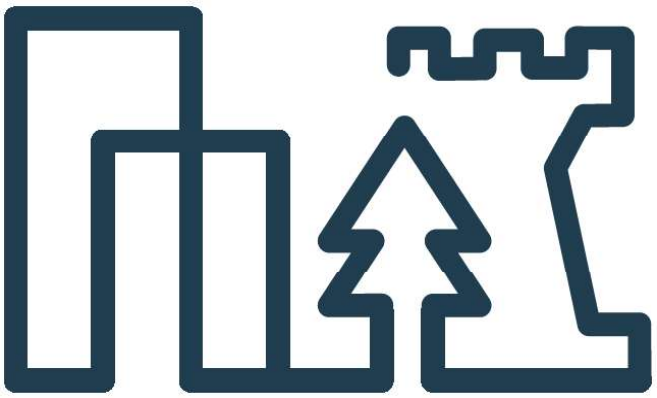
APPENDIX 16: ECONOMIC ASSESSMENT REPORT



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MEMO

DATE 24 February 2026

TO Marcus Koll

RE Te Karaka Flood Mitigation Economic Appraisal

Christensen Consulting Limited has been engaged by Gisborne District Council (GDC) to undertake an economic appraisal of the proposed upgrade to the Te Karaka flood protection scheme. The upgrade is in response to the significant damage and disruption that occurred in February 2023 during Cyclone Gabrielle. The proposed design standard is for conveyance of a 5,625 m^3/s flood which is consistent with the level of service provided by the downstream Waipaoa stopbank upgrades.

The following memo describes the sources of data, proposed methodology and key assumptions that have been used for the economic appraisal.

Overall Methodology

The methodology has been developed based on technical guidance from the United Kingdom combined with New Zealand specific depth-damage data as well as Australian information on indirect and intangible flood related losses. The overall method that has been chosen is aligned with the method described in the UK Flood Hazard Research Centre Handbook[1]. The key features being that depth-damage analysis is undertaken at the individual property scale and that a minimum of three floods are analysed. The methodology has recently been used by the Bay of Plenty Regional Council for assessing different flood mitigation options for Ngongotahā and is also proposed to be used for evaluating a proposed stopbank upgrade in Ōpōtoki. Upper Hutt City Council are also using it for evaluating different stream upgrade options within the Pinehaven catchment.

Modelling Data

DHI have completed modelling of the existing (current) situation and the proposed design situation with the stopbank upgrade for the following flood events -

- Cyclone Gabrielle – 4,200 m^3/s;
- Design Flood 5,625 m^3/s;
- Overdesign Flood 14,869 m^3/s.

GDC have advised[2] the approximate return periods of these events to be respectively 40-years, 100-years and 500-years including 100 years of significant climate change to the overdesign event only. The return periods for Cyclone Gabrielle and the Design Flood are in terms of the present day without any allowance for climate change. Average flood depths and levels for all property parcels as well as at all buildings within the protected area have been extracted from the model data and provided in an excel spreadsheet.

[1] Flood Hazard Research Centre UK (2005). Multi-Coloured Handbook - The Benefits of Flood and Coastal Risk Management: A Handbook of Assessment Techniques.
[2] Pers Comm (2026) Email from GDC 10 Feb 2026.

Dwelling Floor Levels

WSP have completed an assessment of dwelling floor levels above ground level. For residential dwellings the following hierarchy of data based on availability has been applied –

1. Consented height from Future of Severely Affected Land (FOSAL) data added to Digital Elevation Model (DEM) ground level;
2. Estimated floor height from Google StreetView added to DEM ground level;
3. Estimated floor height from site visit added to DEM ground level.

Where no data has been provided 350 mm has been assumed as the floor height above ground. This is based on the average height from the surveyed dwellings excluding the ones that have been raised by 1 m +.

Direct Flood Damage Assessment – Dwellings, Contents & Vehicles

Damages to individual dwellings have been based on August 2023 GDC improvements rateable values along with NZ average contents[3] and vehicle values[4]. Only property within the protected area have been assessed and any increases in flood levels outside of the protected area have been factored into the project cost and not covered within the flood damages assessment.

The below and overleaf stage damage curves from an earlier version of the RiskScape[5] tool have been used with an assumption that the timber one story pre 1970 curve provides a reasonable approximation for the affected dwellings.

