

Assessment of Effects on Flooding for Proposed Pōrangahau Stopbanks

• Prepared for

Hawke's Bay Regional Council

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PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 523 6900
Web www.pdp.co.nz



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DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Steph Patchett

Reviewed and approved by

SIGNATURE

Gerald Strayton

Limitations:

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1.0 Introduction

Pattle Delamore Partners Limited (PDP) has been engaged by Hawke's Bay Regional Council (HBRC) to support the development of Land Categorisation Engineering Solutions for the South Zone of Pōrangahau. This work has been initiated in response to the widespread flood damage experienced during Cyclone Gabrielle in February 2023, which significantly impacted the Pōrangahau township and surrounding areas.

A process of elimination approach was employed to identify feasible flood mitigation options. This approach incorporated a range of inputs, including a comprehensive review of existing baseline data, input from community consultation and site walkovers, and hydraulic modelling. PDP's scope of work included:

1. Reviewing the existing Land Categorisation maps and baseline data sets.
2. Attending and participating in community meetings and recording mitigation options suggested by local residents.
3. Compiling a suite of potential enhancement options for Category 2A, 2C, and 2P properties to enable their potential reclassification to Category 1 or 3.
4. Identifying engineering solutions to support risk reduction for Category 3 properties, or alternatively identifying and documenting key constraints that make engineering solutions impractical for some locations.
5. Shortlisting technically feasible and practicable mitigation options.
6. Recommending preferred solutions, including the development of concept designs, indicative construction costs, and high-level implementation timelines.

The mitigation options considered through this process included structural measures such as stopbanks and floodwalls, as well as building relocation and elevation. Following detailed analyses, a combination of stopbanks and flood walls emerged as preferred primary mitigation measure for Pōrangahau. This selection process and its conclusions are outlined in PDP's companion report, *Pōrangahau Flood Defence Options Assessment* (PDP, 2024a).

To inform the design and evaluation of these measures, a hydraulic model of the Pōrangahau River was developed to:

- ∴ Determine the design crest elevations for proposed stopbanks located along the Pōrangahau River based on a 1% Annual Exceedance Probability (AEP) event as derived by NIWA through generalised extreme value analysis.

- ∴ Assess the impact of proposed mitigation structures on flood levels, flood extents, flow velocities, and flood hazard classifications.

The hydraulic model development process, including its construction and validation, is detailed in the report *Pōrangahau River: Design Model Build Report* (PDP, 2025). The current report presents the flood effects associated with the proposed flood mitigation works.

2.0 Overview of Proposed Mitigation Work

The preferred flood mitigation works for the township of Pōrangahau focus on reducing flood risks for properties categorised as Category 2C under HBRC's Land Categorisation framework. The key components of the proposed scheme include:

- ∴ The construction of stopbanks and floodwalls along the true left bank of the Pōrangahau River to provide a continuous line of defence for the main township.
- ∴ The construction of a low-height bund to the northwest of the urupā, primarily designed to reduce flow velocities across this culturally sensitive site.

The proposed stopbanks and floodwalls are designed to mitigate flooding associated with the 1% AEP event with a design freeboard to account for projected increases to peak flows under future climate change scenarios. Refer to Figure 1 for the locations and alignments of the proposed structures.

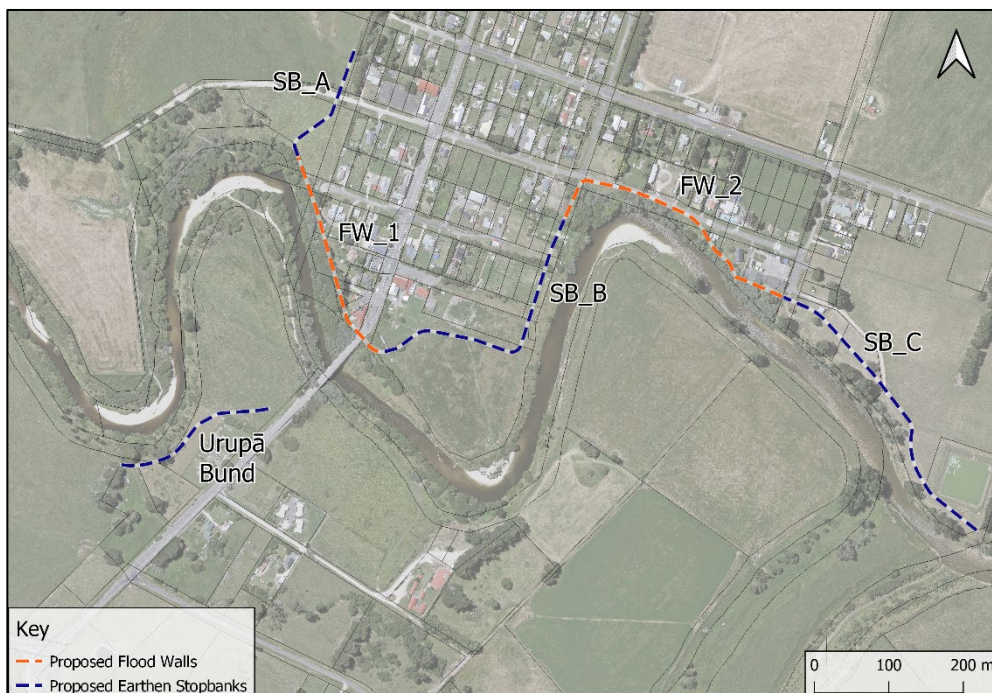


Figure 1. Proposed alignment of stopbanks and floodwalls

3.0 Design Approach

The design of the proposed flood mitigation structures was informed by hydraulic modelling outputs as is detailed in PDP’s 2025 model build report (PDP, 2025).

The key design parameters and assumptions include the following:

- ∴ Design Event: The stopbanks and associated flood mitigation structures are designed to contain flows from the current state 1% AEP (100-year average recurrence interval) flood event.
- ∴ Freeboard: A freeboard of 500 mm was added to the peak flood level determined from the model for the 1% AEP event. This additional height provides a margin of safety to account for uncertainties in the modelling, potential debris loading, and predicted increases to peak flow magnitude due to climate change.
- ∴ Urupā Bund: The low bund adjacent to the urupā is intended to reduce flood velocities across the urupā site rather than flood depths. As such, freeboard was not added to its crest elevation.

Table 1 and Figure 2 outline the derived crest elevations for each proposed stopbank and floodwall segment.

Table 1. Derived crest elevations.						
Level	SB A	FW 1	SB B	FW 2	SB C	Urupā Bund
1 % AEP Peak Flood Level (m RL)	11.11	11.07	10.03	9.45	9.02	
Nominal Crest Elevation (m RL)	11.67	11.32 – 11.67	10.00 – 10.54	9.62 – 9.97	9.45 – 9.58	11.97 ^[1]
Minimum Freeboard (m)	0.55	0.56	0.51	0.52	0.54	
<i>Notes:</i> 1. The urupā bund has been modelled without freeboard, as its primary purpose is to reduce flow velocities through the urupā, rather than reduce flood depths.						

