BEFORE INDEPENDENT HEARING COMMISSIONERS
IN CHRISTCHURCH

TE MAHERE Ā-ROHE I TŪTOHUA MŌ TE TĀONE O ŌTAUTAHI

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the hearing of submissions on Plan Change 14 (Housing and Business Choice) to the Christchurch District Plan

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STATEMENT OF PRIMARY EVIDENCE DAMIAN DEBSKI ON BEHALF OF CHRISTCHURCH CITY COUNCIL

COASTAL HAZARDS - INUNDATION

Dated: 11 August 2023

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EXECUTIVE SUMMARY

1. My full name is **Damian Debski**. I am employed as a Principal Hydraulic Engineer at Jacobs New Zealand Limited.

2. I have prepared this statement of evidence on behalf of the Christchurch City Council (the **Council**) in respect of matters arising from the submissions and further submissions on Plan Change 14 to the Christchurch District Plan (the **District Plan**; **PC14**).

3. This evidence relates to the determination of the proposed Qualifying Matter Coastal Hazard Risk Management Areas (**QM-CH**) for coastal inundation.

4. The base data for the determination of the QM-CH for coastal inundation is from the *Coastal Hazards Assessment for Christchurch District* (**CHA 2021**) by Tonkin & Taylor Limited (**Tonkin & Taylor**). The methodology employed in this assessment to calculate extreme sea levels follows standard practices, makes use of current datasets, and is in accordance with the parameters listed in Policy 24 of the New Zealand Coastal Policy Statement (**NZCPS**). The 'bathtub' method used to map the areas susceptible to coastal inundation from the extreme sea levels is an accepted and precautionary method, which in my opinion is consistent with the precautionary approach to the use and management of the coastal area in Policy 3 of the NZCPS.

5. The Jacobs *Risk Based Coastal Hazard Analysis for Land-use Planning Report* 2021 (**Jacobs 2021**) and subsequent *Addendum Report to Risk Based Coastal Hazard Analysis for Land-use Planning Report* (**Jacobs 2022**) selected the most appropriate Sea Level Rise (**SLR**) increments from the CHA 2021 and identified appropriate probability and water depth thresholds to define levels of coastal inundation risk for use in land-use planning. Extreme sea level values were taken directly from the CHA 2021 data, where available, or estimated from those data, using standard methods. The analysis recommended the following high, medium, low, and very low coastal inundation risk categories for Christchurch City:

   (a) A High Coastal Inundation Risk Category defining the area where the water depth under the 0.2% Annual Exceedance Probability (**AEP**) extreme sea level with 0.6 m Relative Sea Level Rise (**RSLR**) is greater than 1 m. The corresponding depth for the 0.2% AEP sea level with 1.2 m RSLR is 1.6 m.

(b) A Medium Coastal Inundation Risk Category defining the area where the water depth under the 0.2% AEP extreme sea level with 0.6 m RSLR is between 0.4 m and 1 m. The corresponding depth for the 0.2% AEP sea level with 1.2 m RSLR would exceed 1 m.

(c) A Low Coastal Inundation Risk Category defining the area where the water depth under the 0.2% AEP extreme sea level with 0.6 m RSLR is less than 0.4 m. The corresponding depth for the 0.2% AEP sea level with 1.2 m RSLR would be between 0.4 m and 1 m.

(d) A Very Low Coastal Inundation Risk Category defining the area where there is no inundation for the 0.2% AEP extreme sea level with 0.6 m RSLR and the corresponding depth under the 0.2% AEP with 1.2 m RSLR is less than 0.4 m.

INTRODUCTION

6. My full name is **Damian Debski**. I am employed as a Principal Hydraulic Engineer at Jacobs New Zealand Limited (**Jacobs**), located in their Wellington Office.

7. In preparing this evidence I:

   (a) Was a co-author of the of the Jacobs 2021 Report and Addendum to the report in 2022, with responsibility for the coastal inundation thresholds section of the report. This report has subsequently been updated in March 2023.

   (b) Reviewed the submissions to PC14 relevant to QM-CH.

8. I am authorised to provide this evidence on behalf of the Council.

QUALIFICATIONS AND EXPERIENCE

9. I am a civil engineer and hold the qualifications of BA from the University of Cambridge (UK) and MSc from the University of Southampton (UK).

10. I have 28-years working experience in investigating fluvial, pluvial and coastal flood processes, providing flood risk assessments for major infrastructure developments and developing flood risk management

strategies and interventions. I have provided technical reviews of Resource Consent applications and District Plan provisions for a range of projects throughout New Zealand.

11. I am a Chartered Member of the Chartered Institution of Water and Environmental Management and a Chartered Engineer with the Engineering Council UK.

