	Minimum	Nil	No	No	No	current	current	Minimal

Note that where any of the above 'base' flood resilience options provide less than the HRFMP standard then land use policy may need to be used to manage current and future flood risk (refer to section 3.3 Policy Options below).

3.2 Physical Works Options – Making Places and Transport

Options for achieving the Making Places and Transport objectives have been integrated with the flood resilience 'base' options. The Making Places and Transport options are 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 are required. In all of the options, there is a greater or lesser ability to have environmental enhancements (ecological, recreational, park open space) which is largely a function of the width of the river corridor that can be provided.

The extent to which the options provide for enhancements is addressed in the evaluation process[15]. If it is assumed that the displacement of people resulting from property acquisition is an adverse effect[16], the social effects of the options also vary, from maximum for those options with largest

[11] The property take is greatest for those options that extend the corridor width. However, all the options that include replacement of the Melling Bridge require a private property to the north of the current bridge to be acquired.
[12] Building a wall on the west side would make changing the corridor later very difficult without large deconstruction and sunk costs expended.
[13] This table shows that Option 4 can meet the standard for now, but is not expected to be able to at some time past 2045 assuming GWRC climate change scenario policy
[14] With no replacement bridge – when bridge replaced it would meet the current (2015) 2800 cumec standard
[15] Refer to section 5.
[16] It is recognised that for those people being displaced it would be seen as an adverse effect, but the wider social effects could also be seen as beneficial in terms of the use of those acquired properties protecting the much larger group of people living on the river floodplain.

property take to minimal for those where there is very little property take. These effects are also addressed in the evaluation process.

There are multiple combinations possible when integrating Making Places and Transport options (refer to Figures 5 – 15) into the base options: the combinations used are described below. The Making Places and Transport options are summarised in Table 2 below:

- Maximum Option 1A and 1B
  There are two variations of this option, with the key difference between options being that, in Option 1A, traffic currently using the city centre west ring road would be transferred to High Street, while in Option 1B, traffic would be maintained along Daly Street in the form of an underpass between the new stopbank and new development (Figure 5 and 6). Options 1 (A and B) provide opportunity for new walking/cycling connections to the river from the city, as well as frontage opportunity for apartments and commercial development to be built adjacent to the river corridor with an associated promenade development. Parking could be retained in the river corridor.

- Medium Option 2A, 2B, 2C and 2D
  Option 2 provides moderate opportunity for apartments and commercial development abutting the River. There are four variations of this option: Option 2A maintains traffic along Daly Street in the form of an underpass between the new stopbank and new development; Option 2B diverts traffic to Dudley/Rutherford Street and removes parking in the river corridor for increased development investment; Option 2C could maintain parking in the river corridor and diverts traffic to Dudley/Rutherford Street; and Option 2D widens the river corridor but takes out current commercial land back towards High Street and diverts traffic to Queens Drive. In Options 2A and 2C, a new pedestrian bridge[17] connects pedestrians and cyclists directly to the railway station at Melling (Figure 7, 8, 9 and 10).

- Medium Option 3A
  Option 3 provides moderate opportunity for apartments and commercial development abutting the River and would divert traffic to Dudley/Rutherford Street. A new pedestrian bridge connects pedestrians and cyclists directly to the railway station at Melling (Figure 11).

- Minimum Option 4A
  Option 4 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 railway station at Melling (Figure 12). This option is that same as Option 2C on the city side, but does not extent west and therefore no private property is required.

[17] It was assumed that for options with a longer promenade building edge (Options 1A, 1B, 2B) that these would not need a pedestrian bridge as people would choose to walk/cycle along this sheltered edge which extends up to the Melling Bridge, and cross on the new bridge footpath/cyclepath

- Minimum Option 5A and 5B
  Option 5 provides no opportunity for apartment and commercial development abutting the river, while traffic can be maintained along Daly Street. New apartment and commercial development could be accommodated on the blocks back from the stopbank, but the stopbank would not be engineered to allow the new buildings to abut and form a promenade edge. The difference between Options 5A and 5B is that there is a new Melling Bridge in Option 5A, but not in 5B (Figure 13 and 14). All other options (except 5B and Option 6 – Status Quo) provide for a new Melling Bridge.

- Status Quo Option 6A
  There is no opportunity under the status quo Option 6 for apartments and commercial development abutting the river, while traffic would be maintained along Daly Street. No new Melling Bridge is anticipated under Option 6A (Figure 15).

Table 2: Summary Making Places and Transport Options

Option	Type	Traffic[18] Route	Parking[19]	Develop[20]	Ped. Bridge	City Connection[21]	Environment
1A	Maximum	High	Yes	Extensive	No	Maximum	Maximum
1B	Maximum	Daly + u/p	Yes	Extensive	No	Medium	Maximum
2A	Medium	Daly + u/p	Yes	Moderate	Yes	Medium	Medium
2B	Medium	Dudley	No	Extensive	No	Medium	Medium
2C	Medium	Dudley	Yes	Moderate	Yes	Medium	Medium
2D	Medium	Queen	No	Extensive	No	Maximum	Medium
3A	Medium	Dudley	Yes	Moderate	Yes	Minimal west	Minimal west
4A	Minimum	Dudley	Yes	Moderate	Yes	Medium	Medium
5A	Minimum	Daly	Yes	Nil	No	Minimal	Minimal
5B	Minimum	Daly	Yes	Nil	No	Minimal	Minimal
6	Status Quo	Daly	Yes	Nil	No	Minimal	Status Quo

3.2.1 SH2/Melling Bridge Connections and Business Case

The full benefit of flood protection works would not be realised until the Melling Bridge is replaced. The integration of the replacement of the Melling Bridge with SH2/Melling intersection

[18] Traffic refers to the main route that the eastern part of the city ring route would be provided on – other streets may need changes too. U/P = underpass. Described as an underpass, rather than a tunnel, to recognise that Daly Street would have bridging over at intervals rather than being continuously underground.
[19] Parking means that car parking could be retained in river corridor – approx. 400 parks city side are possible
[20] Development means the extent to which vertical mixed use (commercial and residential development) is encouraged by the option. In this regard the options only indicate possibilities - the extent to which opportunities for development are taken up will rest with the land owners. Any change will occur over a long period.
[21] City connection means the number of opportunities to have a hierarchy of connecting ramps/steps and bridges to the river across the stopbank from the city

improvements in conjunction with the flood protection works is one of the opportunities presented by the project.

There are a number of efficiencies that can be expected by integrating design and implementation of other works at the intersection with flood protection works. For these reasons, a business case process was initiated in partnership between GWRC, NZTA and HCC. The purpose of the business case is to coordinate an investment programme in the Melling area and identify the range of benefits, including timing of the Melling Bridge replacement which is important to flood protection and integral to transport and Making Places proposals.

When considering the intersection area there are also associated improvements that can be made at the Melling Station, which could include repositioning the platform and shelter further south to align with train stopping positions, supplementing the existing 'park and ride' car parking, and improving access to the station for pedestrians and cyclists.

Determining the timing of the SH2 Melling intersection improvements as part of a broader package of improvements to the SH2 corridor by NZTA will assist with integration of the flood protection works.

3.3 Policy Options

An alternative or supplementary option for managing the risk of flood hazard in the Hutt Valley is through the use of land use policy developed under the Resource Management Act (1991) (RMA) to manage uses on those areas where the flood hazard exists. There are already policies of this type in the Hutt City District Plan that came from the HRFMP and these could be applied further afield or supplemented. In this way policies as well as structural options are not new to the area.

Such policies can be calibrated according to the level of risk and the degree to which any physical options may mitigate that risk. In general, where there is a significant level of residual risk that is not mitigated through flood protection works, policies could be introduced to support a regulatory regime to manage land use and development in areas affected by such risk.

Policies could range from little or no land use controls, focusing on informing and promoting risk mitigation, through to strong regulatory controls that could include prohibiting some activities, requiring resource consents for other activities, and/or imposing building design and location standards. Policies could also address the need to protect flood protection assets from the effects of other activities, or to ensure their ongoing maintenance and upgrading.

Broader policy considerations (whatever the extent of physical flood mitigation works) could include the way in which urban development is encouraged or discouraged into the future with a view to reducing overall risk as climate change continues over time.

3.3.1 Existing Policy Situation

Overarching policy already exists in the Wellington Regional Policy Statement[22] (WRPS) which recognises that flooding in the Hutt Valley is an important natural hazard. The WRPS policies require District Plans in the region to avoid subdivision and development in high risk areas (Policy 29) and to minimise risks and consequences of natural hazards (Policy 51).

The City of Lower Hutt District Plan also recognises[23] that there is risk to harm of people and property from natural hazards including flooding (Issue 14H.1.1.1). Policy (d) requires *suitable engineering, emergency management and land use control measures to be adopted to reduce the vulnerability of people and their property to flood hazards.* In response to Policy (d), the District Plan recognises that:

- The Hutt River Floodplain Management Plan (HRFMP) has a programme of actions to upgrade physical protection.
- That land uses are managed by identifying a river corridor as identified on the District Plans (Primary and Secondary River Corridor within a River Recreation Zone). The zoning provides for flood protection works/maintenance, but restricts development activities[24]. Outside the River Recreation Zone, however, there is no policy that responds to flood risk on the floodplain in the event that the physical protection is breached.

The HRFMP also promotes "non-structural" measures which include a range of regulatory and guidance measures that could be applied as they relate to Primary and Secondary River Corridor and floodplain areas. Some of those voluntary actions recognise the benefit of more vulnerable facilities (e.g. healthcare) having contingency planning for a greater than 2800 cumec event breaching flood protection at the River.

It is anticipated that impending changes to the Resource Management Act (1991) will include more directive matters for managing natural hazards than those currently in the Act.

3.3.2 Potential Policy Options

Consideration has been given in the identification and evaluation of options with the potential for a range of policies with varying levels of impact on current land uses and their management under the District Plan. These policy options consider managing land use and development:

a) in relation to the level of residual risks (ie with any protection there always remains a risk of failure or breach) from physical or structural protection measures; and
b) in relation to future flood protection works and their phasing over time.

In the matter of (a) above there could be policies that take up any 'gap' in the performance of any physical work options relative to the standard of protection from a 2800 cumec flood. In this way, a lesser performing physical option (say Option 5 or 6 – the status quo) could have a correspondingly

[22] Wellington Regional Policy Statement (2013) Policy 29 and 51
[23] Section 14H Natural Hazards
[24] Section 7C 1.1.3 Flood and River Protection

stronger land use management policy to address the relatively greater risks. Conversely, where a greater extent of physical protection is provided (say in Option 1), the complementary land use policies could allow for a lighter regulatory framework to be applied.

A stronger regulatory policy framework could include imposing restrictions on development across the floodplain that requires all buildings to be built at 2m or 3m above current ground to address the increased risk of the lesser protection not meeting the 2800 cumec flood standard (for example because of affordability of meeting the standard in cost of the physical works). It may even require important existing emergency facilities to be raised above current ground level. Clearly this would put a substantial onus on individual property owners to provide for their own flood risk mitigation, and could only practically be implemented over time.

Table 3 outlines a range of potential policy responses that could be considered in concert with physical options.

Table 3 Summary Policy Implementation Options

Policy Option Examples	Example Methods	Comment
1. **Guidance and information**	Information provided to owners of properties within area of risk on measures to reduce risk or flood preparedness Some reference to risk in District Plan (for example, in zone explanations) and/or Regional Plan	Could use overlay in District Plan maps to identify areas of highest risk, but care needed (LIM and property impact considerations) Staged approach could be identified in Plans (i.e. risks to be reviewed at time of each Plan Review)
2. **Designation for flood protection work**	Use of designation for implementing 15 year protection works programme	Robust alternatives assessment required to justify 15 year lapsing period. Need not give full effect within the lapsing period, but would need to 'commence' such work (for example, property acquisition and clearance)
3. **Floodway Zoning**	Identify area for floodway development through use of designation Possibly impose specific development controls on identified floodpaths outside river corridor, such as minimum floor levels, or preventing habitable use of ground level	Floodway development could not be implemented through District Plan rules since floodpaths cannot be clearly identified as breach locations cannot be accurately predicted, and the development of a purpose-built floodpath would require third party intervention and actions (i.e. GWRC) to implement. Specific development controls best used for existing natural flood

Table 3 Summary Policy Implementation Options		
		paths, but would need strong justification in terms of risk
4. **Controls on development near stopbanks**	Setback rules for new development or alterations to existing structures near stopbanks; implemented through overlay on existing zones Rules to require relocatable building near stopbanks Specific rules would be necessary to ensure Making Places outcomes in CBD re: direct access to river	Potentially required, notwithstanding which physical options are pursued, depending on proximity of buildings to stopbanks Areas of highest risk from breaching could be identified and development downstream restricted Relocatable building rules would need strong justification in terms of risk
5. **Controls on development and land uses in areas of highest risk from stopbank breaches**	Rules for minimum floor level of new buildings Rules to require relocatable buildings or temporary buildings in areas of highest current or future risk Rules to prevent sensitive land uses (hospitals, elderly care, etc) from locating in areas of highest risk	Would best apply to inundation risks Higher level of justification needed in terms of risks
6. **Controls on building design**	Rules on the design of buildings to reduce impact of flooding: for example, prevention of habitable occupation at ground level, or siting of critical utilities	Higher level of justification needed in terms of risks
7. **Controls on development density and spatial distribution**	Rules to either prevent intensification in areas of high risk or promote intensification in areas of least risk, or both	Could be in conjunction with Options 5 and 6 Issues associated with any down-zoning – i.e. reducing the development potential of private properties

In the matter of (b) above (future planning), it is appropriate to consider the longer term future of land use responses to flood risk. It is increasingly expensive for the community to fund construction of flood defences, as higher and more engineered responses are required to fit the constraints of the

land available to accommodate the river, and as flood events increase in intensity and/or frequency. These expenses are passed from generation to generation. It is also a phenomenon that increasing protection levels induces higher levels of investment in properties that are being affected, which consequently results in there being more at stake to protect. It is often difficult for land use policy, however, to impose regulatory controls for future scenarios more than ten years out, given the increasing levels of uncertainty, although they could signal the need to review policies in the future to address the effects of climate change.