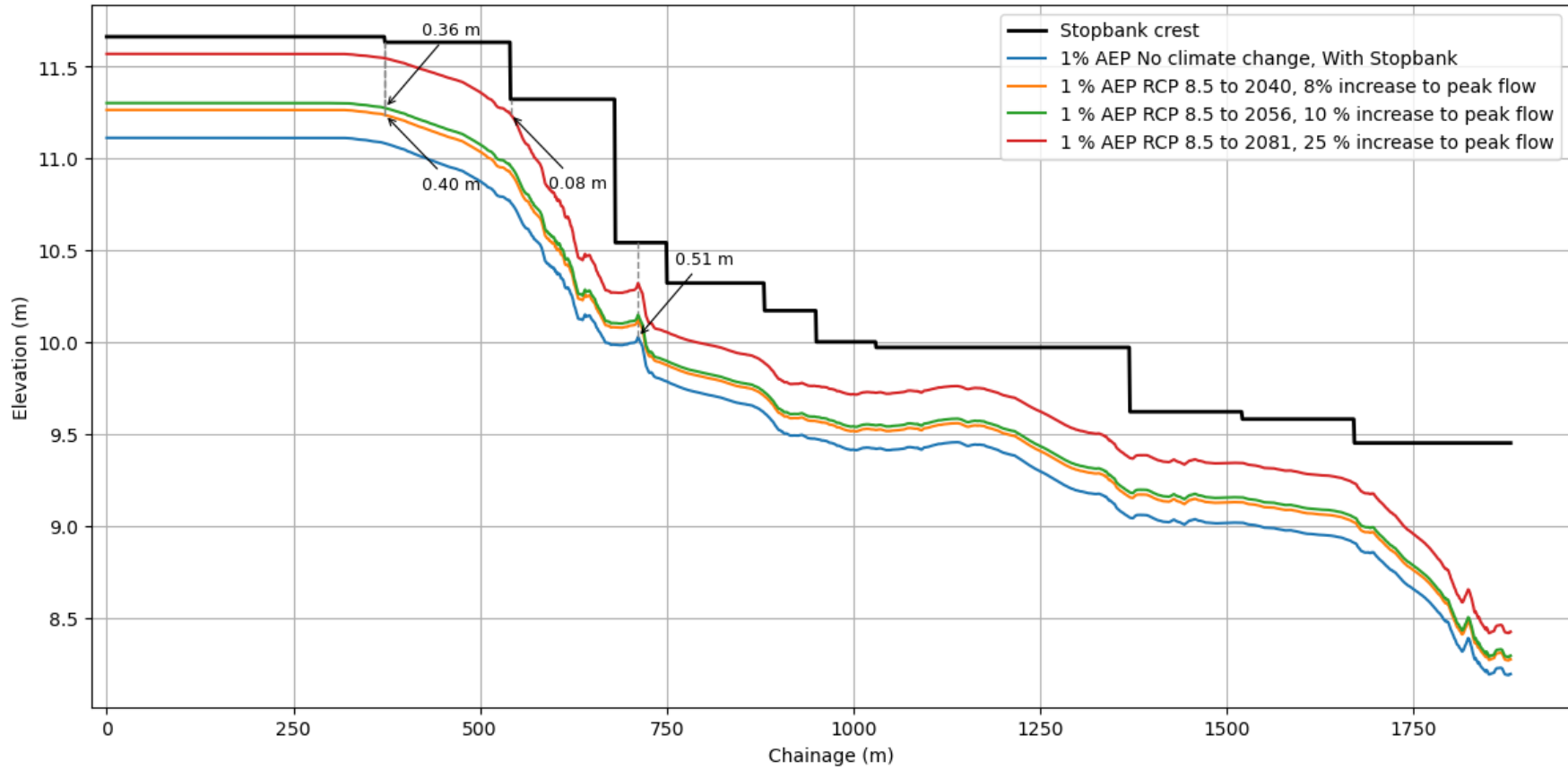


Figure 2. Comparison of modelled flood event peak water levels in relation to proposed stopbank crest height.

4.0 Flood Hazard Method

Flood hazard classifications were applied using a combination of flow depth and velocity data generated by the hydraulic model. Classifications follow the methodology outlined in *Australian Rainfall and Runoff 2019* (ARR, 2019), adapted by Smith et al. (2014), which has also been adopted in the Greater Wellington Regional Council (GWRC) *Flood Hazard Modelling Standard* (2021).

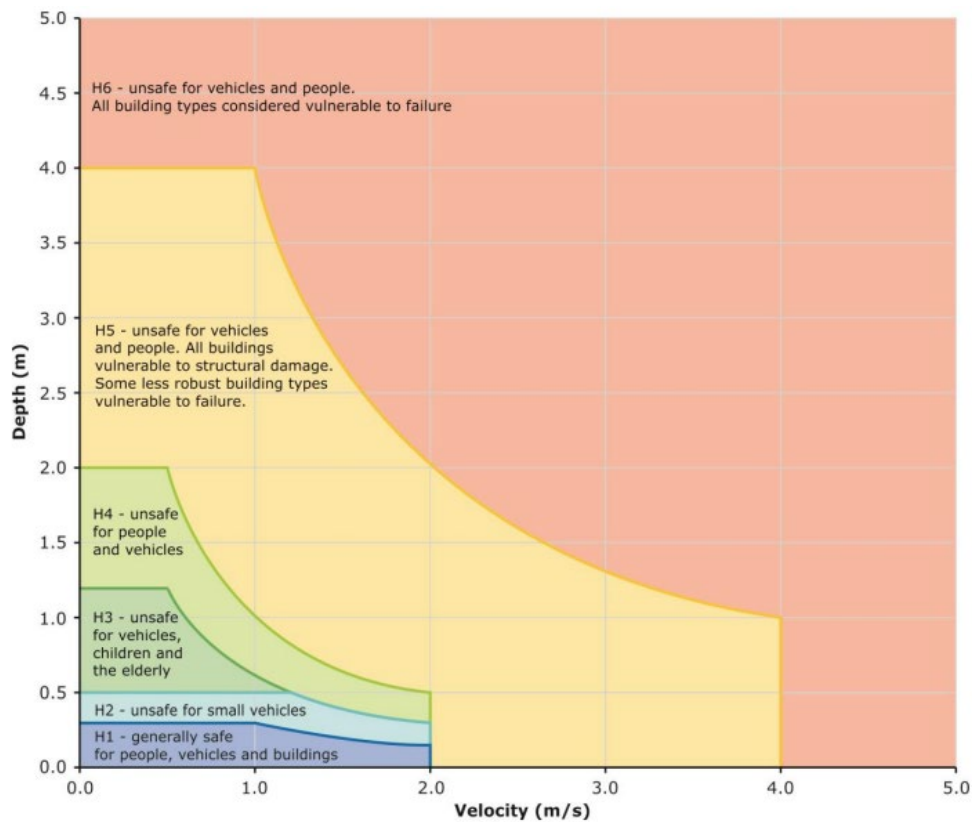


Figure 3. Flood hazard curves (Smith et al., 2014)

5.0 Effects on Flooding (Consequential Flood Effects Assessment)

To assess the flood-related impacts of the proposed mitigation works, the hydraulic model was simulated for both pre-development (baseline) and post-development (mitigation) scenarios for the 1 % AEP RCP8.5 to 2056 event (represented by a 10 % increase to peak flow magnitude above the 1 % AEP design event). The results were compared to evaluate changes in flood extents, flood depths, flow velocities, and hazard classifications.

The outcomes of this comparison are illustrated through mapping outputs in the following appendices:

- ✧ Appendix A – Flood Depth Maps
- ✧ Appendix B – Flood Hazard Maps
- ✧ Appendix C – Flood Velocity Maps

Flood effects on building footprints were assessed based on the Land Information NZ (LINZ) Layer 101290 NZ Building Outlines (LINZ, 2021), and corresponding addresses sourced from LINZ Layer 105689 NZ Addresses (LINZ, 2023). Some initial screening of the building outlines layer was undertaken to remove obviously uninhabitable buildings; however, the assessments do not distinguish between dwellings and outbuildings (e.g. garages or sheds). While the reporting of flood depths on buildings footprints has not considered any existing freeboard of the buildings, it can be assumed that minimum finished floor levels sit at least 150 mm above surrounding ground level (Standards New Zealand, 2011; MBIE, 2023).

5.1 Changes in Flood Depths and Extents

5.1.1 Positive Effects

The modelling results indicate that the proposed works will lead to a moderate reduction in flood extent and significant reduction in the number of buildings subject to inundation. These results are summarised in Table 2. A more detailed assessment of changes in flood depths on specific building footprints is provided in Appendix D.

Table 2. Summary of inundation area and affected buildings.				
Event AEP	Area of Flooding (ha)		No. Buildings in Flooded Area	
	Before proposed works (pre)	After proposed works (post)	Before proposed works (pre)	After proposed works (post)
1 % AEP RCP8.5 to 2056 (+10 % increase in peak flow)	1051.5	1023.4 (↓3 %)	232	105 (↓ 55 %)
<p><i>Notes:</i></p> <ol style="list-style-type: none"> 1. All flooded depths > 0 mm are reported 2. Buildings and appurtenant structures have not been distinguished (i.e. dwelling vs. garage) 3. Building footprints have been identified (and screened) using LINZ layer NZ building outlines; ID101290 4. Climate change is represented by a 10 % increase in peak flow rate. 5. The "post" total includes one property that was not previously affected by flooding but is newly affected as a result of the stopbanks. A total of 128 properties that were previously at risk are protected by the proposed works, giving a net reduction of 127 properties in the flooded area 				

The most significant reduction in flood extent is observed within the Pōrangahau township, which is the primary area protected by the proposed stopbanks (Figures A1 – A3, Appendix A). The proposed scheme protects 128 building footprints (55 % of those that are predicted to be inundated under the baseline scenario).

5.1.2 Adverse Effects

A total of 82 building footprints are predicted to experience an increase in peak flood depth as a result of the establishment of the proposed flood protection works. These increases range from <10 mm to 140 mm and are located on Beach Road, Cooks Tooth Road, Keppel Street, and Pah Road, as summarised in Table 3.

Table 3. Summary of peak flood depth increase on affected building footprints.				
Beach Road				
Address	Number of Building Footprints with an Increase in Peak Flood Depth			
	0 - 10 mm	10 - 50 mm	50 - 100 mm	100 - 200 mm
324 Beach Road	4	0	0	0
360 Beach Road	0	1	0	0
392 Beach Road	0	1	0	0
Opposite 392 Beach Road	1	0	0	0
416 Beach Road	0	10	0	0
418 Beach Road	0	43	0	0
420 Beach Road	0	4	0	0
424 Beach Road	0	3	0	0
Cooks Tooth Road				
Address	0 - 10 mm	10 - 50 mm	50 - 100 mm	100 - 200 mm
36 Cooks Tooth Road	0	0	1	0
Opposite 58 Cooks Tooth Road	0	0	0	1
81 Cooks Tooth Road	0	0	0	1
96 Cooks Tooth Road	0	0	0	1
Keppel Street				
109 Keppel Street	0	0	0	1
Pah Road				
Address	0 - 10 mm	10 - 50 mm	50 - 100 mm	100 - 200 mm
9 Pah Road (Kaumātua Flats)	0	0	1	2
14 Pah Road	0	0	2	0
27 Pah Road (Marae)	0	0	3	2
Total	5	62	7	8

Beach Road

Beach Road properties experience minor flood depth increases of 8-11 mm across 67 affected building footprints. The area of increased flooding is primarily around the Beach Road camping ground and neighbouring properties near the Beach Road bridge (Figure 4). These properties already experience severe baseline flooding (0.4 - 2.5 m depths), so the increase represents a minimal change in flood risk.

- ∴ Total building footprints affected: 67;
- ∴ Baseline context: Properties already experience severe flooding (0.4 - 2.5 m depths);
- ∴ Flood depth increase range: 8 - 11 mm across all affected buildings.