CODE OF CONDUCT

12. While this is a Council hearing, I have read the Code of Conduct for Expert Witnesses (contained in the 2023 Practice Note) and agree to comply with it. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this statement of evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SCOPE OF EVIDENCE

13. In this statement of evidence, I:

    (a) Explain the QM-CH and why I consider it is needed to appropriately manage the effects of coastal inundation hazards;

    (b) Identify the provisions which currently address coastal inundation hazard in the District Plan, and the areas which the QM-CH will apply to in terms of coastal inundation;

    (c) Outline the methodology for determining the QM-CH for coastal inundation, including the selection of probability and hazard thresholds to determine the different risk categories;

    (d) Respond to points raised in submission #814 (J. Appleyard on behalf of Carter Group Ltd) on the proposed policy to avoid intensification of any site within the CH-QM Areas unless a site-specific assessment demonstrates the risk is low or very low; and

    (e) Respond to the point raised in Submission #834 (Kāinga Ora) that the policy of avoidance of intensification should only apply to areas at high risk from coastal inundation rather than both medium and high-risk areas.

14. I address each of these points in my evidence below.

QUALIFYING MATTER FOR COASTAL HAZARD RISK MANAGEMENT

15. Under a risk-based approach to land use planning, as required by both the NZCPS and Environment Canterbury's Regional Policy Statement (the **RPS**), it is recognised that over time the level of risk to land exposed to coastal hazards will increase as the sea level rises. Intensification of land use as required to be enabled by the Medium Density Residential Standards (**MDRS**) could result in more people and property being exposed to coastal hazards. However, there are some land uses that are possible and appropriate to continue until the level of risk becomes unacceptable for those uses.

15. A risk-based approach seeks to identify the levels of risk from hazards to inform appropriate planning policies and provisions. This can enable some types of development where it is safe to do so and apply necessary controls to manage development in areas of higher risk.

16. In Jacobs 2021 a standard definition of risk[1] was applied, combining the probability of an event occurring (or its 'likelihood') with the 'consequence' of the event for assets or people. For coastal inundation, the consideration of likelihood included both the probability of an extreme storm tide level occurring and the uncertainties in the magnitude and timing of future SLR, which together define future extreme sea levels.

17. Scientific research has shown that the hazard posed by inundation depends primarily on the depth and the velocity (or 'speed') of the flood water and that the threat of serious injury to people, or loss of life, occurs at lower thresholds of depth and velocity than that of severe damage to buildings. Recognising that residential development will be occupied by people who may also need to access and egress buildings during a flood, the consequence thresholds for categorising flood risk in Jacobs 2021 were selected through consideration of published guidelines[2] for flood hazard thresholds to people.

18. In CHA 2021, the extent of coastal inundation has been mapped along the entire coastline of the district. This mapping is at 0.2 m increments of

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[1] 'Risk is often expressed in terms of a combination of consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.' From *Coastal Hazards and Climate Change: Guidance for Local Government in New Zealand.* (MfE, 2017).

[2] Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019.

RSLR[3] relative to the 2020 mean sea level. The range of increments generally aligns with the range of SLR scenarios over a 100-year period of time in the Ministry for the Environment's (2017) *Coastal Hazards and Climate Change: Guidance for Local Government in New Zealand*, thereby meeting the requirement of the NZCPS.

19. In Jacobs 2021, likelihoods of extreme sea levels, a range of SLR increments, inundation hazard thresholds, and inundation depths from the CHA 2021 were investigated to identify appropriate combined criteria for defining categories of very low, low, medium, and high coastal inundation risk that could be used to plan future land use.

20. Coastal inundation risk was assessed over the mapped inundation area in the CHA 2021, in which inundation depth data were available. **Figure 1** shows the landward boundary of the CHA 2021 coastal inundation mapping using the 'bathtub' method[4]. To the west of this boundary, the CHA 2021 considered that extreme inundation levels are increasingly influenced by flooding from rivers and streams and that the coastal water level used for the mapping becomes less reliable. In my opinion this boundary reasonably defines the area in which extreme inundation is primarily or wholly determined by coastal conditions and in which it is therefore appropriate to consider the risk of coastal inundation in planning.

21. Application of the risk criteria developed in Jacobs 2021 and subsequently updated in Jacobs 2022 resulted in zones of all four risk categories being defined along Christchurch City's open coast and surrounding the Avon-Heathcote estuary. The extent of these zones is shown in **Attachment A**.

22. Two Qualifying Matters for coastal hazards have been defined: a Medium Risk Coastal Hazard Qualifying Matter Area and a High Risk Coastal Hazard Qualifying Matter Area. In terms of coastal inundation, the Medium Risk CH-QM Area comprises residential properties categorised as being at Medium Coastal Inundation Risk and the High Risk CH-QM Area comprises properties categorised as being at High Coastal Inundation Risk. In both cases the inundation risk is as defined in Jacobs 2022. The high inundation and medium inundation risk areas are considered to pose more significant risk than the low and very low inundation risk areas. In this way the Coastal

[3] Relative Sea Level Rise (RSLR) combines both rising sea level from climate change and allowance for vertical land movements.
[4] In this method the estimated extreme sea level at the coastline is projected horizontally across the ground surface and a depth of inundation is calculated wherever the ground level is below the extreme sea level.