It is appropriate that together with physical protection improvement as set out in the structural options in 3.1 above, that consideration is given to a land use policy framework that is suitably calibrated to the flood protection scheme. The policy development process will require its own plan to be advanced and sufficient time to allow community understanding and engagement. It is important the community is aware that if flood protection cannot be provided by the physical works options then policy may need to be implemented which would have a greater burden on the owners of the properties affected by that policy to provide the protection on site.

3.4 Adaptation of Options

The physical options can be phased in over time such that, for example, a lesser scaled option could be developed now with an expectation that it will need to be upgraded in the medium term (planning starting in 20 years so it is in place in 30 years[25]). Alternatively, a larger scaled option can be developed now with an expectation that this will not require upgrading for a long time (60+ years). The way in which these decisions are made is assisted by an 'adaptive pathways' approach. This approach considers the range of flood resilience options (such as the Options 1-6 described in 3.1 above) and maps a pathway for each identifying the 'use by' date of each option and whether it can reasonably practically transfer to another more long lasting option. In this way the options can change over time to accommodate change conditions.

For the five (Option 6 is the status quo) flood protection physical works options, there are a number of staged adaptive combinations possible. The critical decision revolves around corridor width – i.e., does more land need to be acquired to accommodate flood protection works? This is because the bigger cost and the greater social disruption is in land acquisition – once the land is secured then the decisions about what and when to build are less of an issue. Figure 16 describes the adaptation 'pathways'. The diagram is read as follows:

(a) the black line is today – 2015. There are a series of decision choices (black circle) of pathway forward (the options as represented by the coloured lines).

[25] Time scales are flexible, but 30 years is considered a reasonable decision-making point because (a) it matches a generation span, recognising that over one generation different people will be making decisions to match their own values and aspirations; (b) it provides a reasonable period over which to observe changes in climate and its influence on rainfall events and sea level rise which is a significant uncertainty in planning for flood protection; and (c) long terms plans will commonly use a 30 year time frame to plan to (eg Wellington Urban Growth Plan) even when the implementation actions are on a 10 years cycle (under the Local Government Act)

(b) starting at the bottom – status quo (Existing - Option 6) has a 'use by' date of today – 2015. Even now it doesn't meet the standard.

(c) The next options up (Options 5 and 4) have 'use by' dates of about 2045. At that time a decision is needed (black circle) – from there the choice is to upgrade to Option 3, 2 or 1.

(d) The next options up (Options 3, 2 and 1) last a long time into the future (past 2100) before they would reach 'use by' dates and require upgrades to be built. Option 3 would be difficult to upgrade given the large flood wall it includes.

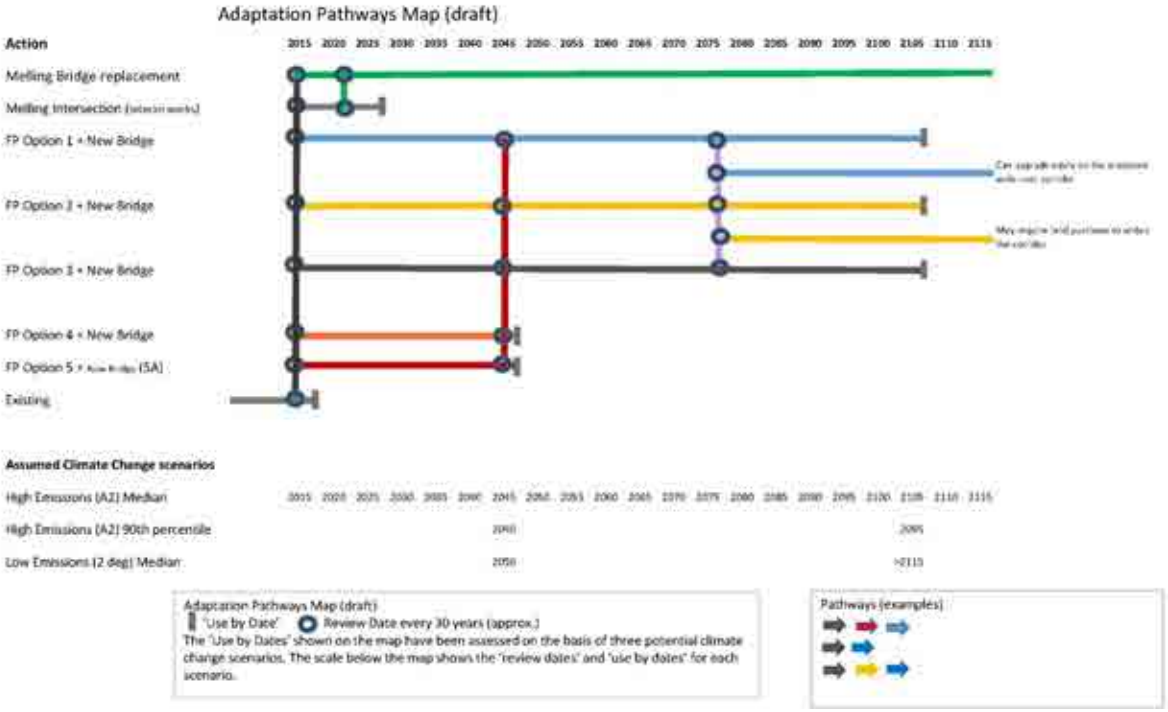


Figure 16: Adaptive Pathways Map

3.4.1 Optimising Investment

The decision as to when to undertake upgrading from one option to another will be linked by the rate by which climate change increases the scale and regularity of floods. However, the protection will ideally be in place before the climate change has generated the larger scale or more regular flood events.

With some uncertainty about this rate of change, monitoring the influence of climate change will assist to gauge the time at which decisions need to be made for an upgrade. It is also important to recognise that there is about a 10 year period required to plan and implement flood works given the need for funding to be secured, consultation and consenting. In this way the decision as to when to proceed with an upgrade needs to occur by following climate change trends and making decisions based on the best information available at the time.

It is clear an upgrade is required now because the existing 'status quo' does not meet the standard. The decision to be made at this time is whether to upgrade for the shorter term (Options 4 or 5 with

the expectation that this will last to about 2045 based on current expectations of climate change), or to upgrade for a longer term (Options 1 or 2 with the expectation that this will last past 2100 based on current expectations of climate change).

There is a risk that: (a) if the decision is made to implement Options 1 or 2 now, that climate change will happen less slowly than expected and the investment will have been made well in advance of when its needed (ie over investment); or (b) alternatively if the decision is made to implement Options 4 or 5 now, that climate change will happen more quickly than expected meaning there is insufficient protection in place and a large flood occurs damaging property and endangering life. Further consideration of the investment influences on decision making processes is provided below (5.5 Investment Pathways).

3.5 Other Options

Outside of civil defence preparedness for a flood, there could be other provisions made for relieving the extent of damage from a flood by planning for it. In this type of option the level of flood protection would not be upgraded, or upgraded minimally (i.e. lower cost option but higher damages costs when a flood occurs), but measures are put in place for when a large flood threatens. A range of these types of options were considered including providing a wide flood path through the urban area, or a sequence of streets and open spaces that could be activated by a deliberate breach of the stopbank. This was considered impractical on the basis that: (a) choosing a place to activate a breach would not necessarily correspond to where the relief is required; (b) trying to direct a river in flood would be unpredictable as to its outcomes as it may not respond as planned; and (c) a very extensive area of private land would need to be acquired and re-contoured to take a flood if it was even possible to determine where a breach might direct it. Another option considered was to remove the Melling Bridge (which currently constrains flow in floods) but only when the river is threatening to breach due to water banking up behind it. However, this would also be a highly unpredictable as to direction of flow, structural response of the bridge and be very hazardous to undertake with a flooding river. This is not a long term solution to the issue of flood resilience management in the Hutt Valley.

4. Evaluation Methods

A range of methods exist to evaluate the relative merits of options for any given project. In determining the method to be used for the subject project, the following objectives were established:

- Satisfies the requirements of the Resource Management Act
- Transparent and enables multiple factors to be assessed
- Provides efficient and effective means to screen options and derive a preference to take for consultation
- Internal consistency and logical soundness
- Easy to understand and apply

- Delivers results that can be confidently relied upon
- 'Fit for purpose' relative to the scale and complexity of the project
- Able to provide an audit trail

There were three methods that provided potentially suitable application to the project at hand. These are described and considered relative to the objectives in Table 4 below.

Table 4: Evaluation Methods Comparison

Methods	Description	Benefits	Limitations	Models
Cost-benefit analysis (CBA)	**Quantitative**			
	Quantitative technique that evaluates in monetary terms as many of the costs and benefits of a proposal as feasible, including items for which the market does not provide a satisfactory measure of economic value. It involves determining the various benefits and costs associated with each alternative/option over an agreed analytical timeframe, to determine the relative economic efficiency of the alternatives/options. The results for the chosen alternative/option indicate the overall value of an investment from an economic efficiency viewpoint.	• Provides decision-makers with a consistent basis for assessing proposals, particularly in terms of their financial implications • Forces disciplined consideration of options, and recognises that each option has an associated cost • Considers the gains and losses to the wider community, not just those with direct interests in a proposal • Values impacts in terms of a single, familiar measurement scale – money – and can therefore in principle show that implementing an option is worthwhile relative to doing nothing • Monetary values used to weight the relative importance of different impacts are based on people's preferences generally using established	• Relevant monetary data may be unavailable or too expensive to collect, and projected results may be highly dependent on assumptions made • Results need to be interpreted with care, particularly in projects where benefits are difficult to quantify • It may not be possible to present some impacts in terms where people are able to make reliable trade-offs against money • There may be impacts which cannot readily be quantified in a way which could be set against a scale of monetary values • Interactions between	

		methods of measurement (e.g. stated preference, revealed preference, subjective well-being)	different impacts generally not taken into account • Conclusions often highly sensitive to specific assumptions, such as discount rate and risk/uncertainty • Valuation techniques are imperfect and loaded with assumptions • Relies on a reliable source of predictive data generated by other methods • Discount rates favour early and more expensive options	
Cost effectiveness analysis (CEA)	**Quantitative/Qualitative**			
	Used instead of a full CBA where the objective is to compare the cost of alternative ways of achieving a given effect (e.g. level of service), or comparing the relative cost of alternative options with the same or similar effects in both quantitative and qualitative terms. Equally, where there are alternative options to achieve a specific objective but the objective itself cannot be valued, CEA can be used to assess the	• Provides decision-makers with a consistent basis for assessing proposals • Forces disciplined consideration of options • Enables costs and benefits that may be difficult to assess in monetary terms to be assessed; however, still requires the valuation of as many benefits of a project as possible • Measures project outcomes/outputs in both quantitative and qualitative terms	• Fairly technical and requires specialist economic or social research expertise and project knowledge to objectively assess effectiveness • Requires clear measures or proxies for project outcomes which may be difficult to source • Can be time and resource intensive	

	least-cost way of achieving the objective.	• Makes explicit the economic assumptions that might otherwise remain implicit or overlooked at the design stage of a proposal	• Cannot be used directly to compare projects with different objectives; however, the fact that costs and benefits are identified allows subjective decisions to be better informed	
Multi-criteria analysis (MCA)[26]	**Qualitative/Quantitative**			
	Qualitative techniques commonly used to compare and rank unvalued costs and benefits. Usually involve assigning weights to a given set of objectives and/or criteria and then assessing and scoring options (typically by a panel of relevant technical experts/representative stakeholders) in terms of how well they perform against the weighted criteria. The weighted scores are then summed, and these sums used to rank options. However, MCA can be used without explicit weighting of the criteria being applied but this would reduce the transparency and validity of the ranking process.	• Provides decision-makers with a consistent basis for assessing complex information relating to a proposal • Forces disciplined consideration of options • Allows for the inclusion of effects which can be measured physically fairly precisely, but on which there is greater uncertainty as to their monetary value • Enables a diverse range of information to be incorporated/ considered • Allows explicit weighting to be applied to a range of possible impacts and thus achieve a greater degree of transparency	• Less rigorous than CBA/CEA • Depends on an unambiguous assessment of impacts being undertaken; while it can generate a series of 'what-if' outcomes, it cannot by itself evaluate these in such a way as to secure robust planning of the outcomes, particularly in relation to wider economic impacts • Generally, neither the criteria nor the weighting are based on any underlying analysis and could therefore be easily altered;	• Continuous MCA models (infinitely variable alternatives) • Non-compensatory methods • Multi-attribute utility models • Linear additive models • Outranking methods (with/without qualitative data)

[26] UK Department of Communities & Local Government (2009), *Multi-criteria Analysis: A Manual*, Communities & Local Government Publications

		• Enables consistency with economic impact measures because the methods of determining weights imply the use of a form of utility function • Relatively easy to implement and provides greater flexibility and comprehensiveness than CBA/CEA as it can be used to assess and compare options that involve both monetary and non-monetary impacts • Can aid decision-making by complementing quantitative techniques (e.g. CBA/CEA) • Provides an audit trail, especially in situations where decision-making is required to follow rules and to be justified in explicit terms	however, this can be overcome by consulting experts and stakeholders when criteria, weightings and ranking are being determined • Subject to bias from the operator	

Several methods have been used to evaluate the options:

- The MCA method (more qualitative than quantitative) was used to allow the relative merits of the project options to be evaluated. This is a commonly used and recognised method for evaluation and, although there are limitations, these are known and can be avoided or recognised in the use of the tool.
- Cost evaluation methods used (quantitative) in addition to the MCA process to determine the relative costs of the options as well as the investment versus timing issues. This is discussed further in section 5.4 and 5.5 below.

Recognising that there would need to be a range of technical inputs to enable the options to be compared, specialist consultants were engaged to assist with the project to consider the options and provide advice on the following matters:

- traffic design modelling
- economic modelling to understand the benefits and costs of options
- ecological opportunities
- recreation uses
- modelling of the flood protection performance
- structural design for walls and provision for adjacent development
- landscape design
- urban design in terms of the ability to make a better place in the city
- costing of the options in terms of land and construction
- the implications of climate change on flood frequency; and
- dynamic adaptive pathways methodology for planning under conditions of uncertainty.