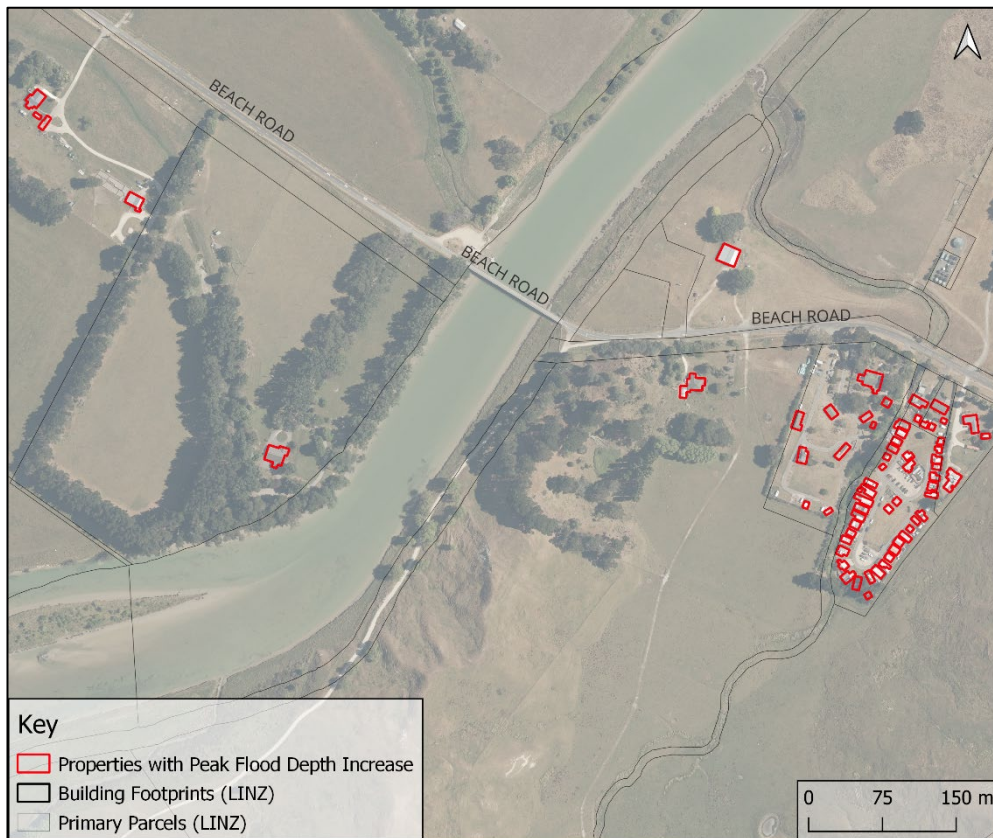


Figure 4. Beach Road building footprints that show an increase in peak flood depth as a result of the proposed flood mitigation works.

Cooks Tooth Road

On Cooks Tooth Road, 4 building footprints are predicted to experience an increase in peak flood depth (Figure 5).



Figure 5. Cooks Tooth Road building footprints that show an increase in peak flood depth as a result of the proposed flood mitigation works.

- ∴ New flooding (1 building footprint):
 - 96 Cooks Tooth Road: 0 mm to 120 mm (Figure 6);

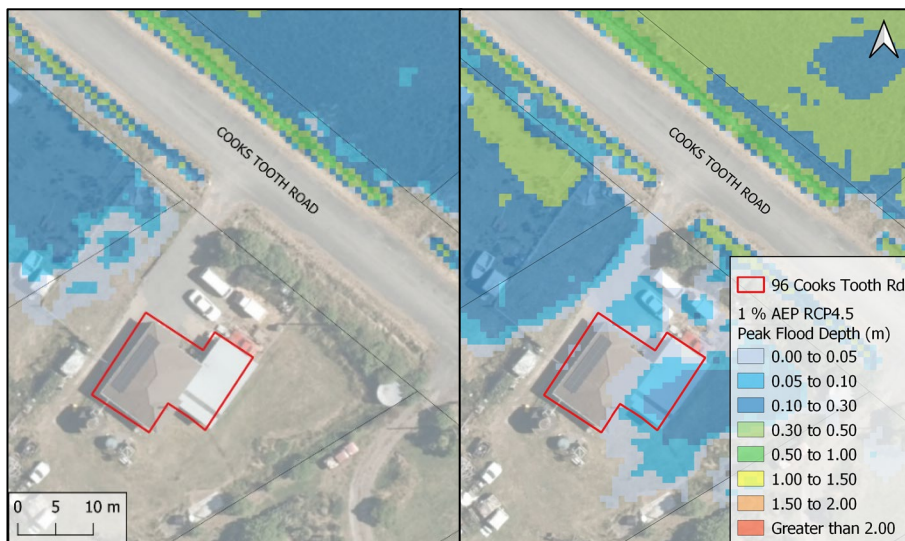


Figure 6. 96 Cooks Tooth Road peak flood depth pre- versus post-flood mitigation works.

- ∴ Increased existing flooding (3 buildings):
 - 36 Cooks Tooth Road: 250 mm to 310 mm (+60 mm, possible floor level exceedance);
 - Opposite 58 Cooks Tooth Road: 640 mm to 770 mm (+130 mm);
 - 81 Cooks Tooth Road: 80 mm to 200 mm (+120 mm, possible floor level exceedance).

Keppel Street

One buildings footprint at 109 Keppel Street is predicted to experience an increase in peak flood depth (Figure 7):

- ∴ Assumed primary dwelling: 190 mm to 330 mm (+140 mm, possible floor level exceedance);

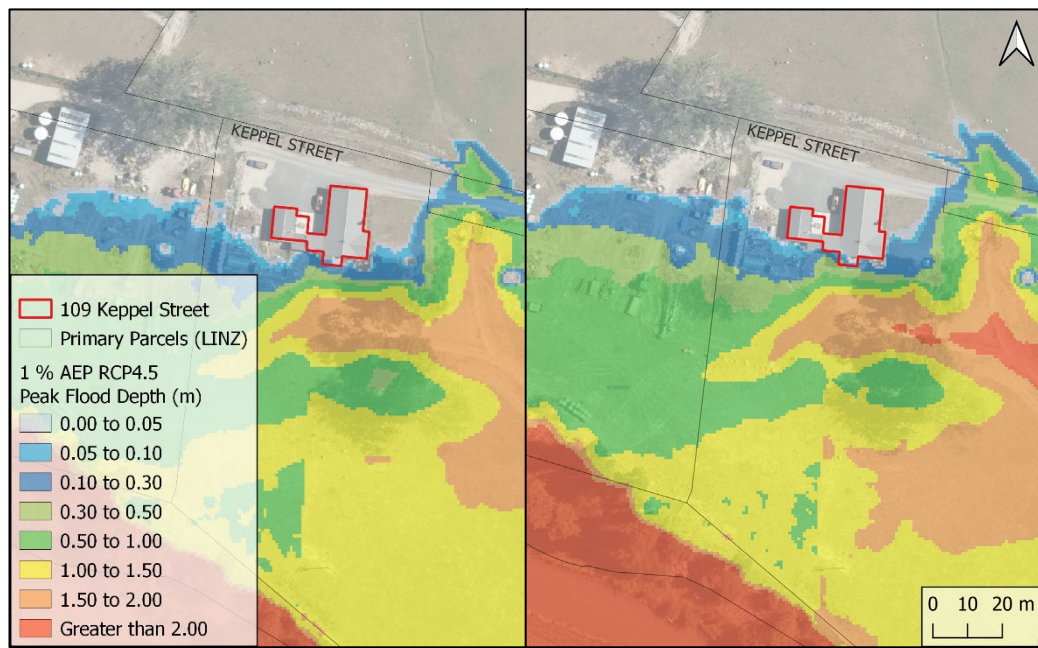


Figure 7. 109 Keppel Street peak flood depth pre- versus post-flood mitigation works.

Pah Road

Pah Road impacts are concentrated on culturally significant sites, with moderate flood depth increases (Figure 8):

- ∴ Kaumātua flats (3 building footprints):
 - Peak flood depth increases of 66 - 110 mm;
 - Baseline depths of 1.04 - 1.43 m increasing to 1.11 - 1.54 m.

- ✧ Marae (5 building footprints):
 - Increases of 86 - 108 mm;
 - Baseline depths of 510 - 650 mm increasing to 600 - 740 mm.
- ✧ 14 Pah Road (2 building footprints):
 - Increases of 77 - 80 mm;
 - Baseline depths of 0.87 - 1.04 m increasing to 0.95 - 1.12 m.



Figure 8. Pah Road building footprints that show an increase in peak flood depth as a result of the proposed flood mitigation works.

5.2 Changes in Flood Hazard

Flood hazard categories were compared between the baseline and post-mitigation scenarios using the ARR 2019 H1-H6 hazard classification system. Changes are summarised in terms of both land area (Table 4) and affected building footprints (Table 5).

Table 4. Flood risk areas before and after proposed works (based on ARR 2019 H1-H6 hazard rating).

Event AEP	Total area of flood risk per hazard category before proposed work (ha)					
	H1	H2	H3	H4	H5	H6
Baseline 1 % AEP RCP8.5 to 2056 (+10% peak flow)	100.1	85.9	286.9	244.6	186.9	194.6
Event AEP	Total area of flood risk per hazard category after proposed work (ha)					
	H1	H2	H3	H4	H5	H6
Mitigation 1% AEP RCP8.5 to 2056 (+10% peak flow)	94.4 (↓ 6 %)	80.7 (↓ 6 %)	275.6 (↓ 4 %)	229.7 (↓ 6 %)	188.8 (↑ 1 %)	199.2 (↑ 2 %)

Notes:

- River corridors are included in the assessed area and will likely appear in the H6 category in both before and after proposed work scenarios.