Hazards Qualifying Matters provide levels of control over development relative to the level of risk from coastal inundation hazard.

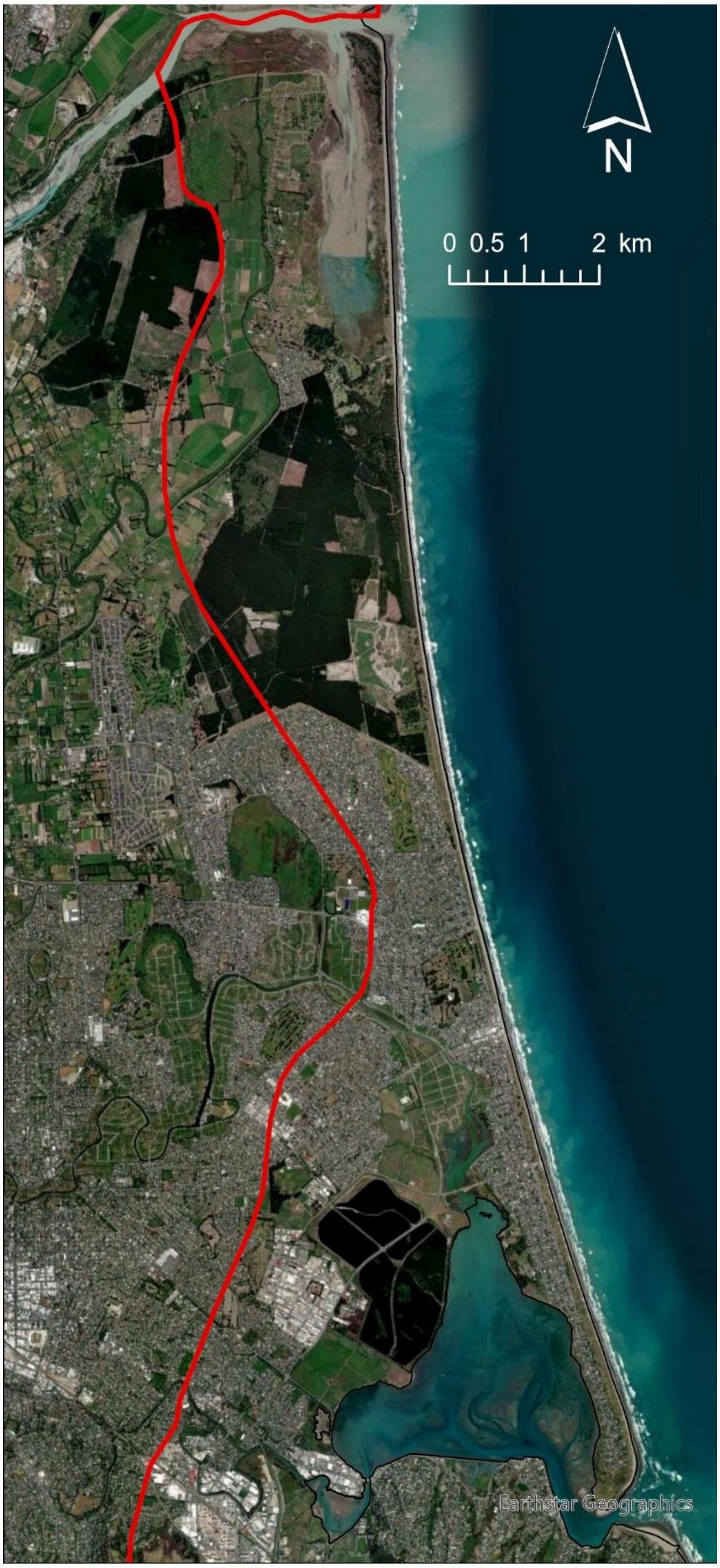

Figure 1. Landward limit of inundation mapping in CHA 2021 for the Christchurch city area, indicated by the red line, which also forms the landward limit of the coastal inundation risk assessment in Jacobs 2021.

CURRENT INUNDATION HAZARD PROVISIONS IN THE CHRISTCHURCH DISTRICT PLAN

23. The operative District Plan does not currently identify specific coastal inundation hazard areas. Flood hazards are managed more generally through policies and rules referenced primarily to the Flood Management Area and the High Flood Hazard Management Area together with the Fixed Minimum Floor Level Overlay within the Flood Management Area and the Residential Unit Overlay within the High Flood Hazard Management Area.

24. The Flood Management Area is defined by the maximum of:

    (a) modelled water levels for a 0.5% AEP rainfall event plus a 5% AEP storm tide event plus 250 mm freeboard and including an allowance for 1 m of sea level rise and an increase in rainfall intensity by 16% as a result of climate change to 2115;

    (b) modelled water levels for a 0.5% AEP tide event plus a 5% AEP rainfall event plus 250 mm freeboard and including an allowance for 1 m of sea level rise and an increase in rainfall intensity by 16% as a result of climate change to 2115; and

    (c) a water level of 11.9 m above Christchurch City Council Datum (representing the maximum 0.5% AEP storm tide level with an allowance for 1 m of sea level rise) plus 250 mm freeboard.