The Māori cultural considerations are being provided for through Hutt City and Greater Wellington Regional Council's cultural advisers and direct consultation with iwi.

5. Evaluation Process and Outcomes

The Multi Criteria Analysis (MCA) method was used to evaluate the relative merits of the options. To determine the 'Value for Money' (VfM) from 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. The MCA process has an element of subjectivity involved in it as it requires the evaluators to make a judgement about the relative merits of the options being evaluated. Similarly the calculation of project costs is based on a very general set of concepts given the early stage of the process, so it has a margin of error that needs to be recognised.

As noted above (section 3.4 Adaptation of Options) another factor being considered in the evaluation process is the element of time. The evaluation was undertaken by Infometrics and PS Consulting and consideration was given as to which option(s) enable the best match of investment to the uncertainties about the timing and extent of changing flood risks from climate change influences. This evaluation process is further summarised in section 5.5 below.

5.1 Criteria

With the inputs from the consultant experts, a set of evaluation criteria were developed (refer to Table 5). These criteria have a relationship to the design objectives agreed by the HRFMS.

Table 5: MCA Evaluation Objectives and Criteria	
Objective	Criteria
Flood Resilience	
Hutt Valley people (current and future generations) and properties have	1. River corridor contains a 2800 m^3/s flow (over 100 years to recognise future generations and adaptation to climate change scenarios)

protection to the level set out in Hutt River Floodplain Management Plan (2001)	2. River channel and berm widths will withstand erosion
	3. Subsurface infrastructure (eg. Sewer main) protected and impacts on flood defences minimised
	4. Stopbanks' form meets design standard (i.e. 3.5m to 1 slope with min. 4m wide top)
Movement	
People and goods move to and through the city centre and to and along the river by a network of paths, lanes, streets, and highways using active modes (waking/cycle), public transport, and vehicles	1. Interface of local roads and SH2 efficient and safe for vehicles pedestrians and cyclists
	2. Car parking walking distance (no more than 400m) to city centre and 'park and ride' walking distance to rail station
	3. City west ring route concept for vehicle movement maintained
	4. Resilient bridge(s) across the river for movement to and from the city centre and Melling rail station
Making Places	
Spatial and functional relationship with the river and takes advantage of changes to the river corridor to increase amenity and to provide a setting for residential and commercial development	1. Realisable (i.e. realistic/viable) residential and commercial/mixed use development opportunities at interface with river corridor
	2. A river promenade with an active edge of publicly accessible uses along the east bank and the river corridor is a linear park
	3. Bridges/steps/ramps link pedestrians and cyclists to river corridor from city centre via streets with walking and cycling amenity
Environmental	
Social, recreational and ecological values are enhanced	1. Private property take / social effects minimised
	2. Diversity of recreation activities enabled in river corridor and adjacent spaces
	3. Ecological diversity on land and in-stream

It is noted that for cultural values, inputs will be provided through discussions with iwi and are being facilitated by cultural advisers with the understanding that at this time the cultural values are not a differentiator between the options. There remains a need to involve iwi in discussions, processes and decision-making to ensure the principles of the Treaty of Waitangi and those embodied in the RMA (refer to Table 6 below) are recognised and provided for.

There are also risk considerations for the options. Some of the options have greater levels of political risk or public relations risk for example. It is appropriate that the HVFMS determines the issue of risk in this regard. This was not part of the consideration in the MCA process.

5.1.2 Criteria Relationship to RMA Part 2

It is important that for the RMA consenting/designating process, that will likely be required to implement any of the options which extend beyond the existing river corridor, that the criteria used are representative of the relevant matters identified in the purpose and principles of the RMA (Part 2).

Table 6: Criteria Relationship to RMA	
Criteria Objectives	RMA Part 2 Reference
Flood Resilience	
Hutt Valley people (current and future generations) and properties have protection to the level set out in Hutt River Floodplain Management Plan (2001)	Section 7 (a) and (aa) kaitiakitanga (b) efficient use and development of resources (f) quality of the environment (g) finite natural and physical resources (i) effects of climate change
Movement	
People and goods move to and through the city centre and to and along the river by a network of paths, lanes, streets, and highways using active modes (walking/cycle), public transport, and vehicles	Section 6 (d) public access to river Section 7 (c) amenity values (f) quality of the environment (j) benefits of use of renewable energy
Making Places	
Spatial and functional relationship with the river and takes advantage of changes to the river corridor to increase amenity and to provide a setting for residential and commercial development	Section 7 (b) efficient use and development of resources (c) amenity values (f) quality of the environment (g) finite natural and physical resources
Environmental	
Social, recreational, and ecological values are enhanced	Section 6 (a) preservation of natural character of river (d) public access to river (e) Maori culture and traditions Section 7 (a) and (aa) kaitiakitanga (c) amenity values (d) intrinsic values of ecosystems (e) quality of the environment (h) habitat for trout and salmon

5.2 Evaluation Process

The process of evaluating the options was through two workshops wherein a score of 1-5 was given for each criteria, with 1 being the worst performing option against that criteria and 5 being the best. The aim was to use the 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 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 Management Group also provided guidance on the criteria. The topics were also weighted to recognise the relative significance of them. The weighting accorded to the themes were:

- Flood Resilience 65%

- Movement 5%
- Making Places 20%
- Environment 10%

The weightings were also 'sensitivity tested' (refer to Attachment 3) to ensure that it was understood what the influence of the weighting was on the outcomes. In this way, if the environmental criteria, for example, were considered to be more important than flood resilience criteria then the decision-makers could understand which option would be preferable on this basis. The outcome of the topic weighting confirmed that regardless of which topics were given significance by weighting, the outcomes of the top ranking options remained the same. With the MCA score determined the economic costs and benefits of the options was calculated against that score to demonstrate the relative value outcomes – i.e. which of the options provided the best set of benefits relative to the cost.

5.3 MCA Outcomes

The ranking of the options based on the MCA process identified that the best of the options is Option 1A with the least favourable option being Option 6A. The table (Table 7) below summarises the findings of the MCA:

Table 7: Summary of MCA Process		
Option	Ranking	Weighted Score
1A	1	4.79
1B	2	4.46
2C	3	3.79
2A	4	3.69
2D	5	3.39
2B	6	3.27
4A	7	2.72
3A	8	2.31
5A	9	1.89
5B	10	1.47
6A	11	1.38

5.4 Costs and Benefits

The costs of the options are set out in Table 8. Note that costs do not include any provision for the impact of changes to policy to compensate for the reduced level of flood protection of some of the options (eg Options 5 or 6).

Table 8: Implementation Costs ($ millions)											
	1 A	**1 B**	**2 A**	**2 B**	**2 C**	**2D**	**3**	**4 A**	**5 A**	**5 B**	**6**

Property	162.0	162.0	42.0	42.0	42.0	90.0	2.5	2.5	2.5	2.5	0
River corridor between Ewen and Melling Bridge (Stopbanks, river channel widen, edge strengthening)	23.4	23.4	26.5	27.3	26.5	26.5	12.7	27.6	27.1	30.5	0
River corridor between Kennedy-Good and Melling Bridge (Stopbanks, river channel widen, edge strengthening)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	0
Floodwall on western bank (Option 3A)	0	0	0	0	0	0	85.0	0	0	0	0
Landscape (promenade frontage, carpark, street, MSE wall, tunnel, bridge (if applicable) etc.)	40.0	36.2	21.6	26.8	23.8	40.0	28.0	31.3	21.1	12.8	0
Melling Bridge Replacement	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	0	0
Pedestrian & Cyclist Bridge	0	0	7.6	0	7.6	0	7.6	7.6	0	0	0
Services (Trunk Sewer, U/G services - wastewater, water, stormwater, power telco)	5.1	3.4	4.7	5.0	5.5	5.1	7.3	8.1	8.2	8.2	0
Total $M	**268**	**262**	**140**	**139**	**143**	**199**	**180**	**114**	**96**	**63**	**0**

By dividing the score for the MCA by the cost, a relative benefit to cost or value for money ranking can be derived. The outcome of this process is set out in Table 9 below.

Table 9: VFM Summary				
Option	Ranking	Weighted Score	Costs $M	Weighted Score/Costs x 100[27]
1A	1	4.79	268	1.77
1B	2	4.46	262	1.70
2C	3	3.79	143	2.65
2A	4	3.69	140	2.63
2D	5	3.39	199	1.70
2B	6	3.27	139	2.35
4A	7	2.72	114	2.38
3A	8	2.31	180	1.28
5A	9	2.08	96	2.16
5B	10	1.47	63	2.33
6A	11	1.38	0	-

The new order ranking from the process in Table 9 is set out in Table 10 below.

Table 10: Summary of VFM Process		
Option	Ranking	VFM
2C	1	2.65
2A	2	2.63
4A	3	2.38
2B	4	2.35
5B	5	2.33
5A	6	2.16
1A	7	1.77
1B + 2D	8 =	1.70
6A	9	1.38
3A	10	1.28

5.5 Flexible Investment Paths

Flexible investment paths are an approach that can be used by decision-makers to reduce two potential types of 'error' that can be made when it comes to the timing of investment. The approach can be used in a range of investment contexts, but in relation to flood protection and the situation at hand for the Hutt River, it recognises that a "Type 1" error would be undertaking investment that adapts too slowly to accommodate changing flood risk, leading to undesirable or

[27] Multiplication by 100 provides a number over 1 – it makes no difference to the outcome

unsafe outcomes; and a "Type 2" error would be undertaking more investment than is necessary at this time and thus wasting scarce community resources.

The evaluation process for the project undertaken by Infometrics and PSConsulting has considered how the different 'adaptive pathways' in Figure 16 perform with regard to the two types of error under different probabilities of climate change. This means analysing the value of delaying investment in a higher standard option to a later date should climate change increase the probability of a breach and a flood occurring.

In summary, a flexible investment strategy (i.e. where as many options as possible remain open for the future) is more likely to deliver a better outcome than pursuing a single option, unless the probability of climate change (of a particular intensity) is almost certain. This holds true regardless of whether the outcome is based on Multi-Criteria Analysis or on minimising the expected total cost (cost of flood protection investment plus the residual risk of property loss in the event of a flood) of each option.

5.6 Balancing Benefits, Future and Cost

5.6.1 The Maximum Options

The MCA process identifies that the maximum options (Options 1A and 1B) deliver best on providing the benefits for flood resilience well into the future, as well as the improvements to the river amenity 'river park', promenade and environment, as well as working for transport movements. The principal justification for the maximum options is clearly the benefits they provide to future generation's health and safety, and the greater certainty for investment decision making in and around the river, but also within the wider Valley. To proceed with the maximum options would mean that no further corridor widening would be required in the future, for at least 100 years, based on reasonable expectations[28] of the influences of climate change. While the impact on the private property owners whose properties would need to be taken to widen the corridor cannot be underestimated, the benefits in resilience for the much larger number of people and the economic future of the valley could be argued to have greater significance.

On balance, too, is the significant cost to implement the maximum options when the level of protection they provide is not needed for at least several decades yet. The level of uncertainty about the influence of climate change increases the further into the future the predictions are attempted to be made. It is reasonable to expect that sometime in the future the river corridor will need to be widened to the extent of Options 1A and 1B, but the timing of that becomes difficult to determine the further forward one looks. On the basis that:

a) the optimum level of flood protection will not be needed for at least 100 years, which could extend for several hundred years if climate change scenarios were less impactful;
b) recognising the findings that waiting to invest until there is greater certainty is the best approach prior to investing large sums is the best strategy; and

[28] Reasonable expectations means as per the GWRC adopted climate change scenario

c) the considerable cost of the maximum options

it is considered that alternative options that can provide a good proportion of the benefits, but at a lesser cost, may be better to pursue at this time.

However, there should be monitoring points instituted to allow decisions to be made as to when planning for a wider corridor should begin. On the basis of the many years such a process requires, a 10 year planning and implementation window for these decisions should be allowed for.

5.6.2 The Medium Options

The medium options (2A-2D) present less very long term future proofing than the maximum options (1A and 1B), but still enable certainty for many decades and well past 2045, based on reasonable expectations of the influences of climate change. These options also come at less cost and, although impactful on private property, are less costly than the maximum options. The analysis of 'value for money' demonstrates that the benefits are still significant, but in considering costs the medium options become better ranked.

5.6.3 The Minimal Options

The minimal options (4A and 5A) do not represent the same level of future flood protection as do the medium or maximum options. Although there are significantly less impacts on private property, these options also are compromised in their ability to deliver on the environmental and river park design objectives as the corridor is more constrained. The minimum options should be able to provide improved flood protection to the design standard (2800 cumecs) until about 2045 based on climate change predictions. However, after that time it is expected the level of service of the minimal options (4 and 5) will reduce below the design standard. At this point, the community of the day will have to make a decision again (as it is now) on how to proceed to provide resilience from flooding on which the local economy and people living in the Hutt Valley rely.

It is noted that, on the basis of a 10 year planning and implementation timeframe, if a minimal option was to be proceeded with from now (2015) and that these options had to be upgraded at 2045, then in 2025 the current upgrade would be completed and in 2035 planning would need to begin again to meet a 2045 date. The issue therefore of proceeding at this time with a minimal option is that the upgrading will need to be revisited in a short time frame. A more strict policy regime may also need to accompany a minimal option to recognise the upgrade requirements in the near future or heightened risk from flooding in the event physical works upgrades were not undertaken.

6.0 Summary

In summary, the option evaluation process has considered a range of representative options including both physical and potential land use policy options to provide the level of flood protection established by the community in the HRFMP. The timing for the options has also been considered and potential adaptive pathways identified to recognise the need for flood protection to have the best ability to respond to uncertain climate change influences.