Table 5. Number of buildings within flood risk areas before and after proposed works (based on ARR 2019 H1-H6 hazard rating).

Event AEP	Total Number of Buildings within Hazard Classification					
	H1	H2	H3	H4	H5	H6
Baseline 1 % AEP RCP8.5 to 2056 (+10% peak flow)	22	55	117	38	1	0
Event AEP	Total Number of Buildings within Hazard Classification					
	H1	H2	H3	H4	H5	H6
Mitigation 1% AEP RCP8.5 to 2056 (+10% peak flow)	16 (↓ 27 %)	3 (↓ 95 %)	54 (↓ 54 %)	35 (↓ 8 %)	0 (↓ 100 %)	0

Notes:

- Buildings and appurtenant structures have not been distinguished (i.e. dwelling vs. garage)
- Building footprints have been identified and screened using LINZ layer NZ building outlines; ID101290.

The results indicate substantial improvements in building exposure to flood hazards, with significant reductions in the number of buildings within all hazard categories. While there are minor increases in land area classified as high hazard (H5-H6), the overall number of buildings affected by high hazard zones decreases. Importantly, no buildings are reclassified into the H6 category as a result of the proposed works

5.3 Impacts on Culturally Sensitive Sites

5.3.1 Marae

As outlined in Section 5.1.2, the establishment of the stopbanks and flood walls are predicted to increase flood levels on the marae building footprints by up to 110 mm. Two buildings within the property are predicted to move from a hazard classification of H2 to H3, whilst the other three buildings remain either H2 or H3 under both the baseline and mitigation scenarios.

5.3.2 Kaumātua Flats

The flood hazard classification for the kaumātua flats' building footprints is predicted to remain unchanged for all but one building. The easternmost flat is downgraded from H4 to H3, reflecting a slight improvement in flood effects due to reduced flow velocities across the site. However, flood depths are predicted to increase by 65 – 110 mm across the three affected buildings.

5.3.3 Urupā

The proposed bund to the northwest of the urupā is predicted to significantly reduce flow velocities across the site, from baseline levels of 1.0 – 1.5 m/s to less than 0.5 m/s. This results in an improvement in flood hazard from a maximum classification of H5 to H3 (refer to Figures C1 and C2, Appendix C).

6.0 Conclusions

The hydraulic modelling assessment of the proposed flood mitigation works for Pōrangahau indicates the following outcomes:

Benefits:

- ∴ Significant reduction in flooded building footprints: 128 buildings that were flooded (55%) are protected from inundation.
- ∴ 23 building footprints see a reduction in peak inundation depth.
- ∴ Moderate reduction in flood extent: 28.1 hectares (3%) decrease in flooded area.
- ∴ Substantial improvements in building exposure to flood hazards, with reductions of 8-100 % across hazard categories H1-H5.

- ∴ Significant improvement in flood conditions at the urupā, with hazard classification improving from H5 to H3.

Adverse Effects:

- ∴ 82 building footprints experience increased flood depths ranging from <10 mm to 140 mm.
- ∴ Most significant impacts occur on Cooks Tooth Road (4 buildings affected with 1 newly flooded) and Pah Road (10 buildings affected), including culturally sensitive sites.
- ∴ Beach Road properties experience minor increases (8-11 mm) in already severe flooding conditions.

Residual Risk Considerations:

The proposed stopbanks are designed for protection against the 1 % AEP flood event with climate change allowances incorporated into the design freeboard. However, residual risks remain:

- ∴ Overtopping risk: Floods exceeding the design standard (>1 % AEP + 500 mm freeboard) would result in inundation of protected areas.
- ∴ Structural failure risk: Should the flood protection works fail during a flood event, the protected areas would experience rapid inundation with potentially greater depths and velocities than under baseline conditions due to the sudden release of retained floodwater.

The modelling demonstrates that 151 buildings would gain flood protection (resulting in either no inundation or reduced depths) while 82 buildings would experience increased flooding, with most increases being minor (< 50 mm for 67 of the 82 buildings). The reduction in overall flood hazard exposure and specific improvements at culturally significant sites represent measurable benefits. However, the adverse effects on Cooks Tooth Road and Pah Road properties, along with inherent residual risks associated with structural flood protection measures, require consideration in project evaluation and ongoing risk management.

7.0 References

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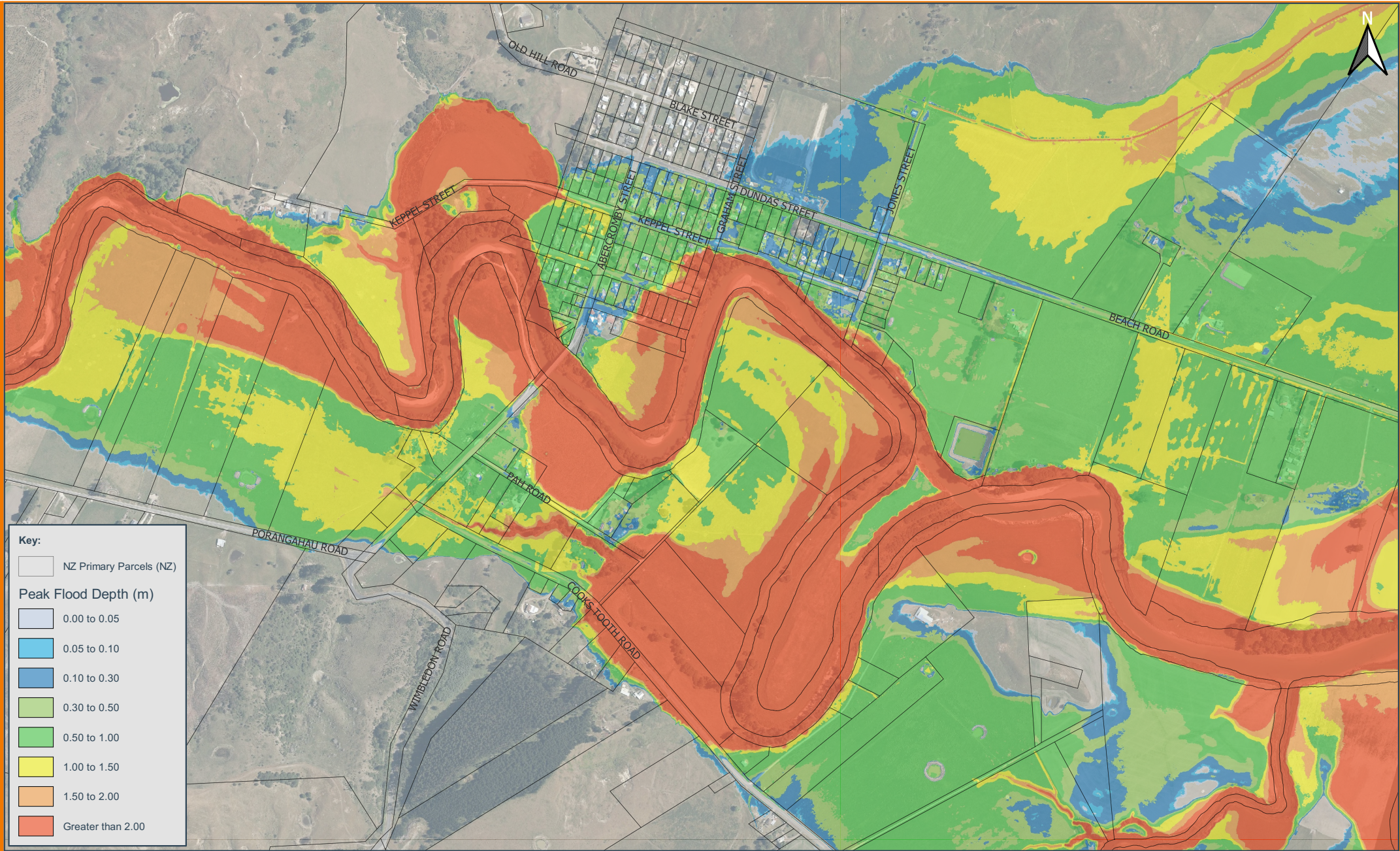
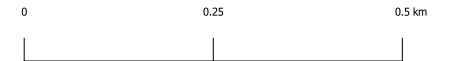