25. The High Flood Hazard Management Area is as defined in the CRPS, being the area where the water depth (in metres) x velocity (in metres per second) is greater than or equal to 1, or where water depths are greater than 1 metre, in a 0.2% AEP flood event, including an allowance of 1 m of sea level rise.

26. These flood management areas are defined along the Avon, Heathcote and Styx Rivers, around the perimeter of the Avon-Heathcote estuary and along the open coastline.

27. I note that new estimates of extreme sea levels have been made since the Flood Management Area and High Flood Hazard Management Area were defined and mapped for the District Plan. CHA 2021 provides an up-to-date assessment of extreme water levels. The differences in these estimates are one reason for differences in inundation mapping between the District Plan, CHA 2021 and Jacobs 2022.

AREAS WHICH THE PROPOSED QUALIFYING MATTER COASTAL HAZARD RISK MANAGEMENT AREAS FOR COASTAL INUNDATION WILL APPLY TO

28. To the north of the city, the proposed High Risk CH-QM Area for coastal inundation comprises a broad corridor of land along the Styx River and a narrower zone around the perimeter of Brooklands Lagoon. Along the open coast south of the lagoon to Southshore Spit it forms a continuous narrow strip of land, largely contained within the existing beach and dune environment. The High Risk CH-QM area is more extensive along the shoreline of the Avon-Heathcote estuary, extending approximately half way between that shoreline and the open coast between the spit and the Pages Road bridge across the Avon River. This area is mainly Residential Suburban Zone and will remain subject to existing District Plan rules. Along the west of the river and estuary, the High Risk CH-QM area is largely contained within the red zoned land between Pages Road and Bridge Street but extends into the Medium Density Residential Zone of Aranui north of Pages Road. To the south, areas of residential properties included in the High Risk CH-QM area are more localised and mainly located around the Heathcote River, for example around Alport Place.

29. Along the eastern side of the Avon-Heathcote estuary and along the Avon River, the proposed Medium Risk CH-QM Area for coastal inundation extends further inland beyond the High Risk CH-QM Area and includes the Medium Density Residential Zone in Aranui south of Pages Road. At the southern end of the estuary, parts of Woolston – both Medium Density Residential Zone and Residential Suburban Zone (which retains existing District Plan rules) – are included in the Medium Risk CH-QM Area.

METHODOLOGY FOR DETERMINING THE QUALIFYING MATTER COASTAL HAZARD MANAGEMENT AREA FOR COASTAL INUNDATION

Coastal Hazards Assessment 2021 (CHA 2021)

30. For coastal inundation, the CHA 2021 used the bathtub method to map the extent and depth of inundation. In this method the estimated extreme sea level at the coastline is projected horizontally across the ground surface and a depth of inundation is calculated wherever the ground level is below the extreme sea level.

31. The CHA 2021 used up to date records of sea levels and wave heights and standard, accepted methods to produce estimates of extreme sea levels,

including wave setup where appropriate, for mapping the 63%, 10% and 1% AEP and for increments of RSLR between 0 m and 2 m relative to mean sea level in 2020. Extreme sea levels were estimated separately for each of eleven coastal 'cells', together covering the coastline of the district, as shown in **Figure 2**.