On this basis the preferred options to proceed to consultation with are Option 2C and Option 4A. The reasons for this are:

- Option 4A provides an improved level of flood protection for a relatively moderate level of cost. It does not require the acquisition of private property which assists to limit the cost, but also the level of social disruption. The option also 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 issue with Option 4A is that it provides little flexibility for addressing the need for managing the influences of climate change on flood frequency and magnitude. It is likely that by about 2035 the planning process will need to begin again to upgrade further. On this basis too it implies the consideration of policy that recognises that in the future, additional land may be required to widen the corridor and maintain flood protection from a 2800 cumec flood.
- Option 2C provides a significantly improved level of flood protection which will 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 will be certain for a much longer time. The option also enables investment in the city side commercial properties by providing certainty as to the edge of the river corridor and can 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.

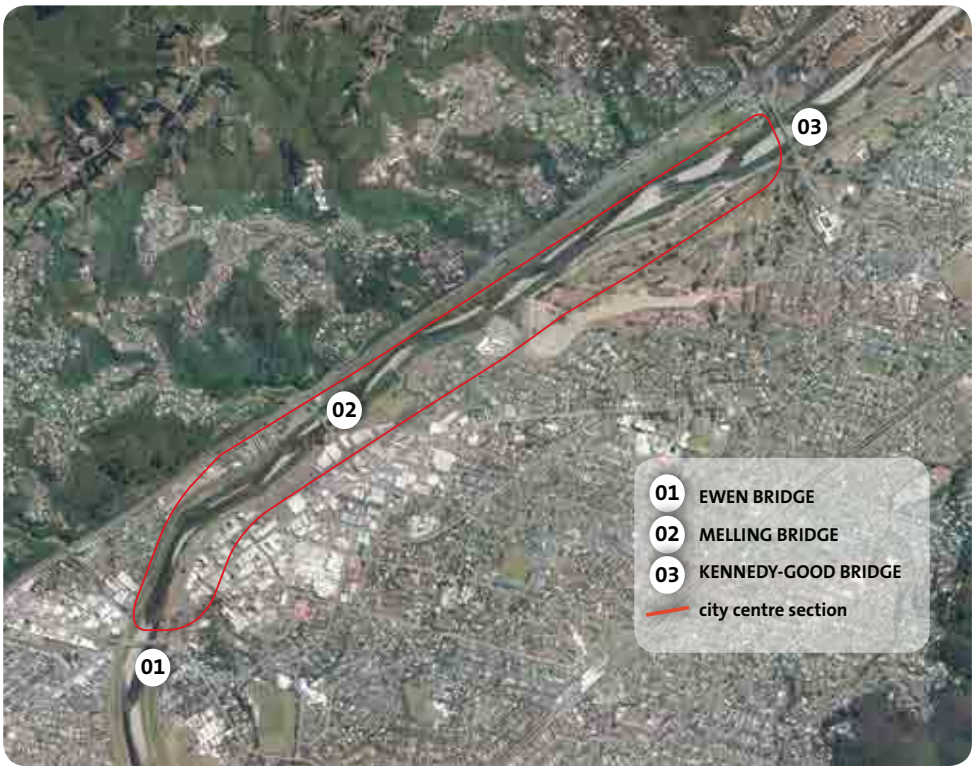
It is noted that for both Option 4A and 2C that the city side improvements are the same. If Option 4A was proceeded with at this time then Option 2C could be advanced to in the future. This does leave the difficult scenario of property owners on the west bank of the river corridor living with some uncertainty as to whether their property may be required in the future. It is likely that if Option 2C was going to follow a more 'interim' Option 4A that the land required later for Option 2C would need to be acquired at the same time as Option 4A was advanced to recognise the unfairness to owners of their land being limited in its use in the longer term.

In terms of policy options there are relatively minor changes required to the District Plan to provide for the management of the development adjacent to the stopbanks on the basis of Options 4A and 2C structural works. In addition, Hutt City Council will be reviewing its District Plan provisions as part of its overall District Plan review and will address the wider matter of the river corridor development setbacks as part of this process. Assuming the options identified above (4A or 2C) are proceeded with any further wide-spread land use policy changes will not be required as the flood protection standards can be provided with the structural upgrades.

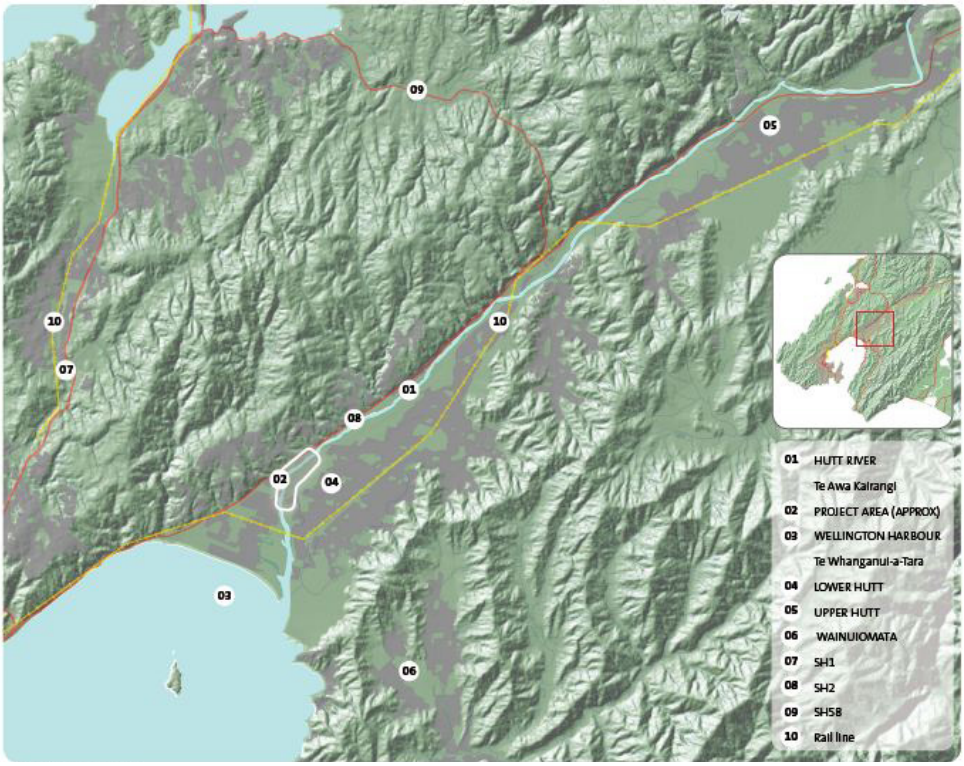
The other structural options (1A, 1B, 3A, 5A, 5B, 6A) were less favoured by the evaluation process as they were (a) either very long term options that provided a level of protection well in excess of what will be required for some time but were extremely costly due to the property acquisition costs; or (b) less expensive to implement as they required no property acquisition or city centre improvement investment encouragement, but provided a lesser level of flood protection over time than the community has identified it seeks.

ATTACHMENT 1: FIGURES

Figure 1 Hutt River City Centre Section



Local Context



District Context

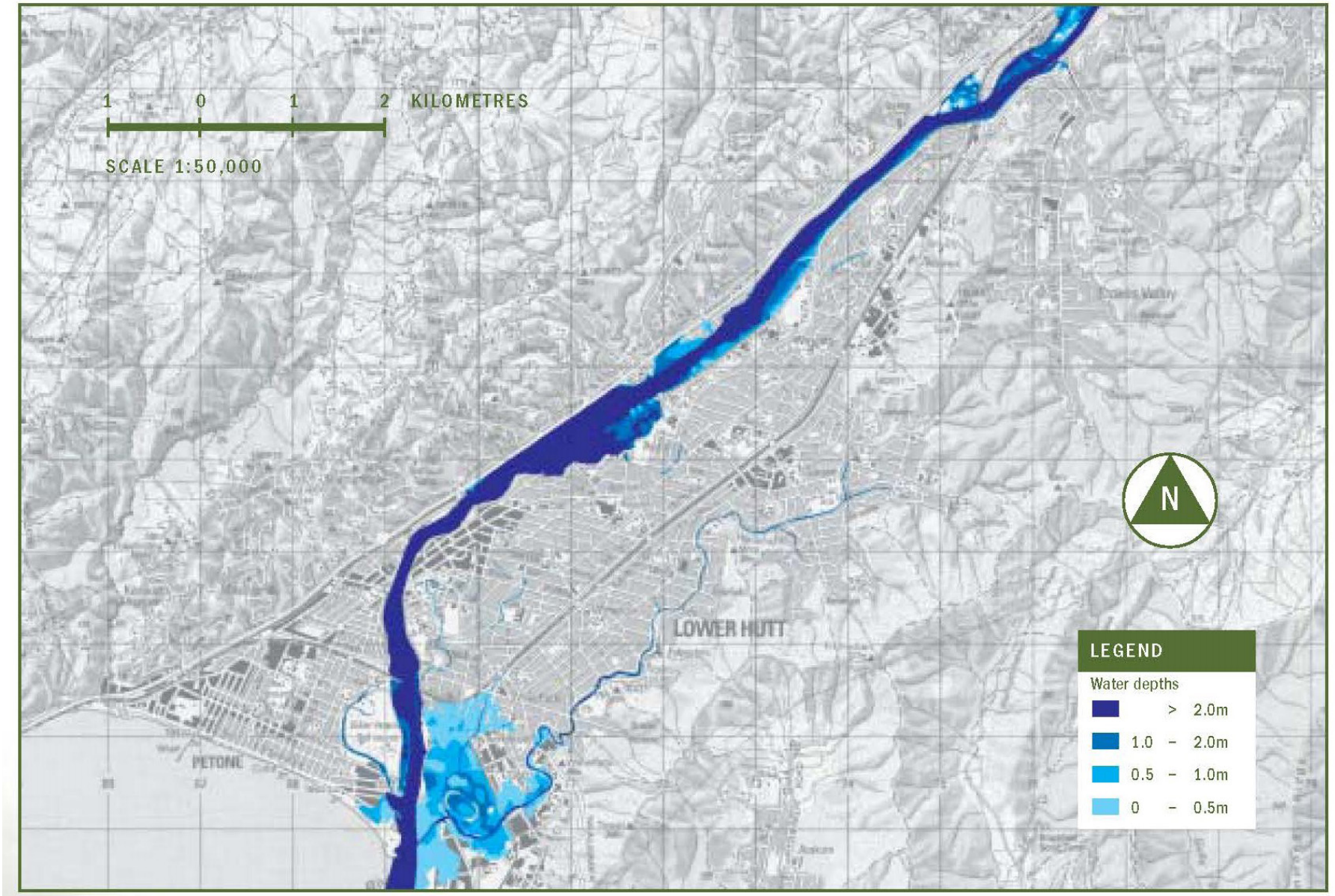


Figure 2 Flood Extent - without breach

from Hutt River Floodplain Management Plan (2001)

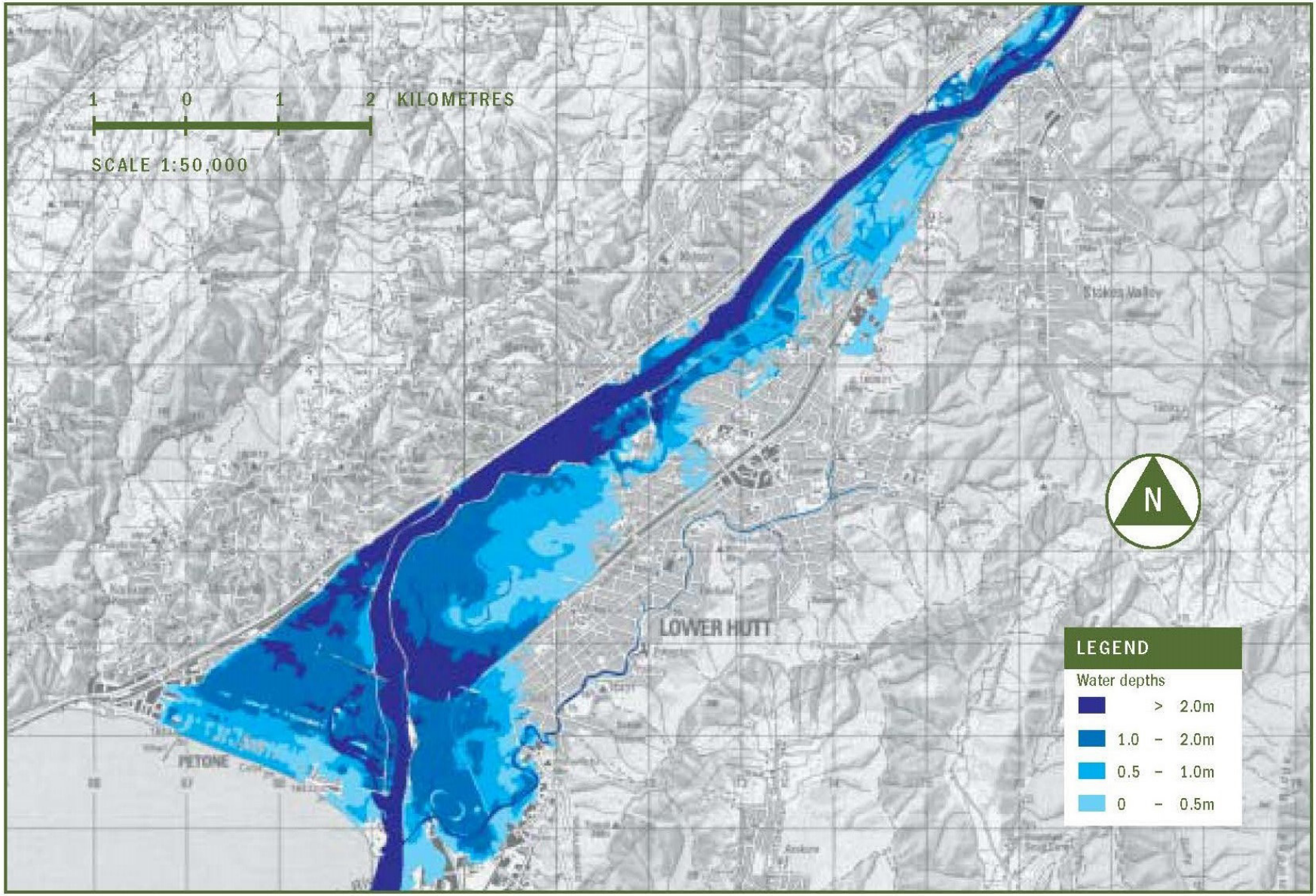


Figure 3 Flood Extent - with breach

from Hutt River Floodplain Management Plan (2001)