FIGURE A1: 1% AEP + 10 % CC Baseline Peak Flood Depth

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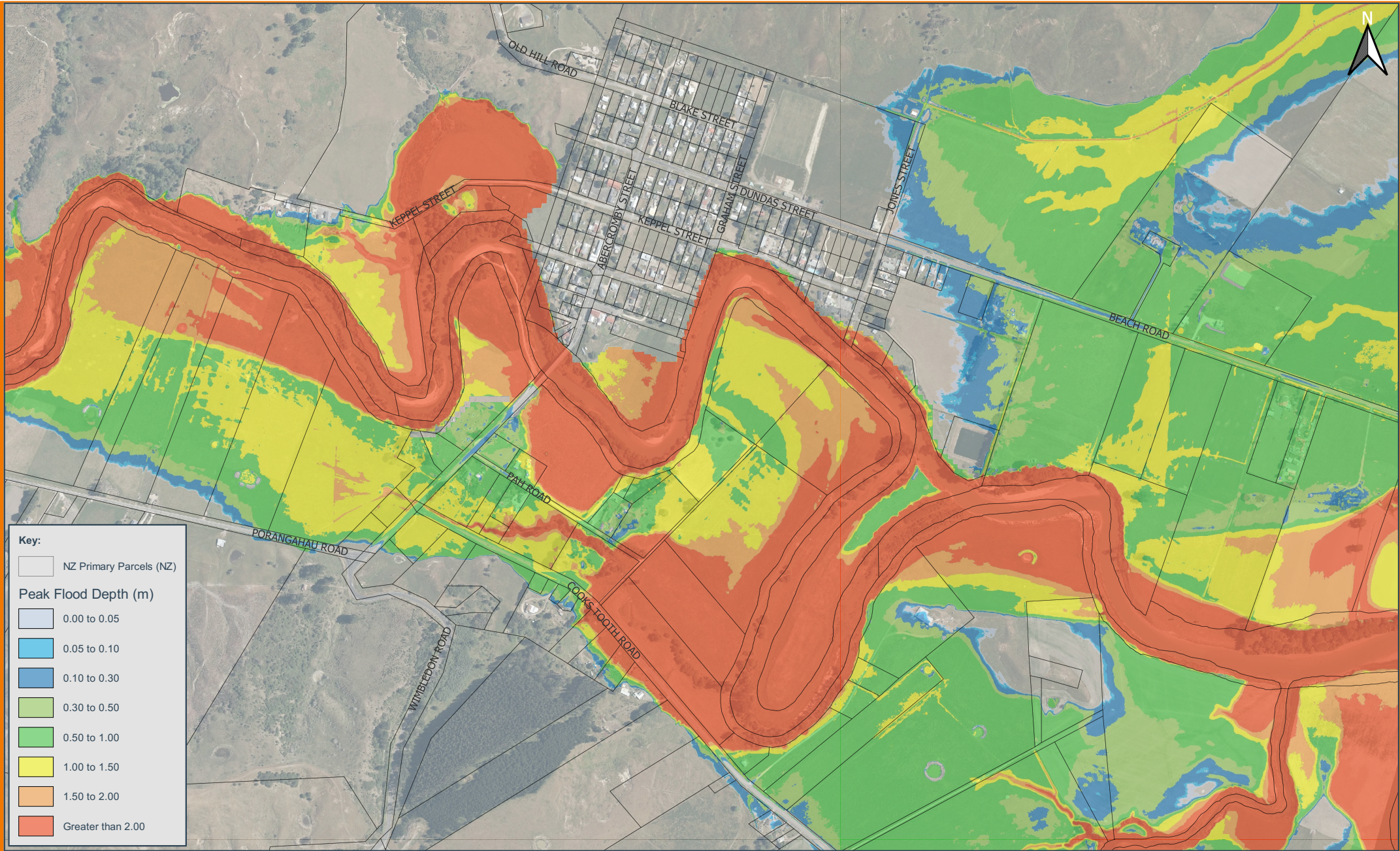


FIGURE A2: 1% AEP + 10 % CC Post-Development Peak Flood Depth

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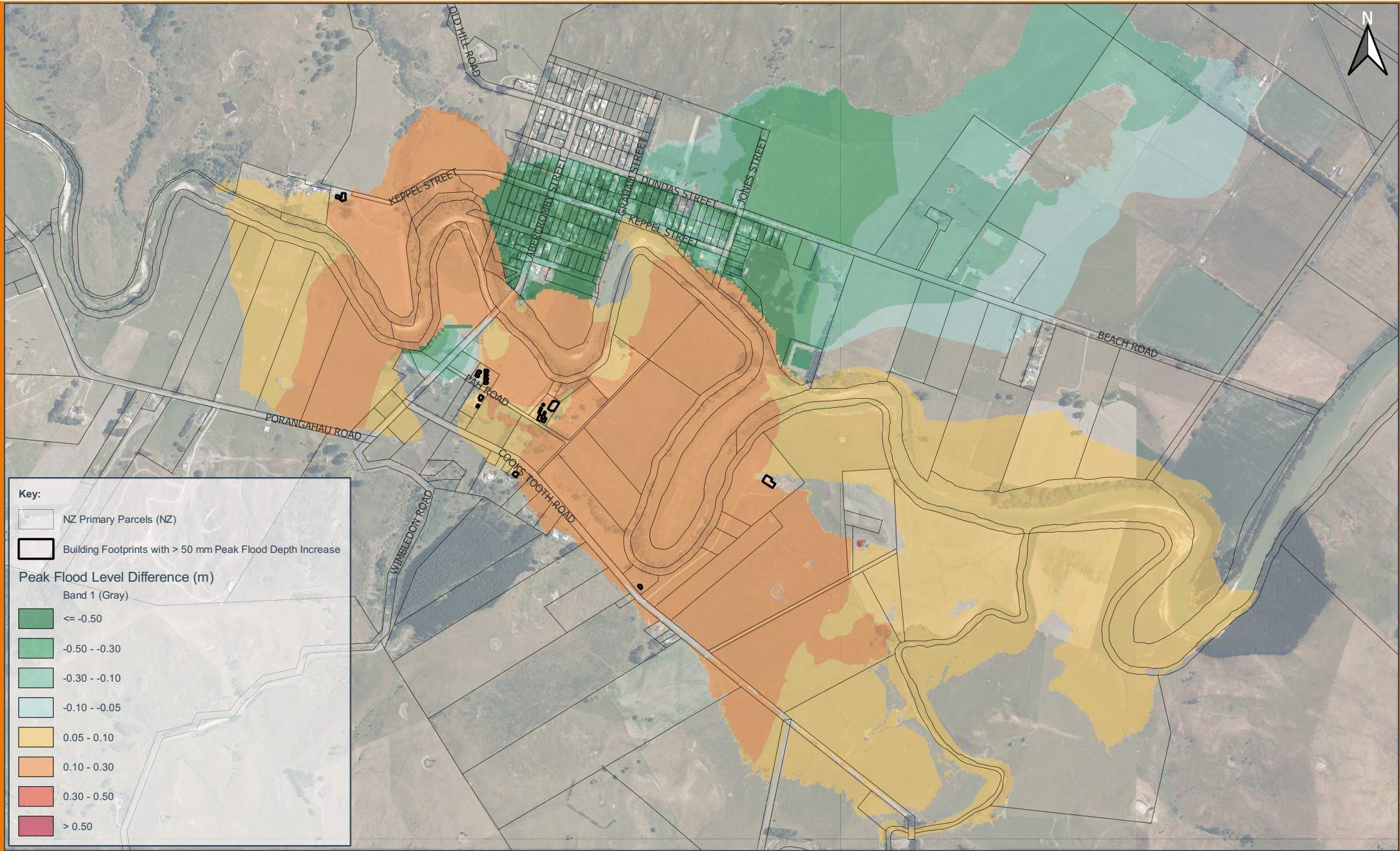
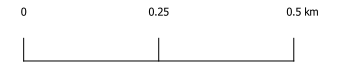


FIGURE A3: 1% AEP + 10 % CC Peak Flood Level Difference (Post-development - Pre-development)

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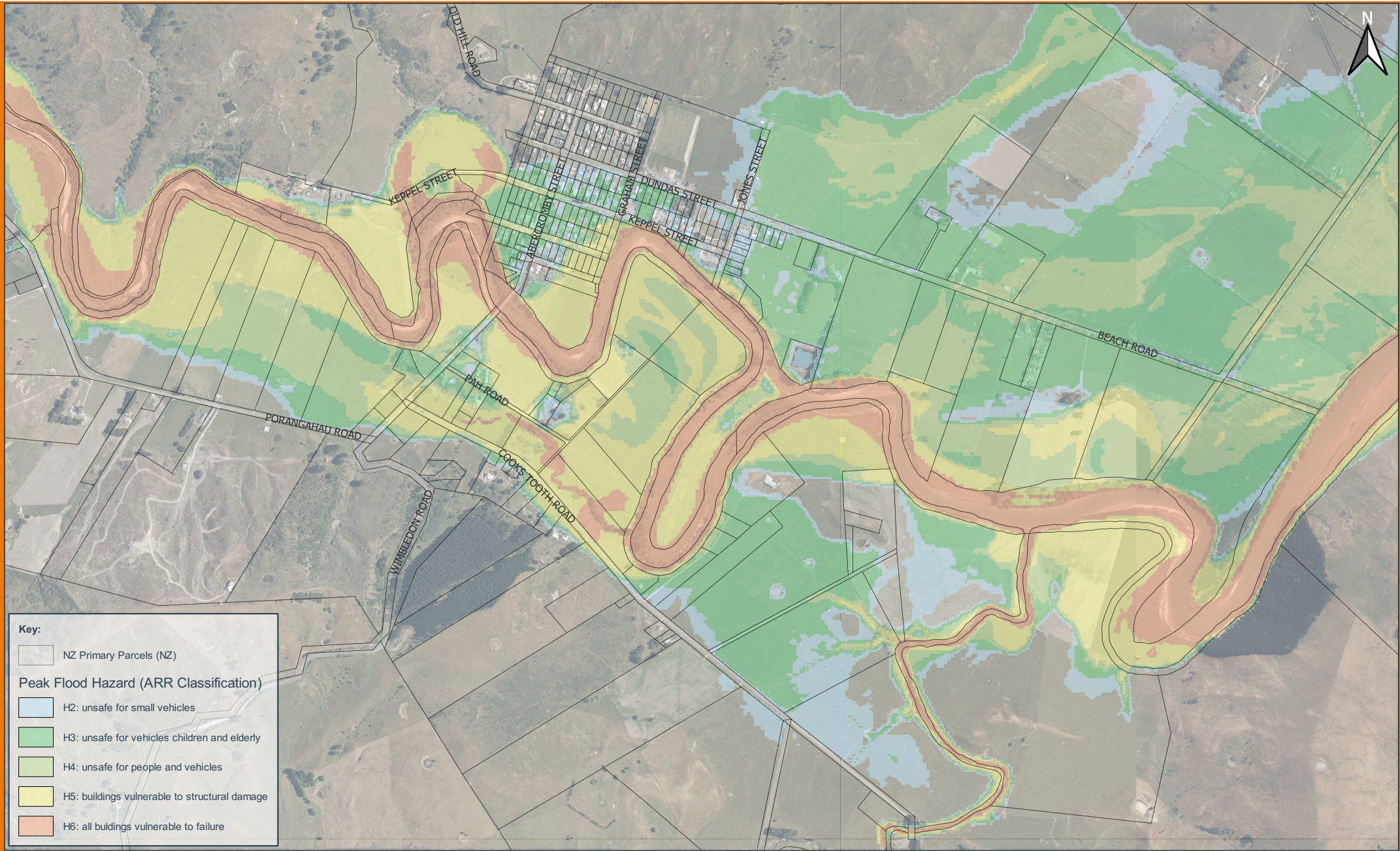
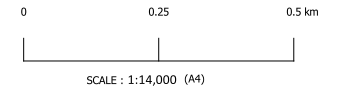