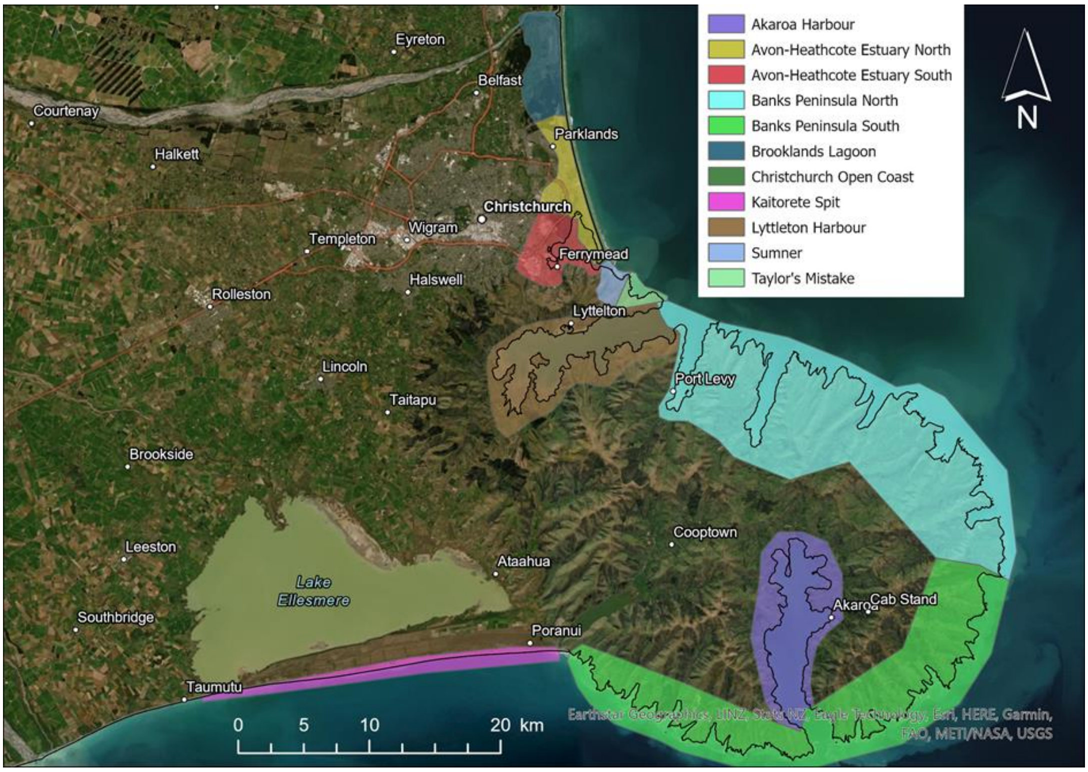

Figure 2. Definition of coastal cells for which discrete estimates of extreme water levels were made in CHA 2021.

32. The resulting inundation depth datasets produced in the CHA 2021 allow the extent and depth of coastal inundation to be mapped for a range of combinations of extreme sea level and RSLR using the bathtub method. There are three main simplifications in this method of mapping inundation.

(a) All areas of land lying below the mapped water level are considered to be inundated regardless of whether flow paths exist between the sea and the land. This can result in inundation being mapped in areas which are protected from flooding by defences such as stopbanks or by natural high ground. However, such areas can be vulnerable to flooding from a failure of defences or from backflow through drainage systems. This approach to mapping therefore takes some account of the residual risk of coastal flooding.

(b) A constant water level is used for calculating inundation over the entire extent of inundation within each coastal cell. In practice, water levels may be attenuated through inland flooding. However, by limiting the area mapped using this method in the CHA 2021 to that where inundation is determined primarily by sea level, the effects of this limitation will be reduced.

(c) Additional contributions to flooding from fluvial flows and rainfall are not included. In practice, coastal storm tide events often occur in combination with high river flows and rainfall which can increase the extent and depth of inundation. As in b. above, by limiting the area mapped to that where inundation is determined primarily by the sea level, the effect of excluding these other sources of flooding is likely to be very small.

33. In my opinion, the bathtub approach adopted in the CHA 2021 and applied over the area where inundation is largely determined by water level in the sea, estuary, or harbours, is an appropriate precautionary method for estimating the extent and depth of flooding for the purposes of informing land use planning in that area.

Jacobs Risk Based Coastal Hazards Analysis (Jacobs 2021 and Jacobs 2022)

34. For the development of a risk based method of categorising coastal inundation risk, the Jacobs 2021 and 2022 reports considered a range of inundation probabilities and RSLR increments – i.e., likelihood of inundation – and a range of flood hazard thresholds – i.e., consequence of inundation. Alternative methods for combining likelihood and consequence to define the criteria for high, medium, low, and very low coastal inundation risk for use in land use planning were also considered.

Selection of likelihood of coastal inundation

35. Selection of an appropriate likelihood of inundation considered the following factors:

(a) Sea level probabilities should take account of the planning timeframe so that the likelihood of any land use activities enabled by the District Plan being exposed to the inundation hazard is acceptable for a reasonable period without the need for hazard mitigation measures. For example, the chances of a 10% AEP event occurring at least once in a 30-year time period is 96% whereas the chance of a 1% AEP event occurring at least once in the same period is 26%.

(b) The extreme sea level probabilities should give effect to the CRPS policies to avoid development in ‘areas subject to inundation’ and avoid inappropriate development in ‘high hazard areas’. In the CRPS, areas subject to inundation are defined by the 0.5% AEP and high hazard areas are defined by depth and velocity thresholds for the 0.2% AEP.

(c) Timeframes are also important for defining the ‘certainty’ of the magnitude of RSLR. There is greater certainty that lower projected magnitudes of RSLR will occur over the planning timeframes than higher projected magnitudes.

(d) For RSLR, there needs to be consistency between the likelihood or timing of the RSLR increments selected to define inundation risk categories and erosion risk categories.

36. Considering the above factors, it was my recommendation, as the author for coastal inundation risk in Jacobs 2021 and Jacobs 2022, that the most appropriate probabilities to adopt for extreme sea levels were:

(a) 0.5% AEP for defining the overall extent of coastal inundation risk; and

(b) 0.2% AEP water depths for defining individual risk category thresholds.

37. I consider that the chance of an event of these magnitudes occurring within the planning timeframe would be considered acceptable for the purposes of intensification of development given the controls on level and type of development which would be permitted in such areas.