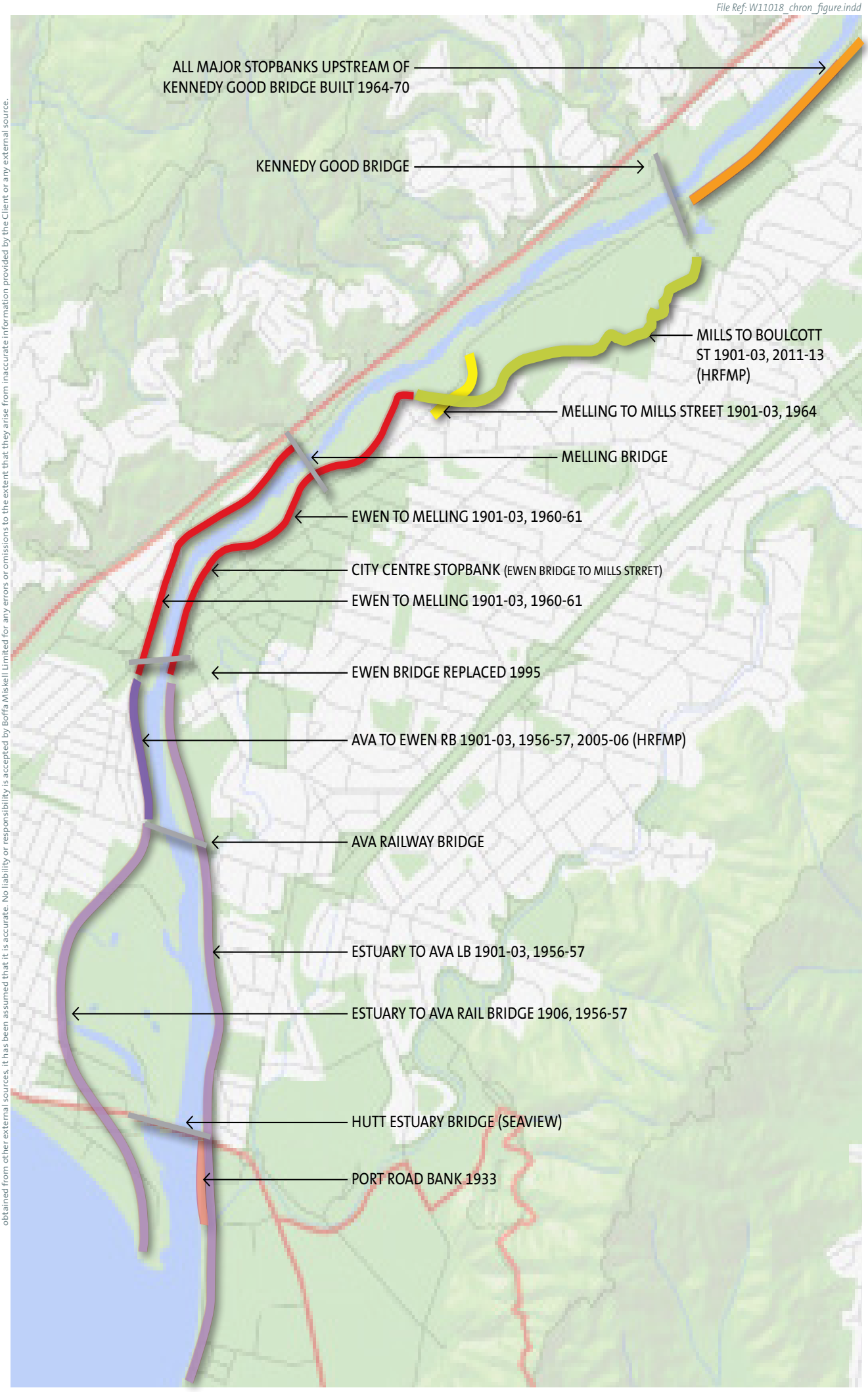
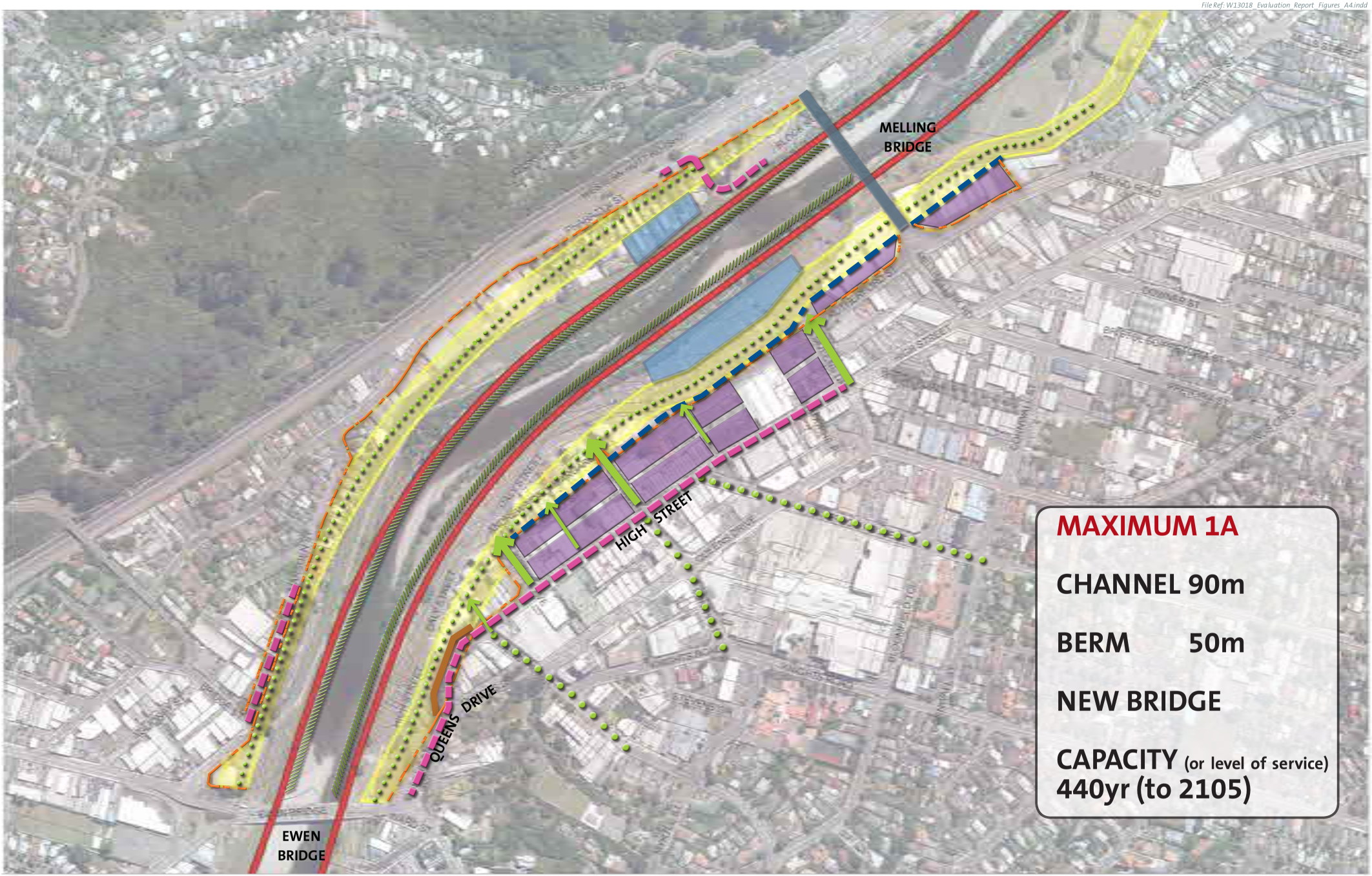


Figure 4 River Upgrade Process

from City Centre Section Scoping Report Hutt River Floodplain Management Plan (2013)



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Projection: GD1949 New Zealand Map Grid

- PROPOSED DESIGN CHANNEL (90m)
- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- STOPBANK RETAINING WALL
- ECOLOGICAL EDGE
- PROPOSED STOPBANK (50m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 5 MAX 1A

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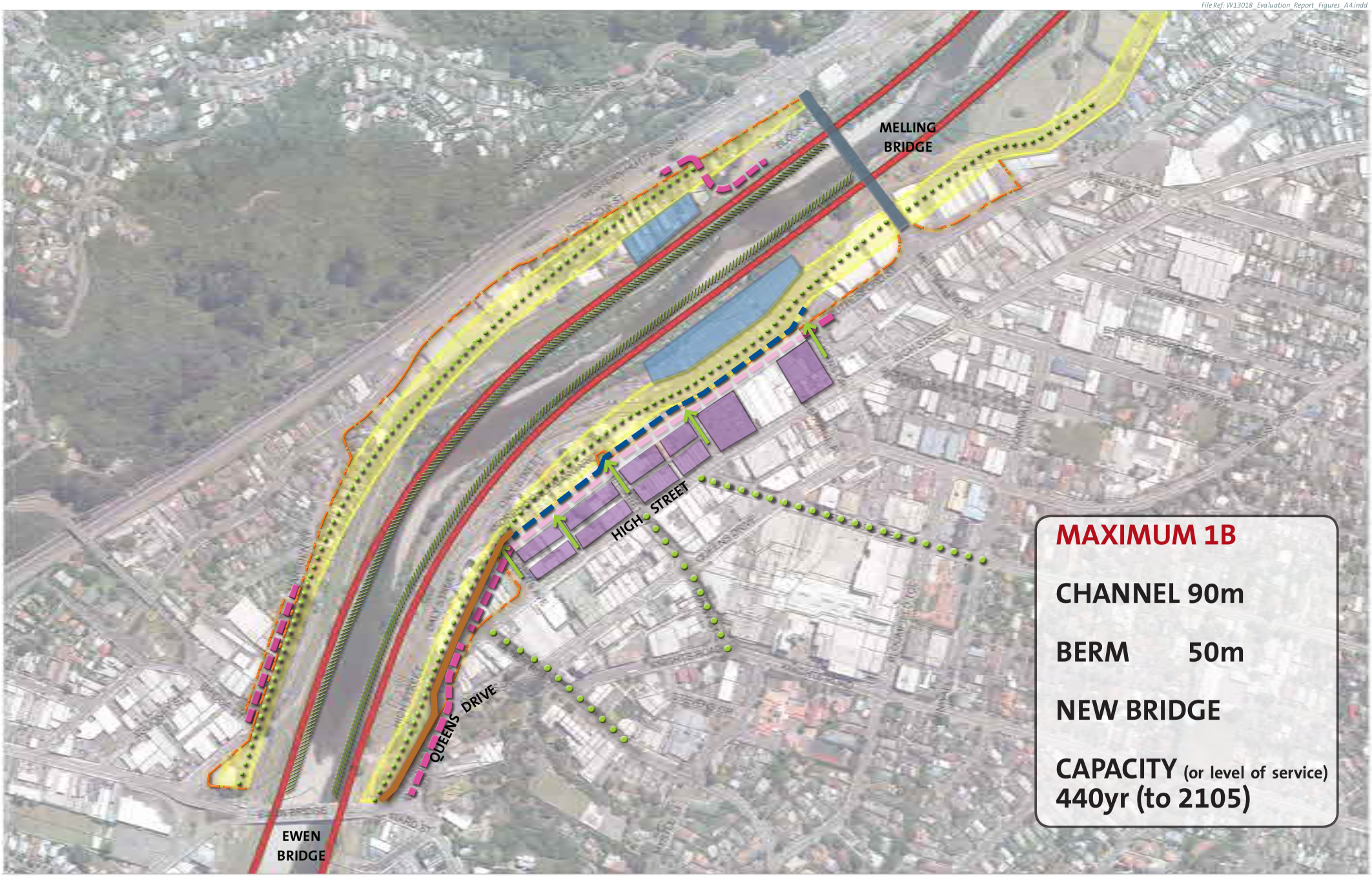

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Projection: GD1949 New Zealand Map Grid

- PROPOSED DESIGN CHANNEL (90m)
- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- STOPBANK RETAINING WALL
- ECOLOGICAL EDGE
- PROPOSED STOPBANK (50m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 6 MAX 1B