FIGURE B1: 1% AEP + 10 % CC Baseline Peak Flood Hazard Classification

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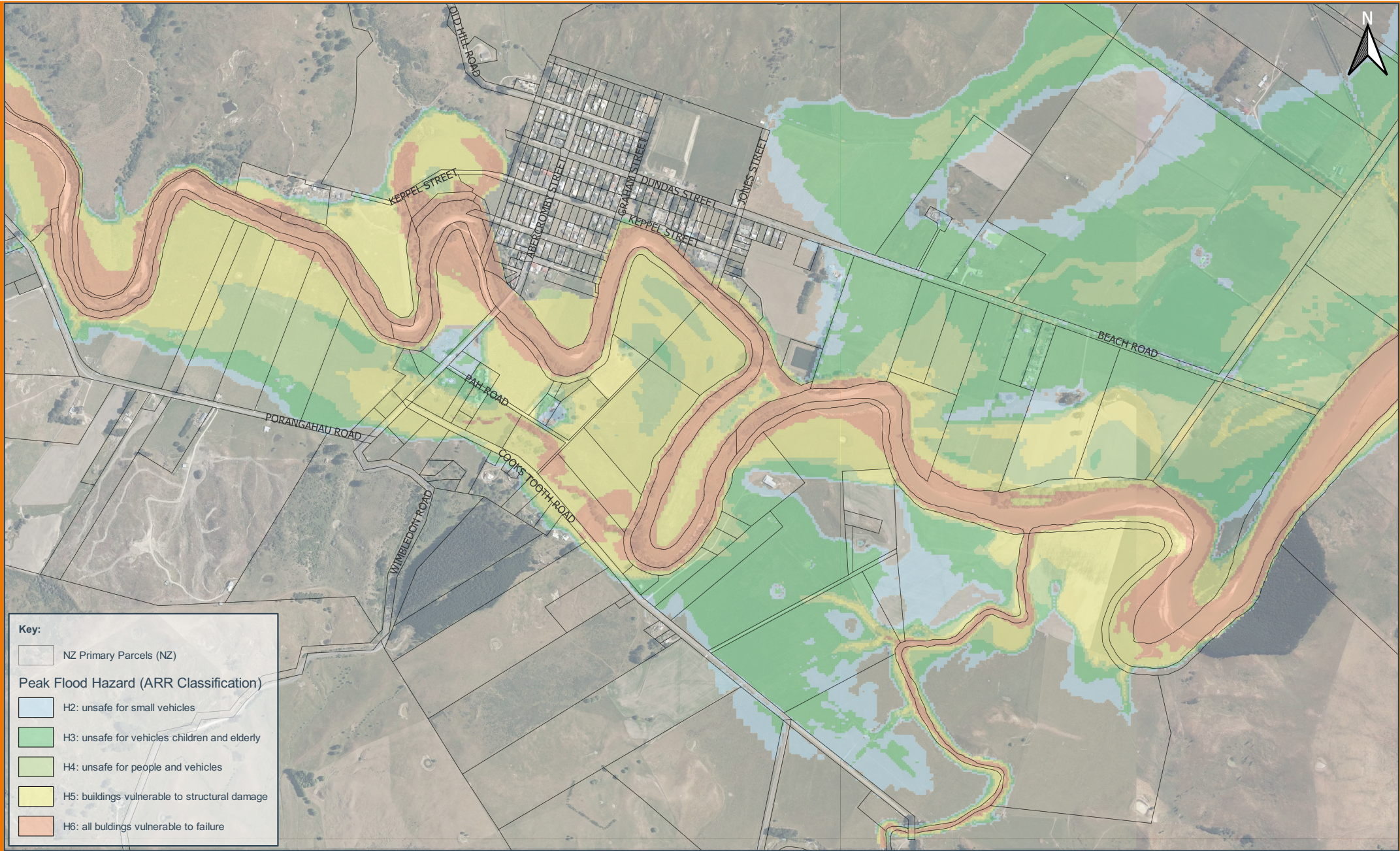
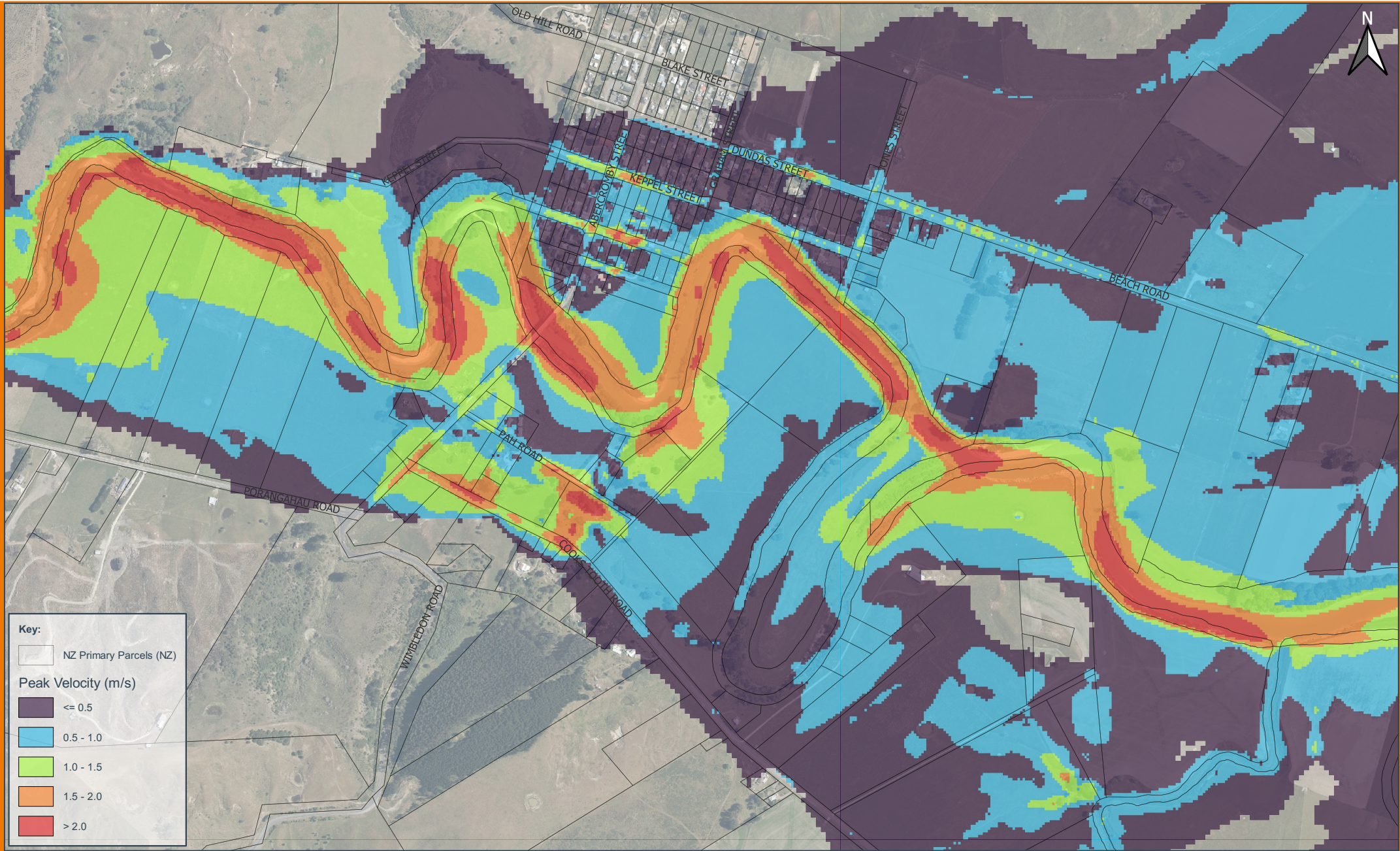


FIGURE B2: 1% AEP + 10 % CC Post-Development Peak Flood Hazard Classification







NOTES:
 1. AERIAL IMAGERY AND PRIMARY LAND PARCELS SOURCED FROM THE LINZ DATA SERVICE [https://data.linz.govt.nz] AND LICENCED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