38. The CHA 2021 does not provide estimates of the 0.5% AEP and 0.2% AEP extreme sea levels for all the coastal cells. Where required, these sea levels are estimated in Jacobs 2022 using the CHA 2021 data and the same methods, where possible, are employed to estimate the required levels.

39. In terms of RSLR increments, the values recommended in Jacobs 2021 for defining coastal erosion were also adopted for categorising coastal inundation risk for land use planning, being:

(a) 0.6 m RSLR by 2080; and

(b) 1.2 m RSLR by 2130.

Selection of flood hazard thresholds

40. Selection of appropriate hazard thresholds considered the following factors:

(a) Thresholds should be based on scientific evidence and primarily address the threat of serious injury to people or loss of life;

(b) Thresholds should give effect to CRPS policies through consistency with the definitions of the severity of flood hazard;

(c) Thresholds should be suitable for application to the bathtub method outputs of the CHA 2021 – i.e., extent and depth of inundation.

41. As author of the Jacobs 2021 and Jacobs 2022 reports for coastal inundation, I reviewed alternative published guidelines to categorising flood hazard to people. It was my recommendation to define the following hazard thresholds, informed primarily by the guidance of the Australian Rainfall and Runoff Guide (**ARR**)[5] as summarised in **Figure 3**, which is widely adopted by practitioners, including, for example, Greater Wellington Regional Council in New Zealand.

(a) High Hazard – water depth greater than 1 m,

(b) Medium Hazard – water depth greater than 0.4 m but less than 1 m, and

(c) Low Hazard – water depth less than 0.4 m.

42. The threshold water depth of 1 m for 'high hazard' is consistent with the definition of high hazard areas in the CRPS and a little lower than the 'H4' hazard vulnerability threshold depth in the ARR (1.2 m in still water) at which flood hazard becomes unsafe for all people and vehicles. Adopting a limiting depth of 1 m allows for the additional hazard of a water velocity of up to 0.6 m/s under the ARR guidelines.

43. The depth threshold of 0.4 m for 'medium' hazard is slightly lower than the 'H3' hazard vulnerability threshold depth in the ARR (0.5 m in still water) at which flood hazard becomes unsafe for vehicles, children, and the elderly. Adopting a depth of 0.4 m corresponds to the vulnerability threshold for

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[5] Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019.

larger passenger vehicles for velocities up to 1.1 m/s. This depth also allows for the additional hazard of velocities up to 1.5 m/s for large 4WD vehicles.

44. The CHA 2021 bathtub inundation data provides only water depths. Water velocities cannot be estimated by this method. Although the ARR and CRPS definitions of flood hazard categories refer to the velocity of flooding as well as depth of water, **Figure 3** shows that for lower velocities – less than 0.5 m/s – the flood hazard category is defined by water depth alone. In my experience of modelling coastal inundation, flood velocities tend to be relatively low. Given that the selected water depth thresholds also include some allowance for flood water velocity, it is appropriate in my opinion to apply water depth thresholds alone to the CHA 2021 data.