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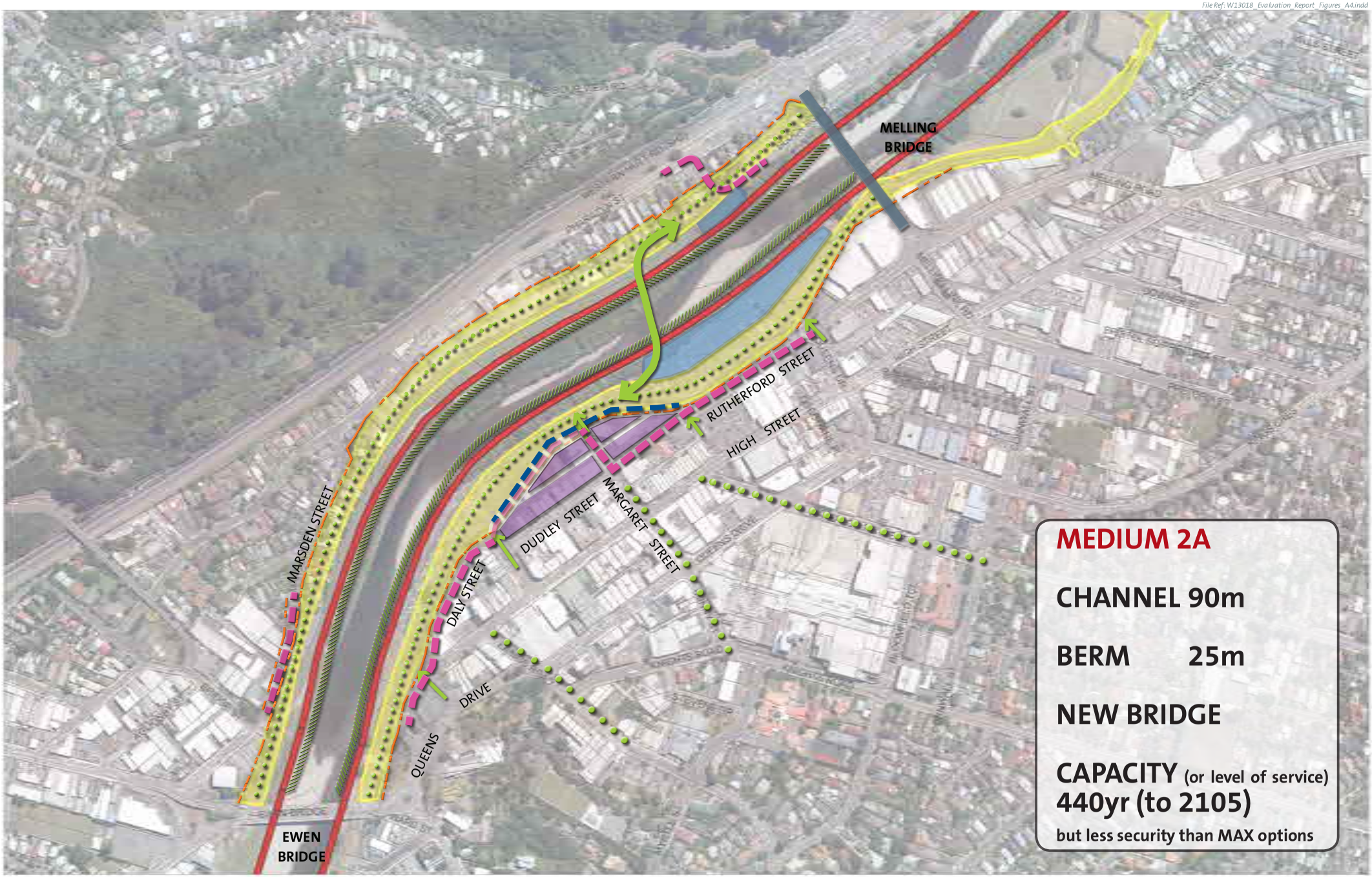

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Projection: GD1949 New Zealand Map Grid

- PROPOSED DESIGN CHANNEL (90m)
- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- ECOLOGICAL EDGE
- PROPOSED STOPBANK (25m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 7 MED 2A

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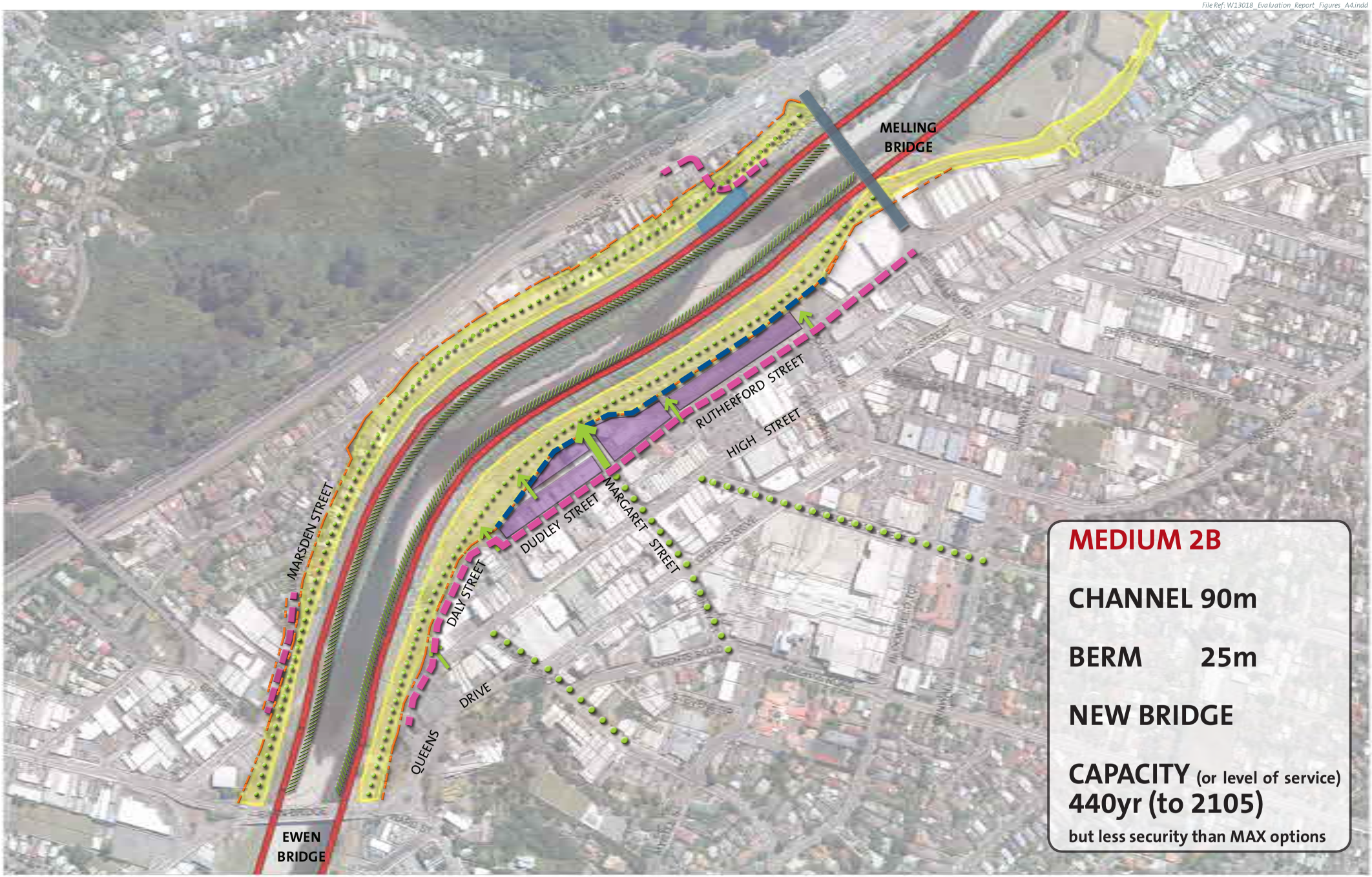

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Projection: GD1949 New Zealand Map Grid

- PROPOSED DESIGN CHANNEL (90m)
- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- ECOLOGICAL EDGE
- PROPOSED STOPBANK (25m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 8 MED 2B

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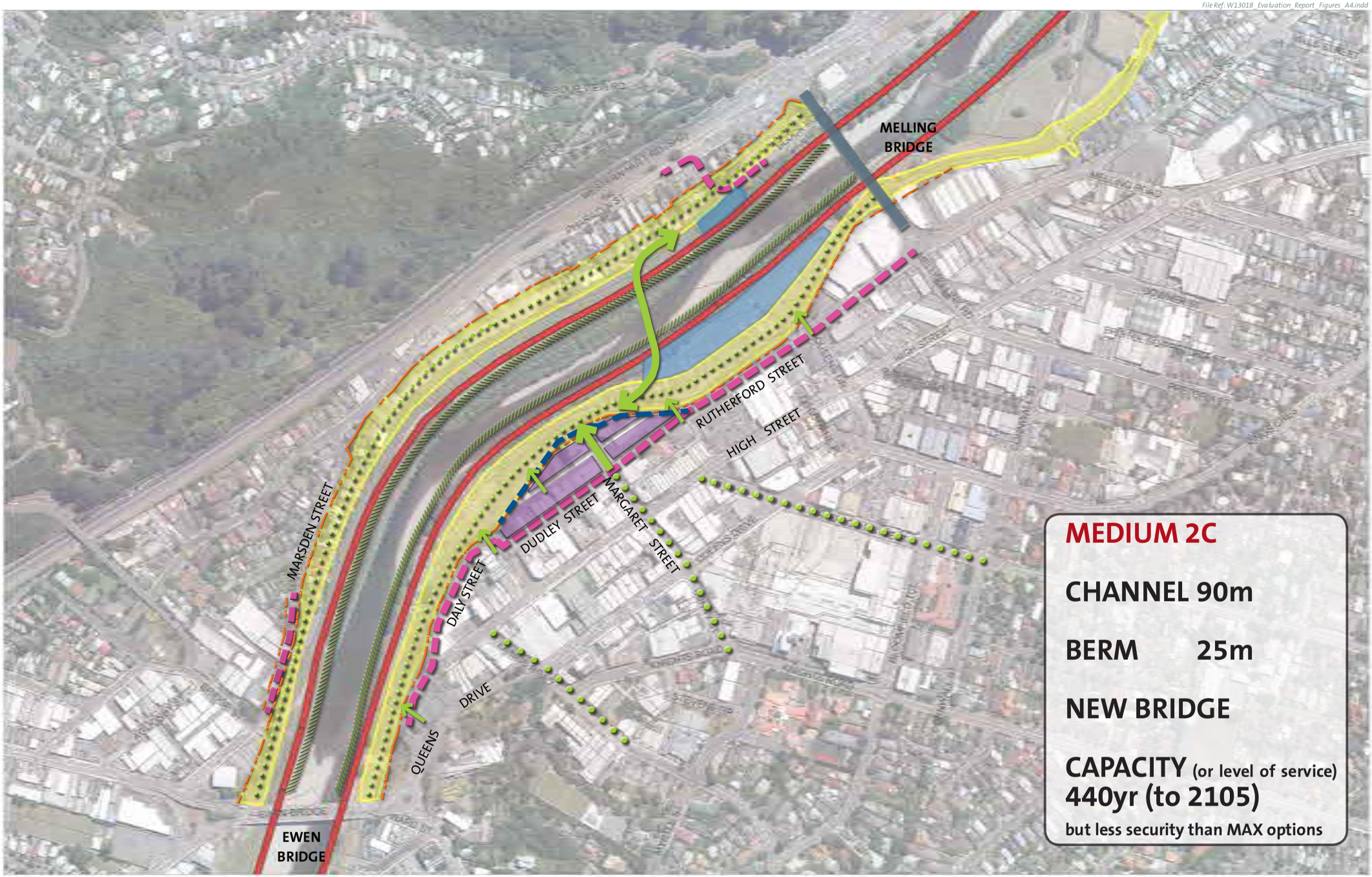

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Projection: GD1949 New Zealand Map Grid

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- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- ECOLOGICAL EDGE
- PROPOSED STOPBANK (25m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 9 MED 2C

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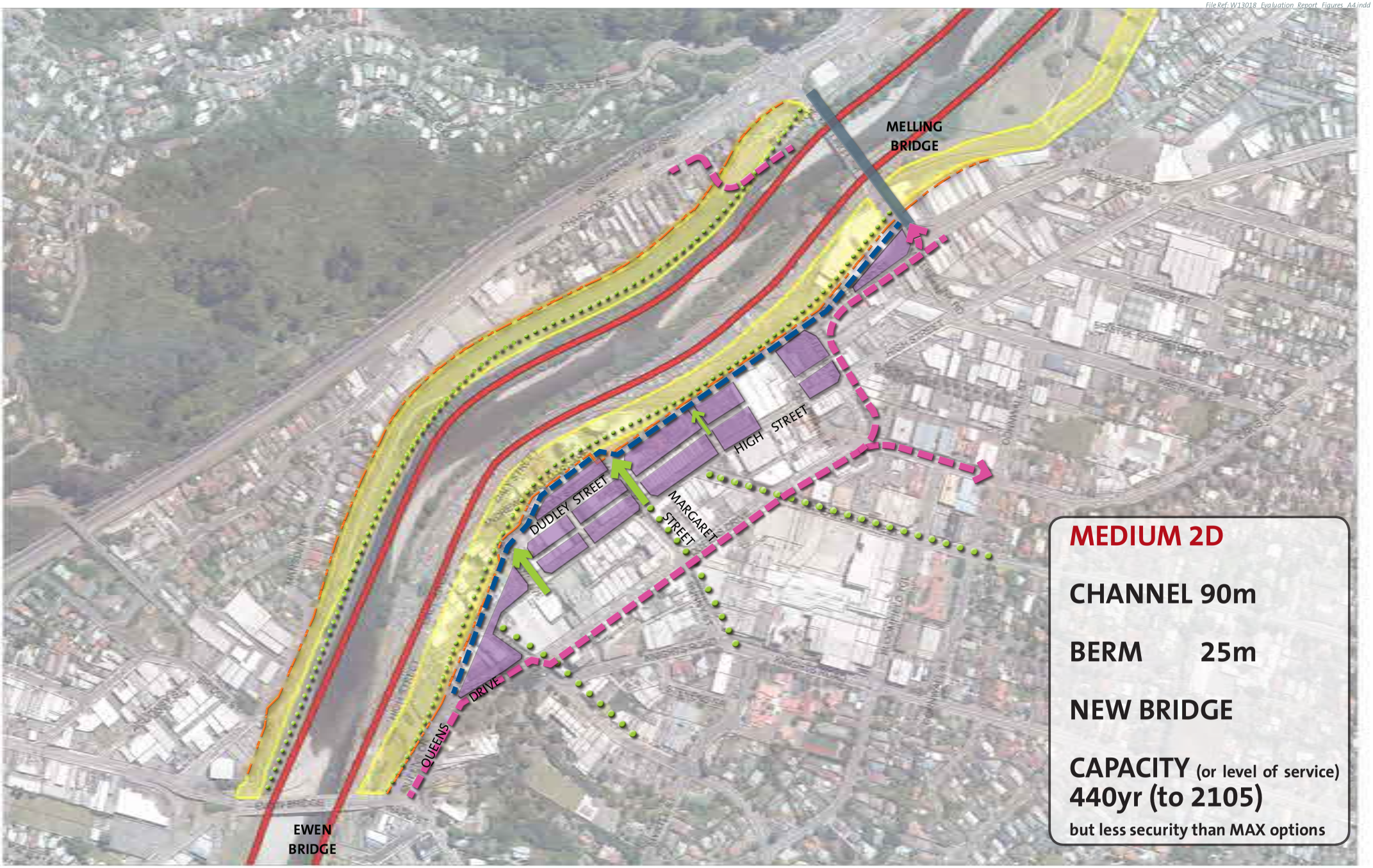