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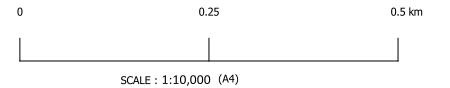
Key:

-  NZ Primary Parcels (NZ)
- Peak Velocity (m/s)**
-  <= 0.5
-  0.5 - 1.0
-  1.0 - 1.5
-  1.5 - 2.0
-  > 2.0

pdp FIGURE C1: 1% AEP + 10 % CC Baseline Peak Velocity

NOTES:
 1. AERIAL IMAGERY AND PRIMARY LAND PARCELS SOURCED FROM THE LINZ DATA SERVICE [https://data.linz.govt.nz] AND LICENCED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

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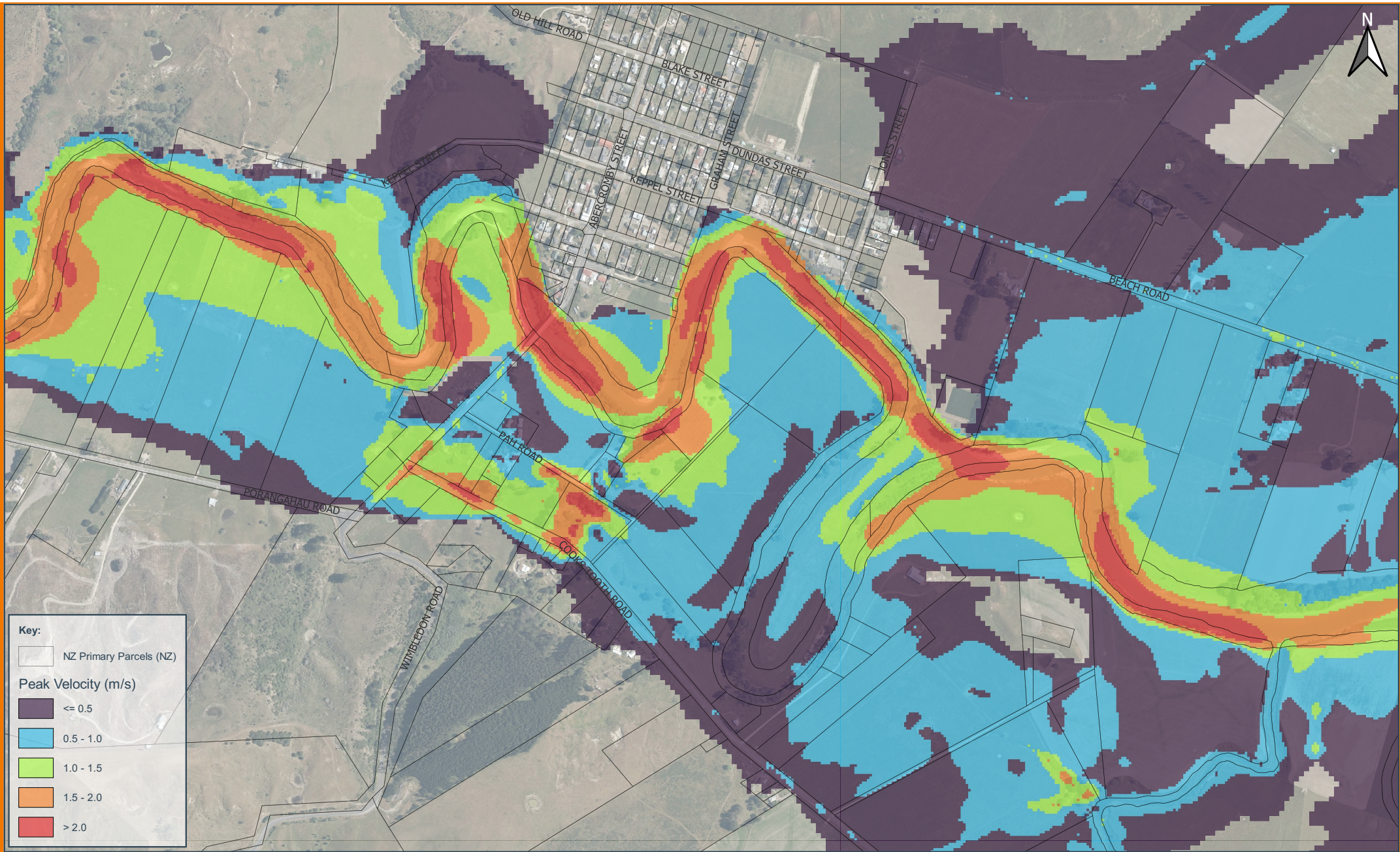


FIGURE C2: 1% AEP + 10 % CC Post-Development Peak Velocity

NOTES:
 1. AERIAL IMAGERY AND PRIMARY LAND PARCELS SOURCED FROM THE LINZ DATA SERVICE
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SCALE : 1:10,000 (A4)

REVISION: 01 | DATE: AUG 25 | BY: SP
 CLIENT: HBRC

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
12 Abercromby Street	0.71	0.00	-0.705	Used to flood & does not anymore	3	0
	0.91	0.00	-0.915		3	0
	0.97	0.00	-0.969		3	0
15 Abercromby Street	0.82	0.00	-0.823	Used to flood & does not anymore	3	0
4 Beach Road	0.30	0.00	-0.297	Used to flood & does not anymore	2	0
	0.33	0.00	-0.326		1	0
	0.37	0.00	-0.365		2	1
	0.49	0.00	-0.490		2	1
	0.49	0.00	-0.495		2	0
	0.55	0.00	-0.551		2	1
	0.57	0.00	-0.570		3	0
	0.57	0.08	-0.497	Used to flood & still floods	2	1
	0.63	0.12	-0.511	3	1	
51 Beach Road	0.53	0.34	-0.182	Used to flood & still floods	2	1
	0.74	0.51	-0.223		3	2
65 Beach Road	0.84	0.73	-0.108	Used to flood & still floods	3	3

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
84 Beach Road	0.79	0.73	-0.063	Used to flood & still floods	3	3
	0.79	0.73	-0.066		3	3
94 Beach Road	0.58	0.57	-0.016	Used to flood & still floods	3	3
	0.73	0.71	-0.018		3	3
	0.74	0.71	-0.029		3	3
	0.77	0.73	-0.035		3	3
	0.81	0.77	-0.041		3	3
	0.83	0.79	-0.045		3	3
207 Beach Road	0.07	0.03	-0.037	Used to flood & still floods	1	1
	0.49	0.43	-0.057		2	2
	0.86	0.86	-0.005		3	3
	1.00	0.99	-0.008		3	3
324 Beach Road	1.22	1.23	0.009	Used to flood & still floods	3	3
	1.22	1.23	0.009		4	4
	1.35	1.36	0.009		4	4
	1.41	1.42	0.009		4	4

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
360 Beach Road	0.63	0.64	0.010	Used to flood & still floods	3	3
392 Beach Road	0.24	0.25	0.011	Used to flood & still floods	1	1
Opposite 392 Beach Road	0.78	0.79	0.010	Used to flood & still floods	3	3
416 Beach Road	1.31	1.32	0.011	Used to flood & still floods	3	3
	1.40	1.41	0.011		4	4
	1.43	1.44	0.011		4	4
	1.52	1.53	0.011		4	4
	1.52	1.54	0.011		4	4
	1.55	1.56	0.011		4	4
	1.58	1.59	0.011		4	4
	1.61	1.62	0.011		4	4
	1.72	1.73	0.011		4	4
	1.78	1.79	0.011		4	4
418 Beach Road	0.88	0.90	0.011	Used to flood & still floods	3	3
	0.92	0.93	0.011		3	3
	0.94	0.95	0.011		3	3

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
	0.96	0.97	0.011		3	3
	1.03	1.04	0.011		3	3
	1.04	1.05	0.011		3	3
	1.05	1.06	0.011		3	3
	1.07	1.08	0.011		3	3
	1.08	1.10	0.011		3	3
	1.09	1.11	0.011		3	3
	1.10	1.11	0.011		3	3
	1.15	1.17	0.011		3	3
	1.16	1.17	0.011		3	3
	1.17	1.18	0.011		3	3
	1.17	1.18	0.011		3	3
	1.17	1.18	0.011		3	3
	1.17	1.18	0.011		3	3
	1.18	1.19	0.011		3	3
	1.22	1.23	0.011		3	3

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
	1.23	1.24	0.011		3	3
	1.25	1.26	0.011		3	3
	1.26	1.27	0.011		3	3
	1.29	1.30	0.011		4	4
	1.30	1.31	0.011		4	4
	1.31	1.32	0.011		4	4
	1.31	1.32	0.011		4	4
	1.36	1.37	0.011		4	4
	1.45	1.46	0.011		4	4
	1.45	1.46	0.011		4	4
	1.46	1.47	0.011		3	3
	1.63	1.64	0.011		4	4
	1.68	1.69	0.011		4	4
	1.71	1.72	0.011		4	4
	1.76	1.77	0.011		4	4
	1.78	1.79	0.011		4	4

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
	1.81	1.82	0.011		4	4
	1.84	1.85	0.011		4	4
	1.88	1.89	0.011		4	4
	1.91	1.92	0.011		4	4
	2.08	2.09	0.011		4	4
	2.18	2.19	0.011		4	4
	2.29	2.30	0.011		4	4
	2.33	2.34	0.011		4	4
420 Beach Road	0.99	1.00	0.011	Used to flood & still floods	3	3
	1.11	1.12	0.011		3	3
	1.15	1.16	0.011		3	3
	1.23	1.24	0.011		3	3
424 Beach Road	0.62	0.63	0.011	Used to flood & still floods	3	3
	0.85	0.86	0.011		3	3
	1.11	1.12	0.011		3	3
36 Cooks Tooth Road	0.25	0.31	0.060	Used to flood & still floods	1	1