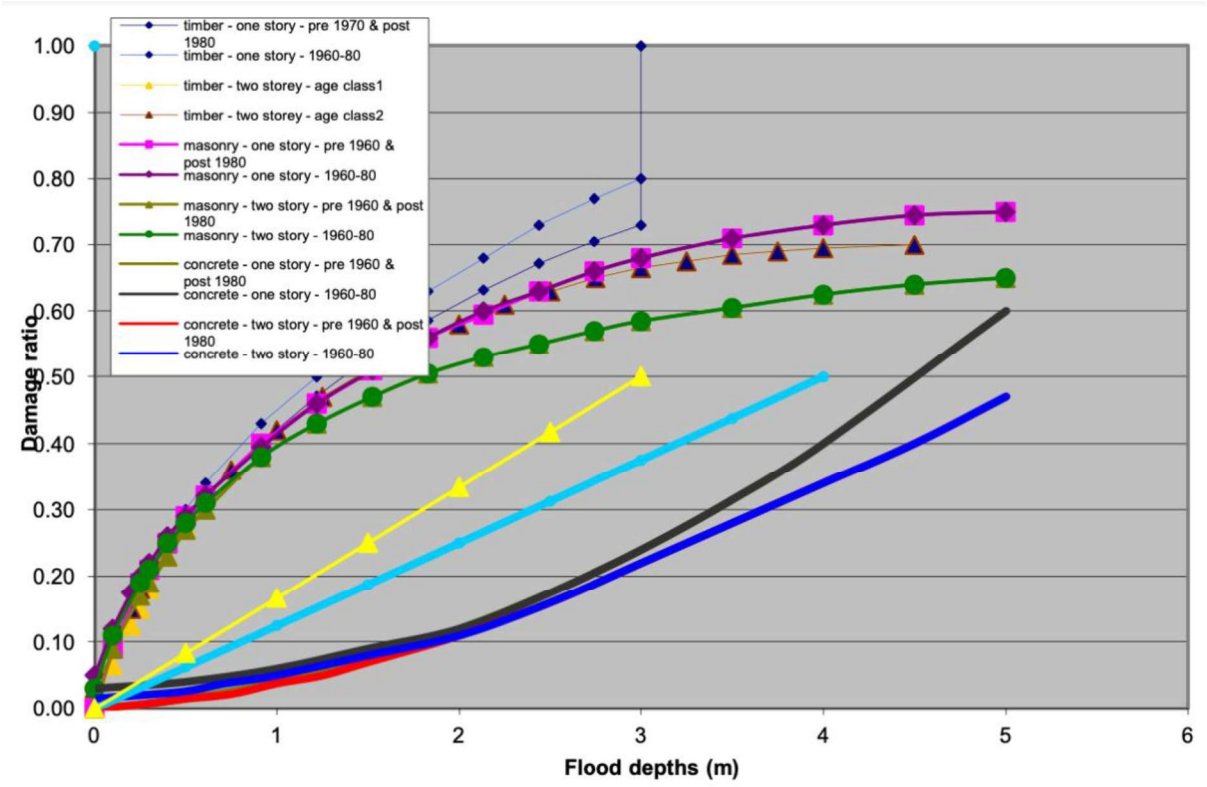

Figure 1. Stage vs Damage Relationship - Dwellings

[3] 2025/2026 Insurance Market Data Range $70-$100K.
[4] 2023 Census 1.6 vehicles per household and average vehicle value $26,640 Passenger Cars NZ Stastita Market Forecast.
[5] NIWA (2010). RiskScape: Flood Fragility Methodology