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- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- ECOLOGICAL EDGE
- PROPOSED STOPBANK (25m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 10 MED 2D

Date: 15 June 2015 | Revision: 15

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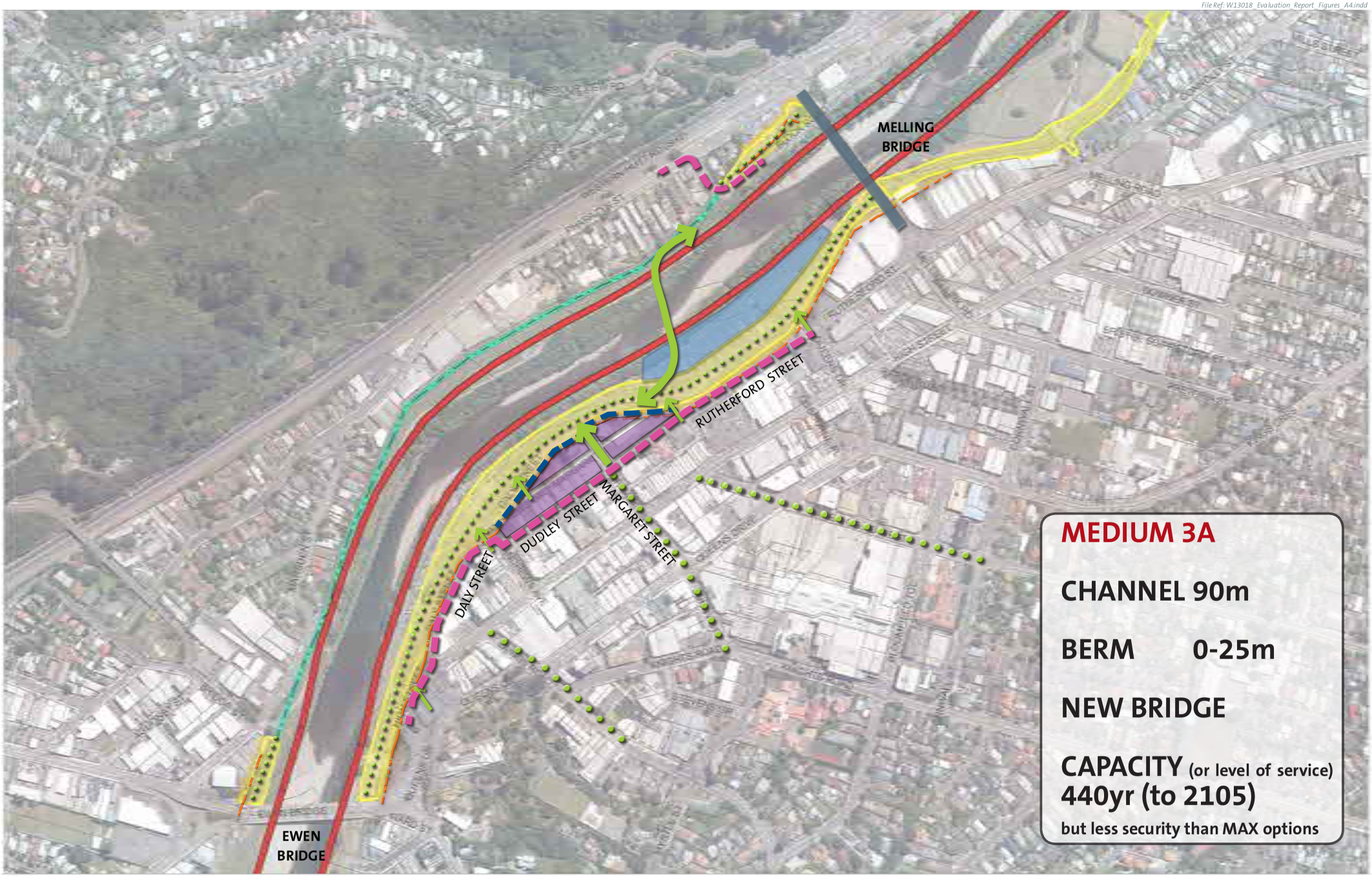

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Projection: GD1949 New Zealand Map Grid

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- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- NEW FLOODWALL
- ECOLOGICAL EDGE
- PROPOSED STOPBANK (0-25m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 11 MED 3A

| Date: 15 June 2015 | Revision: 15 |

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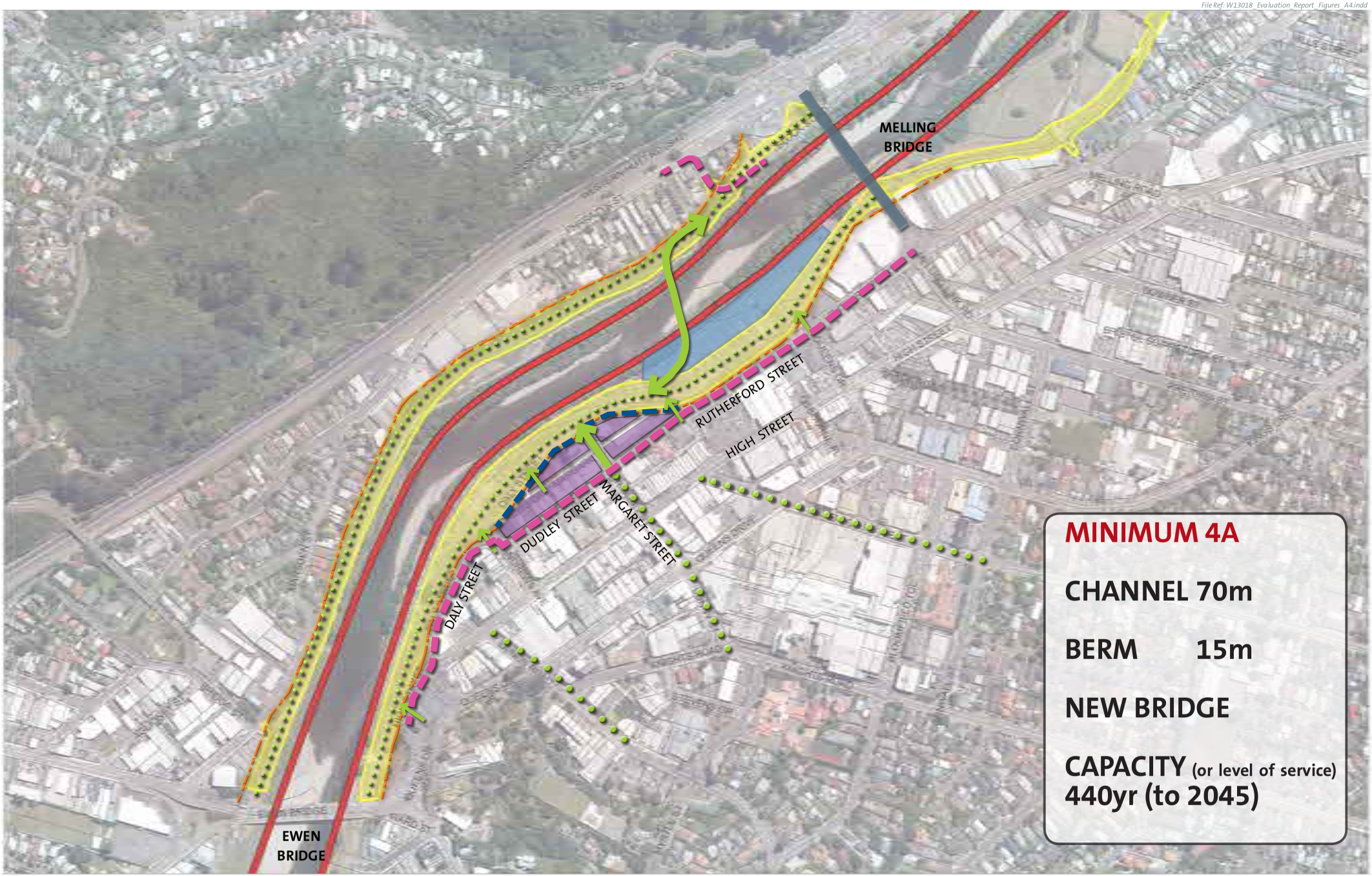

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- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- PROPOSED STOPBANK (15m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 12 MIN 4A

| Date: 15 June 2015 | Revision: 15 |

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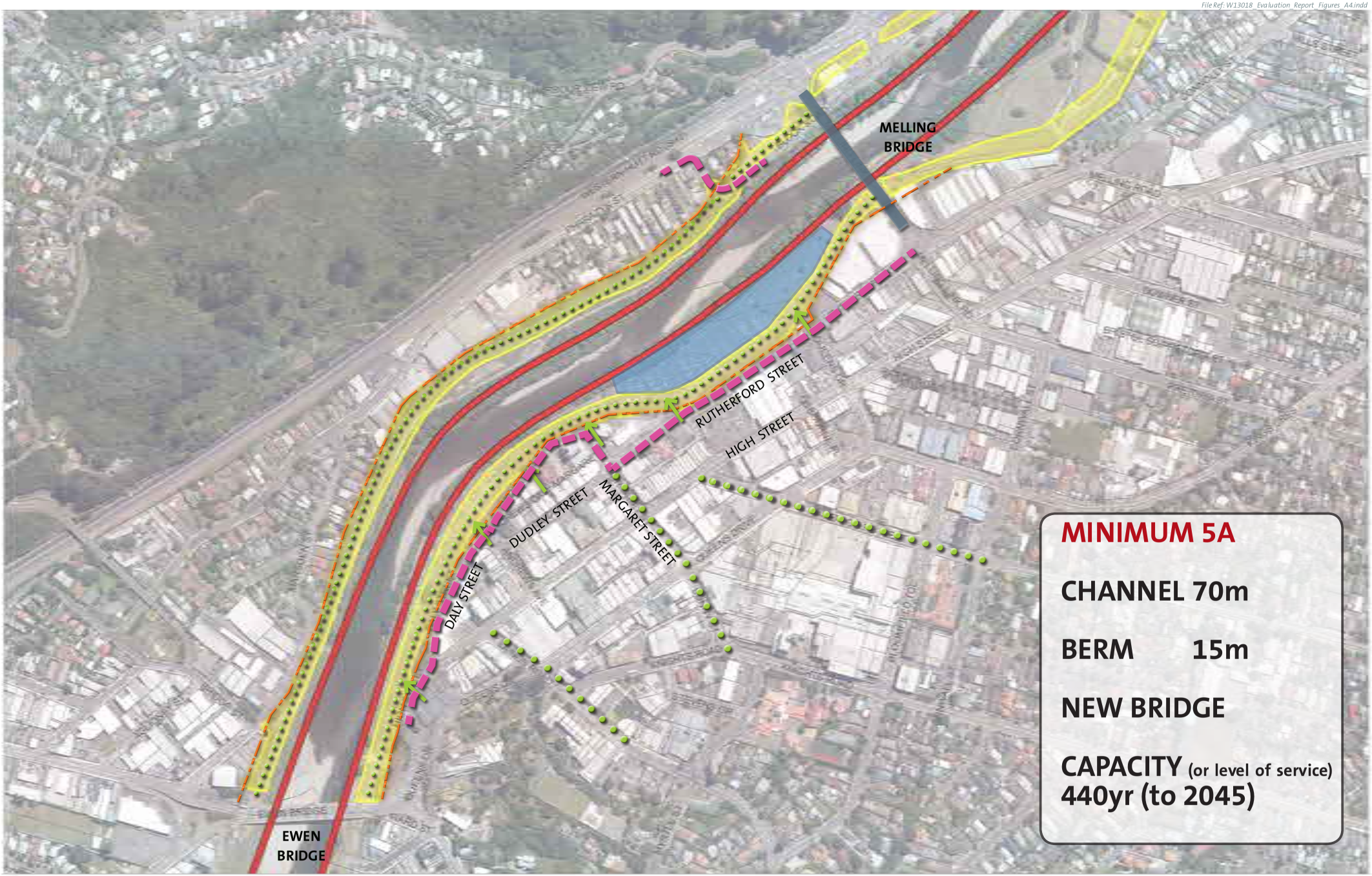

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Projection: GD1949 New Zealand Map Grid