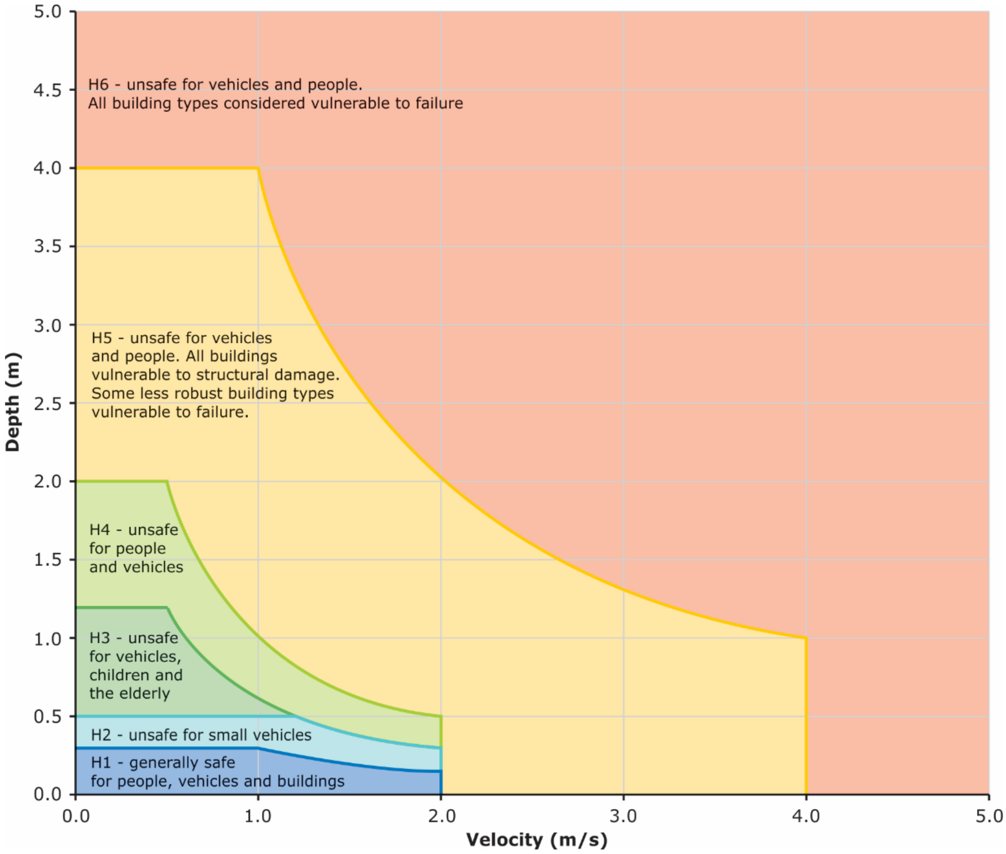

Figure 3. Combined Flood Hazard Curves (Figure 6.7.9. of the Australian Rainfall and Runoff Guide).

Definition of coastal inundation risk categories

45. Jacobs 2021 and Jacobs 2022 set out a recommended method for combining the water depth thresholds of hazards to people with the two recommended values of RSLR to define four categories of coastal inundation risk as shown in **Table 1**.

46. The 0.5% AEP coastal water level and the 1.2 m SLR scenario were selected to define the overall extent of coastal inundation hazard. In my opinion, this scenario supports a precautionary approach to the planning framework by recognising the need to consider intergenerational needs and the significant consequences that could arise in less certain events.

47. The two RSLR values of 0.6 m and 1.2 m were used to define a higher level of risk in areas where a hazard may occur sooner, in a more certain RSLR scenario (0.6 m), than in areas where the same hazard is as likely to occur only further in the future, in a less certain RSLR scenario (1.2 m). The thresholds between hazard categories apply to the water depth for the 0.2% AEP.

Table 1. Coastal Inundation Risk Categories defined in Jacobs 2022. ('d' is the water depth for the 0.2% AEP event).

Coastal flood risk category	Flood hazard with 0.6m SLR		Flood hazard with 1.2m SLR	
Very low	None	(dry)	Low	(d < 0.4 m)
Low	Low	(d < 0.4 m)	Medium	(0.4 m < d < 1.0 m)
Medium	Medium	(0.4 m < d < 1.0 m)	High	(d > 1.0 m)
High	High	(d > 1.0 m)	High	(d > 1.6 m)

RESPONSE TO SUBMISSIONS ON MANAGEMENT OF COASTAL INUNDATION RISK IN THE QUALIFYING MATTER COASTAL HAZARD MANAGEMENT AREAS

48. Submission #814 (J. Appleyard on behalf of Carter Group Ltd) raises concerns about the proposed policy to avoid intensification of any site within the CH-QM Areas unless a site-specific assessment demonstrates the coastal inundation risk is low or very low. The submission suggests that the proposed policy (5.2.2.5.1) is inconsistent with Policies 5.2.2.1.1 and 5.2.2.1.2 which aim to avoid new development where there is unacceptable risk and manage activities in all areas subject to natural hazards in a manner that is commensurate with the likelihood and consequences of a natural hazard event on life and property. The submission claims that site-specific assessments, which provide a pathway for such development to occur equate risk with flood depth rather than floor level, building resilience, flood water velocity or duration. The submission seeks that the development, including intensification should be a permitted activity within

the Coastal Hazard Management Areas subject to compliance with specified minimum floor levels.

49. In my opinion Policy 5.2.2.5.1 is consistent with Policies 5.2.2.1.1 and 5.2.2.1.2 for the following reasons:

(a) Policy 5.2.2.5.1 provides for development, including intensification, in the QM-CH if the risk is low or very low. The Low Coastal Inundation Risk Category comprises water depths less than 0.4 m in the 0.2% AEP event under 0.6 m of RSLR. This risk category is equivalent to a water depth of up to 0.8 m in the 0.2% AEP with 1 m of RSLR, i.e., just below the depth threshold of 1 m in the 0.2% AEP with 1 m of RSLR for the current District Plan High Flood Hazard Management Area. Development in that area is currently controlled through minimum floor levels. In my opinion this is consistent with the intent of Policy 5.2.2.1.2 to manage activities to address natural hazard risks.

(b) The QM-CH Medium Risk Management Area is defined as where the depth of flooding is between 0.4 m and 1.0 m in the 0.2% AEP event under 0.6 m RSLR. The depth threshold in the current District Plan High Flood Hazard Management Area is 1 metre, in a 0.2% AEP flood event, including an allowance of 1 m of sea level rise. For 0.6 m SLR the depth of coastal inundation in the District Plan High Flood Hazard Management Area would be approximately 0.6 m or greater, i.e., within the range defined for the QM-CH Medium Risk Management Area. I therefore consider it appropriate to avoid intensification in this area.