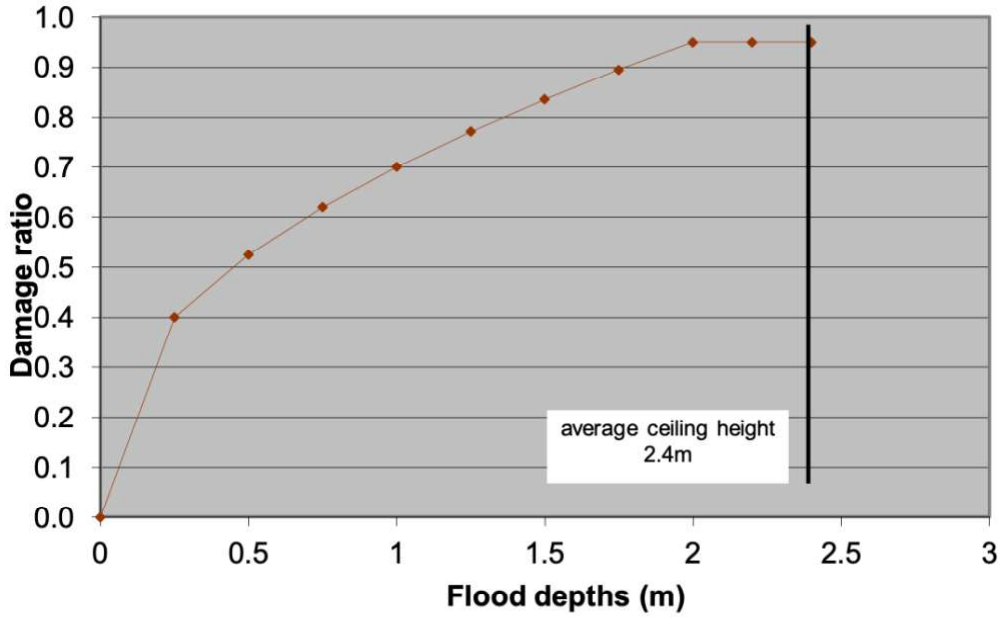

Figure 2. Stage vs Damage Relationship - Contents

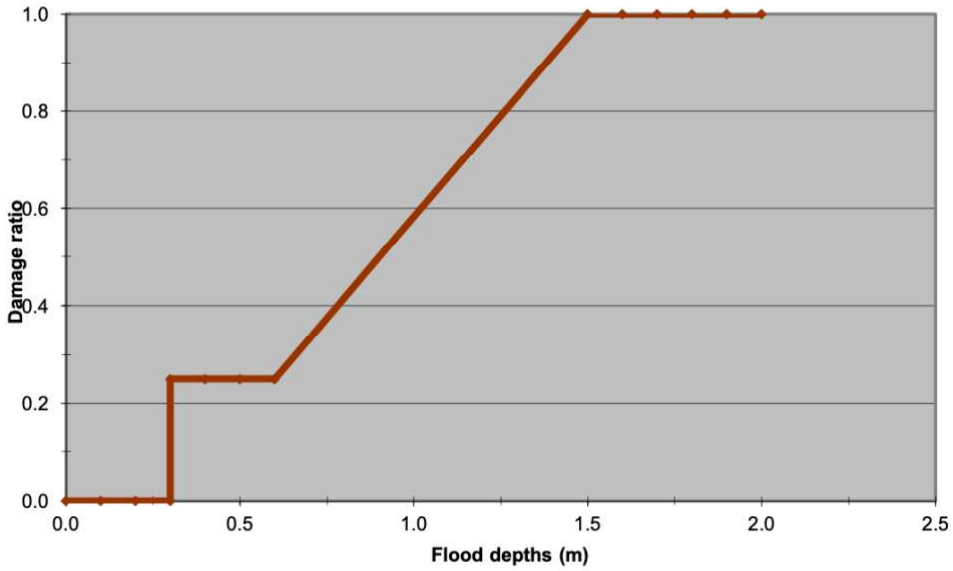

Figure 3. Stage vs Damage Relationship - Vehicles

Losses to Rural Production, Commercial, Retail, Educational & Other

In additional to flood damages to dwellings there have been estimates made on losses in rural production, as well as damage to commercial, retail, educational and other facilities.

Within the protected area four horticultural producing properties have been identified. For the purposes of this assessment an approximate depth damage curve based on per hectare losses has been used. Assumed gross margin per annum is $14,384/ha[6] with additional land remediation increasing to $12,000/ha at 2 m depth.

[6] Typical value from Perrin Ag Consultants, cited in NZIER/HortNZ

A variety of commercial, industrial, retail, education and other properties with improvements have been identified. A typical[7] stage damage curve has been applied based on the August 2023 value of improvements on each property. This is considered an adequate approximation for the purposes of this analysis.

Only one pastoral property has been identified and the benefits are assumed to be negligible so it has not been included in the analysis.

Indirect & Intangible Losses

In addition to the direct flood damage to dwellings including contents and vehicles described above, other indirect financial losses and intangible losses have also been estimated. These have been estimated based on percentage contributions to overall losses based on Australian research[8]. A description of these losses and the percentages that apply to overall losses is provided below. It is highlighted that these indirect losses are only being applied to direct losses associated with dwellings and not the losses from rural, commercial and other land uses. This is on the basis that the "people" effects are already accounted within the dwelling losses and that the estimated damage to the other land uses already includes clean-up, reinstatement and disruption costs.

Other Indirect Financial Losses 28%

- Emergency response including evacuations;
- Temporary housing;
- Public infrastructure damage;
- Clean-up costs;
- Reduced economic activity/business disruption.

Intangible Losses 37%

- Fatalities;
- Mental Health;
- Injuries;
- Chronic Illness;
- Stress – worry about future flooding;
- Loss of memorabilia/irreplaceable items and pets.