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- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- PROPOSED STOPBANK (15m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- NEW BRIDGE
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 13 MIN 5A

| Date: 15 June 2015 | Revision: 15 |

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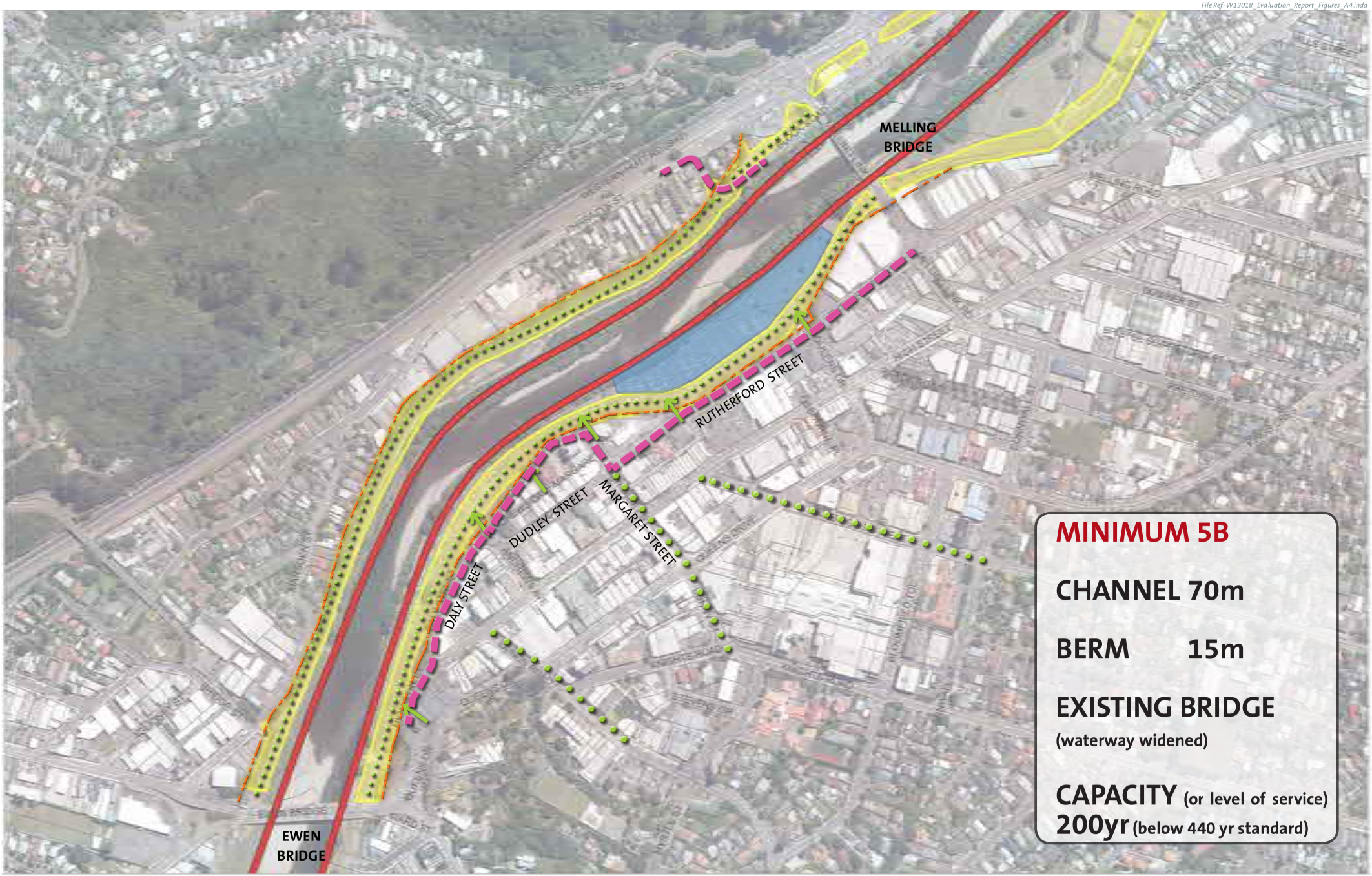

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Projection: GD1949 New Zealand Map Grid

- PROPOSED DESIGN CHANNEL (70m)
- PROMENADE FRONTAGE
- ROAD CHANGES
- ROAD IN TUNNEL
- NEW BOUNDARY
- PROPOSED STOPBANK (15m BERM)
- CAR PARK
- BLOCKS FOR REVELEOPMENT
- WALKWAY/CYCLEWAY LINKS
- EXISTING CHANNEL

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 14 MIN 5B

| Date: 15 June 2015 | Revision: 15 |

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Projection: GD1949 New Zealand Map Grid

HUTT RIVER - CITY SECTION: LONG LIST OPTIONS

Figure 15 STATUS QUO 6A

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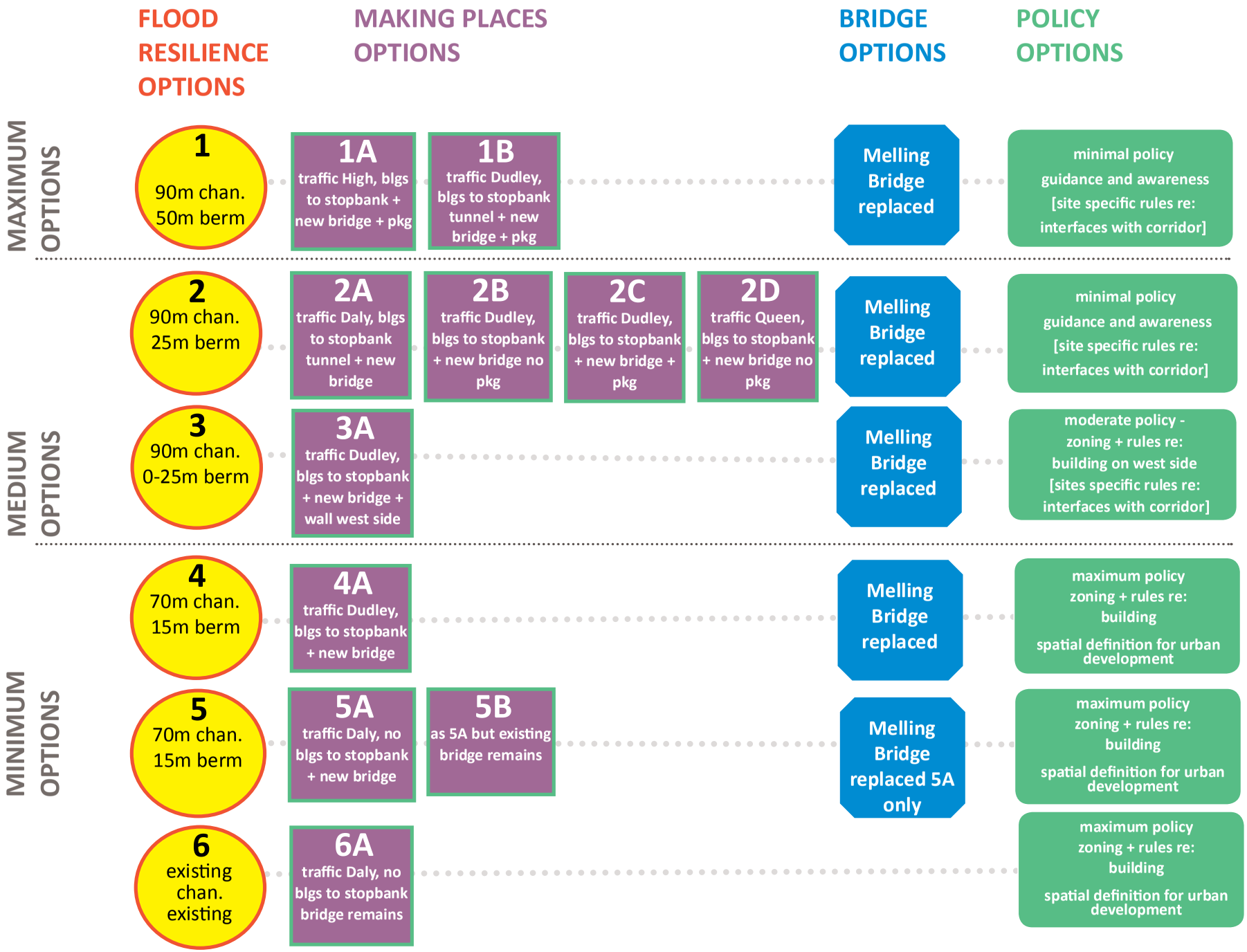

ATTACHMENT 2:
OPTIONS DIAGRAM

ATTACHMENT 3:
SENSITIVITY TEST OUTCOMES REPORT

Introduction

The following report describes the outcomes of Multi-Criteria Analysis (MCA) sensitivity testing on the 11 physical works options for the Hutt River City Section Upgrade Project (HRCSUP). The MCA 'base scoring' is described in the main report to which this Option Evaluation Process - Sensitivity Testing report is an attachment. The sensitivity tests were applied to understand the potential variability in the options preferences from the base scoring that would occur if any one of the four categories of criteria were over-weighted as more important than the others as they apply to the options. The four categories of criteria come under the headings of Environment, Flood Resilience, Making Places, and Movement.

The MCA base option scoring used a weighting for the criteria derived through a workshop process of the project's expert Working Group. The base scoring outcomes are set out below as a comparison with the sensitivity tested outcomes (Table 1). The weights assigned to each criteria in the base scoring (which is the scoring used to guide the selection of the preferred two options for consultation at the time this report was prepared) were not equal themselves. Those weightings were biased towards Flood Resilience as the most important performance outcome for the project (65%), followed by Making Places (20%), Environmental (10%) and Movement (5%).

Approach

A weighting of 40% importance was assigned to each of the four categories of criteria. The remaining three categories were assigned an even split of 20% each so as to achieve a total of 100%. In this way four scenarios were created with each category given a 'turn' at being double over-weighted relative to the others. It is noted that that in some scenarios the categories had a much higher weighting than they had in the base scoring described in the Hutt River City Section Upgrade Project report to which this report is an attachment. For example in the base scoring Environmental had 10% and in the sensitivity testing, even when it was not the 40% weighted biased one, it had 20% assigned as part of the even split.

Regardless of the differences between the base scoring and the sensitivity testing scenarios the key point is that the tests are conducted with a consistent bias which in this case doubles the weight accorded to the subject criteria being positively biased. In this way the outcomes can be compared and any sensitivity to one group of criteria compared to another identified and this recognised in the decision making process around the preferred options for consultation.

Outcomes

The outcomes of the sensitivity testing (refer to Tables 2-5) show that:

- For the MCA scores (first 3 columns of the tables) the options which rank highest under sensitivity testing scenarios continue to be those (like the base scoring in Table 1) which have the wider corridor as this enables all the criteria to be met the best – the greater the area of space the better the score. The highest rankings (1-3) under all the testing scenarios (Tables 2-5) are options 1A, 1B and 2C.
- In considering the costs as well as the benefits (last three columns of the tables) the tests identify ranked "Value for Money" (VFM) preferences for the options which balance the best benefits with the lesser cost of implementation. The highest rankings (1-3) under the testing scenarios (Tables 2-5) have option 4A as consistently ranked 1, followed by options 2B/2C as ranked 2 or 3. Option 5B does come into the ranking of the tops 3 (Environment and Movement bias). This is a function of the very low cost of option 5B. This option fails to meet the criteria for flood resilience.
- In summary the testing demonstrates that options 4A and 2C are within the top 3 of the rankings consistently under the weighted scenarios. This testing confirms the recommendation as to the preferred base scoring options (4A and 2C) to proceed to consultation.

TABLE 1 BASE SCORES (from Hutt River City section Upgrade Project Evaluation Report) MCA			Value for Money		
Option	Ranking	Weighted Score	Costs $M	Weighted Score/Costs x 100[1]	VFM Ranking
1A	1	4.79	268	1.77	7
1B	2	4.46	262	1.70	8 =
2C	3	3.79	143	2.65	1
2A	4	3.69	140	2.63	2
2D	5	3.39	199	1.70	8 =
2B	6	3.27	139	2.35	4
4A	7	2.72	114	2.38	3
3A	8	2.31	180	1.28	10
5A	9	2.08	96	2.16	6
5B	10	1.47	63	2.33	5
6A	11	1.38	0	1.38	9

TABLE 2 ENVIRONMENT BIAS VFM Summary sensitivity tests MCA			Value for Money		
Option	MCA Ranking – Env Bias 40%	Weighted Score	Costs $M	Weighted Score/Costs x 100	VFM Ranking – Env Bias 40%
1A	1	4.17	268	1.55	9
1B	2	3.91	262	1.49	10
2A	4	3.49	140	2.49	4
2B	6	3.36	139	2.41	5
2C	**3**	**3.77**	**143**	**2.63**	**3**
2D	5	3.47	199	1.74	8
3A	8	2.51	180	1.39	11
4A	7	3.19	114	2.79	1
5A	9	2.15	96	2.23	6
5B	11	1.70	63	2.69	2
6A	10	2.06	0	2.06	7

TABLE 3 VFM MAKING PLACES BIAS Summary sensitivity tests MCA			Value for Money		
Option	MCA Ranking – MP Bias 40%	Weighted Score	Costs $M	Weighted Score/Costs x 100	VFM Ranking – MP Bias 40%
1A	1	4.43	268	1.65	9
1B	2	3.81	262	1.45	10
2A	4	3.39	140	2.42	4
2B	6	3.56	139	2.56	2
2C	3	3.63	143	2.53	3
2D	5	3.81	199	1.91	7
3A	8	2.51	180	1.39	11
4A	7	3.19	114	2.79	1
5A	9	1.95	96	2.03	6
5B	11	1.50	63	2.38	5
6A	10	1.72	0	1.72	8

TABLE 4 MOVEMENT BIAS VFM Summary sensitivity tests MCA			Value for Money		
Option	MCA Ranking – Move Bias 40%	Weighted Score	Costs $M	Weighted Score/Costs x 100	VFM Ranking – Move Bias 40%
1A	1	4.13	268	1.54	10
1B	2	3.97	262	1.51	11
2A	4	3.63	140	2.59	5
2B	6	3.51	139	2.52	6
2C	3	3.93	143	2.74	2
2D	5	3.36	199	1.68	8
3A	8	2.96	180	1.64	9
4A	7	3.49	114	3.06	1
5A	9	2.50	96	2.60	4
5B	11	1.70	63	2.69	3
6A	10	2.07	0	2.07	7

TABLE 5 FLOOD BIAS VFM Summary sensitivity tests MCA			Value for Money		
Option	MCA Ranking – Flood Bias 40%[1]	Weighted Score	Costs $M	Weighted Score/Costs x 100	VFM Ranking – Flood Bias 40%
1A	1	4.43	268	1.65	9
1B	2	4.17	262	1.59	10
2A	4	3.63	140	2.59	3
2B	6	3.37	139	2.42	5
2C	3	3.83	143	2.67	2
2D	5	3.40	199	1.70	8
3A	8	2.57	180	1.42	11
4A	7	3.08	114	2.70	1
5A	9	2.15	96	2.23	6
5B	11	1.60	63	2.53	4
6A	10	1.76	0	1.76	7

[1] Note that the base scoring used to make the primary decision on preferred options had a higher weighting than 40% to flood hazard as this was primary issue.