(c) Similarly flood depths in the QM-CH High Risk Management Area are more than 1 m in the 0.2% AEP event under 0.6 m RSLR, equating to a depth of 1.4 m with 1 m of RSLR. In this way the flood risk in the QM-CH is similar to or greater than in the existing High Flood Hazard Management Area where Policy 5.2.2.2.1 (b) seeks to avoid subdivision, use, or development where it will increase the potential risk to people’s safety, well-being and property unless appropriate mitigation can be provided.

50. In my opinion it is appropriate to categorise flood risk in the QM-CH in terms of water depth for the following reasons:

(a) I consider that the primary objective of the proposed Qualifying Matters is to avoid serious injury to people or loss of life rather than damage to buildings for which risk thresholds are usually higher.

(b) Guidelines for assessing flood hazard to people, such as the ARR, consider both water depth and velocity. However, where velocities are relatively low (less than 0.5 m/s for example) the hazard category depends only on the water depth as shown in **Figure 3**.

(c) I consider that in much of the Qualifying Matter area inundation velocities will be low enough that the hazard to people can be adequately categorised by reference to water depth.

51. Submission #834 (B Liggett on behalf of Kāinga Ora) generally supports the risk-based approach to the management of natural hazards but considers that intensification should be avoided only within the QM-CH High Risk Management Area instead of both the High Risk Management Area and the Medium Risk Management Area.

52. I do not agree that intensification should be avoided only within the QM-CH High Risk Management Area. Within the QM-CH Medium Risk Management Area the depth of flooding is between 0.4 m and 1.0 m in the 0.2% AEP event including 0.6 m allowance for RSLR. The current District Plan High Flood Hazard Management Area is as defined in the CRPS, being the area where the water depth (in metres) x velocity (in metres per second) is greater than or equal to 1, or where water depths are greater than 1 metre, in a 0.2% AEP flood event, including an allowance of 1 m of sea level rise. Water depth in the QM-CH Medium Risk Management Area for the same value of RSLR (1 m) would be in the range of 0.8 m to 1.4 m and would constitute a High Flood Hazard and be controlled accordingly under current provisions and rules and in which CRPS policy seeks to avoid inappropriate development.

CONCLUSIONS

53. The base data for the determination of the QM-CH for coastal inundation is the ‘bathtub’ mapping from the CHA 2021. The methodology employed in this assessment to calculate extreme sea levels follows standard practices and makes use of current datasets. The ‘bathtub’ method used to map the areas susceptible to coastal inundation from the extreme sea levels is an accepted and precautionary method, which in my opinion is consistent with

the precautionary approach to the use and management of the coastal area under Policy 3 of the NZCPS.

54. The landward boundary of the QM-CH for coastal inundation is that defined in CHA 2021, beyond which extreme inundation levels are increasingly influenced by flooding from rivers and streams and use of a coastal water level flood mapping becomes less reliable. In my opinion this boundary reasonably defines the area in which extreme inundation is primarily or wholly determined by coastal conditions and in which it is therefore appropriate to consider the risk of coastal inundation in planning.

55. From consideration of the consequences of inundation, as evaluated in published scientific guidelines, and the likelihood of inundation, both in terms of the probability of occurrence of coastal storms and the timing or certainty of occurrence of given magnitudes of RSLR, the Jacobs 2021 and 2022 analysis recommended the following high, medium, low, and very low coastal inundation risk categories for Christchurch City:

(a) A High Coastal Inundation Risk Category defining the area where the water depth under the 0.2% AEP extreme sea level with 0.6 m RSLR is greater than 1 m. The corresponding depth for the 0.2% AEP sea level with 1.2 m RSLR is 1.6 m.

(b) A Medium Coastal Inundation Risk Category defining the area where the water depth under the 0.2% AEP extreme sea level with 0.6 m RSLR is between 0.4 m and 1 m. The corresponding depth for the 0.2% AEP sea level with 1.2 m RSLR would exceed 1 m.

(c) A Low Coastal Inundation Risk Category defining the area where the water depth under the 0.2% AEP extreme sea level with 0.6 m RSLR is less than 0.4 m. The corresponding depth for the 0.2% AEP sea level with 1.2 m RSLR would be between 0.4 m and 1 m.

(d) A Very Low Coastal Inundation Risk Category defining the area where there is no inundation for the 0.2% AEP extreme sea level with 0.6 m RSLR and the corresponding depth under the 0.2% AEP with 1.2 m RSLR is less than 0.4 m.

56. In my opinion, proposed Policy 5.2.2.5.1 for managing development in the QM-CH recognises the varying degrees of risk defined through these coastal inundation risk categories. This risk-based approach to planning is

consistent with Policy 25 of the NZCPS and gives effect to the policies of the CRPS.

11 August 2023

Damian Debski

ATTACHMENT A: COASTAL INUNDATION RISK ZONES DEFINED IN JACOBS 2021 AND UPDATED IN JACOBS 2022