The indirect and intangible losses do make up a significant part of the overall loss but the high depths of flooding 1 – 2m + in the existing situation under design conditions do represent high hazard conditions where serious injury and loss of life would be likely. It is noted that the value of preventing a fatality in NZ is currently $12.5M[9].

[7] Generalised from USACE, UK Multi-Coloured Manual, NZ CBA practice.
[8] Deloitte (2021). Special Report: Update to the Economic Costs of natural disasters in Australia.
[9] NZTA Value of Statistical Life (VOSL)

Key Assumptions for Economic Analysis

Analysis has been undertaken to calculate the Benefit to Cost Ratio (BCR) defined as the present value of benefits (damage avoided) divided by the present value of costs (construction capital costs) for the proposed flood mitigation option.

The following assumptions will be applied -

- 50-year period of future analysis[10];
- 2% discount rate years 1-30 and 1.5% years 31-50[11]
- 8% sensitivity discount rate[11];
- Project costs P50 Expected Estimate including contingency[12].

Results

Tables 1 & 2 below present a summary of the results of the 2% and 8% sensitivity check cost benefit analysis. The cost benefit ratios are based on the updated P50 cost estimate provided by Alta of $25,163,744.

Table 1. Summary of Benefits and Cost Benefit Ratios for Te Karaka Flood Mitigation Works 2% discount rate

Total Direct Benefits - Dwellings, Contents & Vehicles	$ 31,335,180.61
Total Direct Benefits - Commercial, Educational, Other	$ 7,162,700.33
Total Direct Benefits - Horticulture	$ 781,052.60
Sub Total Direct Benefits	*$ 39,278,933.54*
Cost Benefit Ratio Direct Benefits	*1.6*
Indirect Benefits (Associated with Dwellings Only)	$ 25,068,144.48
Intangible Benefits (Associated with Dwellings Only)	$ 33,125,762.35
Total Benefits	**$ 97,472,840.37**
Cost Benefit Ratio Total Benefits	**3.9**

Table 2. Summary of Benefits and Cost Benefit Ratios for Te Karaka Flood Mitigation Works 8% sensitivity discount rate

Total Direct Benefits - Dwellings, Contents & Vehicles	$ 12,061,371.30
Total Direct Benefits - Commercial, Educational, Other	$ 2,757,028.57
Total Direct Benefits - Horticulture	$ 300,638.62
Sub Total Direct Benefits	*$ 15,119,038.49*
Cost Benefit Ratio Direct Benefits	*0.6*
Indirect Benefits (Associated with Dwellings Only)	$ 9,649,097.04
Intangible Benefits (Associated with Dwellings Only)	$ 12,750,592.51
Total Benefits	**$ 37,518,728.03**
Cost Benefit Ratio Total Benefits	**1.5**

[10] UK Ministry of Agriculture, Fisheries and Food (1999). Flood and Coastal Defence Project Appraisal Guidance Economic Appraisal. Flood and Coastal Defence with Emergencies Division.
[11] NZ Treasury (2024). Updated Public Sector Discount Rates for Cost Benefit Analysis.
[12] Alta(2026). Construction Cost Estimate, P95 Total Base Estimate plus Contingency.

Summary

- A cost benefit analysis has been completed for the Te Karaka Flood Mitigation project.
- Flood modelling data for three flood events for the existing and proposed scenarios have been used along with assessed dwelling floor heights as the basis for assessing damages.
- Damages to dwellings have used RiskScape depth damage curves appropriate for a typical dwelling in the Te Karaka community along with the current rateable value of improvements.
- Dwelling contents and vehicle losses have also been estimated using RiskScape depth damage curves along with national average data for contents value, vehicle value and number of vehicles per household.
- Damage to horticultural land has used typical values accounting for lost income and costs for repairs on a per hectare basis.
- Damage to commercial, retail, educational and other non-residential use building has applied an average depth damage curve from a range of international guidance and been applied to the current rateable value of improvements for the property.
- Indirect and intangible damages have been estimated as percentages of total damages associated with dwellings based on recent post flood research undertaken in Australia.
- Applying the appropriate Treasury discount rate (2%) to the proposed investment to reduce flood damages to the Te Karaka community produces a Cost Benefit Ratio of 1.6 when considering Direct Benefits only.
- Once indirect and intangible benefits are included the Cost Benefit Ratio increases to 3.9.
- The sensitivity check at the 8% discount provides a cost benefit ratio of 1.5 including indirect and intangible benefits.
- Based on this analysis it is very likely that the proposed investment in flood mitigation for Te Karaka will provide direct, indirect and intangible benefits to the community that are greater than the capital cost of the scheme.

Prepared by

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