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
Opposite 58 Cooks Tooth Road	0.64	0.77	0.131	Used to flood & still floods	3	3
81 Cooks Tooth Road	0.08	0.20	0.122	Used to flood & still floods	1	1
96 Cooks Tooth Road	0.00	0.12	0.120	Did not flood and now floods	1	1
4 Dundas Street	0.18	0.00	-0.177	Used to flood & does not anymore	1	0
6 Dundas Street	0.17	0.00	-0.172	Used to flood & does not anymore	1	0
8 Dundas Street	0.07	0.00	-0.067	Used to flood & does not anymore	1	0
	0.44	0.00	-0.438		2	0
16 Dundas Street	0.33	0.00	-0.331	Used to flood & does not anymore	2	0
	0.46	0.00	-0.460		2	0
18 Dundas Street	0.48	0.00	-0.478	Used to flood & does not anymore	2	0
	0.60	0.00	-0.597		2	0
20 Dundas Street	0.46	0.00	-0.456	Used to flood & does not anymore	2	0
24 Dundas Street	0.62	0.00	-0.619	Used to flood & does not anymore	3	0
	0.65	0.00	-0.648		3	0

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
	0.73	0.00	-0.732		3	0
26 Dundas Street	0.54	0.00	-0.545	Used to flood & does not anymore	3	0
	0.59	0.00	-0.586		2	0
	0.60	0.00	-0.598		3	0
					3	0
28 Dundas Street	0.80	0.00	-0.800	Used to flood & does not anymore	3	0
30 Dundas Street	0.57	0.00	-0.568	Used to flood & does not anymore	3	0
	0.64	0.00	-0.637		3	0
34 Dundas Street	0.80	0.00	-0.796	Used to flood & does not anymore	3	0
38 Dundas Street	0.82	0.00	-0.816	Used to flood & does not anymore	3	0
41 Dundas Street	0.25	0.00	-0.248	Used to flood & does not anymore	1	0
	0.45	0.00	-0.453		2	0
57 Dundas Street	0.19	0.00	-0.185	Used to flood & does not anymore	1	0
	0.24	0.00	-0.241		1	0
	0.45	0.00	-0.449		2	0
1 Franklin Street	0.78	0.00	-0.781	Used to flood & does not anymore	3	0
	0.94	0.00	-0.943		3	0

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
	0.96	0.00	-0.962		3	0
6 Franklin Street	0.98	0.00	-0.981	Used to flood & does not anymore	3	0
7 Franklin Street	1.09	0.00	-1.094	Used to flood & does not anymore	3	0
8 Franklin Street	0.87	0.00	-0.870	Used to flood & does not anymore	3	0
	0.94	0.00	-0.942		3	0
9 Franklin Street	1.10	0.00	-1.099	Used to flood & does not anymore	3	0
10 Franklin Street	1.19	0.00	-1.193	Used to flood & does not anymore	4	0
12 Franklin Street	0.52	0.00	-0.521	Used to flood & does not anymore	2	0
	0.72	0.00	-0.715		3	0
	0.84	0.00	-0.844		3	0
17 Franklin Street	0.52	0.00	-0.517	Used to flood & does not anymore	2	0
	0.57	0.00	-0.568		2	0
	0.69	0.00	-0.692		3	0
	0.75	0.00	-0.754		3	0
20 Franklin Street	0.59	0.00	-0.595	Used to flood & does not anymore	2	0
21 Franklin Street	0.67	0.00	-0.667	Used to flood & does not anymore	3	0

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
	0.79	0.00	-0.794		3	0
	1.03	0.00	-1.026		4	0
11 Graham Street	0.14	0.00	-0.136	Used to flood & does not anymore	1	0
2A Jones Street	0.58	0.00	-0.583	Used to flood & does not anymore	3	0
2B Jones Street	0.63	0.38	-0.250	Used to flood & still floods	3	1
10 Jones Street	0.53	0.00	-0.533	Used to flood & does not anymore	3	0
	0.56	0.00	-0.564		2	0
12 Jones Street	0.37	0.00	-0.374	Used to flood & does not anymore	2	0
	0.40	0.00	-0.395		2	0
	0.41	0.00	-0.414		2	0
	0.44	0.00	-0.442		2	0
	0.48	0.00	-0.479		2	0
	0.50	0.00	-0.504		2	0
14 Jones Street	0.41	0.00	-0.407	Used to flood & does not anymore	2	0
	0.45	0.00	-0.453		2	0
	0.46	0.00	-0.465		2	0

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
16 Jones Street	0.44	0.00	-0.435	Used to flood & does not anymore	2	0
	0.50	0.00	-0.498		2	0
	0.51	0.00	-0.510		2	0
18 Jones Street	0.50	0.11	-0.394	Used to flood & still floods	2	1
	0.54	0.17	-0.377		2	1
1 Keppel Street	0.63	0.00	-0.634	Used to flood & does not anymore	3	0
3 Keppel Street	0.56	0.00	-0.559	Used to flood & does not anymore	2	0
4 Keppel Street	0.89	0.00	-0.889	Used to flood & does not anymore	3	0
	0.94	0.00	-0.938		3	0
6 Keppel Street	0.91	0.00	-0.914	Used to flood & does not anymore	3	0
8 Keppel Street	1.06	0.00	-1.063	Used to flood & does not anymore	3	0
	1.08	0.00	-1.081		3	0
9 Keppel Street	0.85	0.00	-0.850	Used to flood & does not anymore	3	0
11 Keppel Street	0.74	0.00	-0.741	Used to flood & does not anymore	3	0
12 Keppel Street	0.64	0.00	-0.635	Used to flood & does not anymore	3	0
13 Keppel Street	0.53	0.00	-0.532	Used to flood & does not anymore	2	0

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
15 Keppel Street	0.41	0.00	-0.406	Used to flood & does not anymore	2	0
	0.71	0.00	-0.706		3	0
19 Keppel Street	0.49	0.00	-0.487	Used to flood & does not anymore	3	0
	0.55	0.00	-0.552		3	0
	0.70	0.00	-0.704		3	0
21 Keppel Street	0.53	0.00	-0.533	Used to flood & does not anymore	2	0
23 Keppel Street	0.63	0.00	-0.626	Used to flood & does not anymore	3	0
	0.64	0.00	-0.637		3	0
	0.64	0.00	-0.641		3	0
24 Keppel Street	0.83	0.00	-0.830	Used to flood & does not anymore	3	0
25 Keppel Street	0.63	0.00	-0.629	Used to flood & does not anymore	3	0
26 Keppel Street	1.45	0.00	-1.452	Used to flood & does not anymore	3	0
	2.86	0.00	-2.858		5	0
27 Keppel Street	0.64	0.00	-0.641	Used to flood & does not anymore	3	0
	0.71	0.00	-0.710		3	0
35 Keppel Street	0.68	0.00	-0.681	Used to flood & does not anymore	2	0

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
39 Keppel Street	0.40	0.00	-0.398	Used to flood & does not anymore	1	0
	0.50	0.00	-0.499		2	0
41 Keppel Street	0.32	0.00	-0.320	Used to flood & does not anymore	2	0
43 Keppel Street	0.43	0.00	-0.427	Used to flood & does not anymore	2	0
	0.46	0.00	-0.456		2	0
	0.47	0.00	-0.467		2	0
45 Keppel Street	0.40	0.00	-0.403	Used to flood & does not anymore	2	0
	0.40	0.00	-0.404		1	0
50 Keppel Street	0.61	0.00	-0.609	Used to flood & does not anymore	3	0
53 Keppel Street	0.45	0.00	-0.449	Used to flood & does not anymore	2	0
	0.53	0.00	-0.534		2	0
56 Keppel Street	0.48	0.00	-0.476	Used to flood & does not anymore	3	0
	0.54	0.00	-0.543		2	0
58 Keppel Street	0.33	0.00	-0.328	Used to flood & does not anymore	1	0
	0.45	0.00	-0.453		2	0
	0.45	0.00	-0.455		2	0

Table D1: Pre and post mitigation modelled flood depths on building footprints						
Address	1 % AEP RCP8.5 to 2056 Baseline Max. Flood Depth (m)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Flood Depth (m)	Change in Max. Flood Depth (m)	Flood Extent Change	1 % AEP RCP8.5 to 2056 Baseline Max. Hazard (ARR 2019)	1 % AEP RCP8.5 to 2056 Stop Bank Max. Hazard (ARR 2019)
109 Keppel Street	0.08	0.08	-0.002	Used to flood & still floods	1	1
	0.19	0.33	0.137		1	1
9 Pah Road (Kaumātua Flats)	1.04	1.11	0.066	Used to flood & still floods	3	3
	1.43	1.54	0.110		4	4
	1.12	1.23	0.109		4	3
14 Pah Road	0.87	0.95	0.077	Used to flood & still floods	4	3
	1.04	1.12	0.080		4	4
27 Pah Road (Marae)	0.51	0.60	0.097	Used to flood & still floods	2	2
	0.51	0.60	0.086		2	3
	0.54	0.64	0.107		3	3
	0.54	0.65	0.108		2	3
	0.65	0.74	0.091		3	3
4458 Pōrangahau Road	0.77	0.64	-0.132	Used to flood & still floods	3	3
	0.87	0.84	-0.023		3	4