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 OF ROBERT BRIAN NORTON ON BEHALF OF CHRISTCHURCH CITY COUNCIL

STORMWATER AND LOW PUBLIC TRANSPORT ACCESSIBILITY AREA

Dated: 11 August 2023

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EXECUTIVE SUMMARY

1. My full name is **Robert Brian Norton**. I am employed as a Senior Stormwater Planning Engineer at Christchurch City Council (the **Council**).

2. I have prepared this statement of evidence on behalf of 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. My evidence discusses the expected impact of PC14 on flooding, water quality and the planning for future stormwater infrastructure to support growth. My evidence also discusses the proposed Low Public Transport Accessibility Areas and the proposed Qualifying Matters related to flooding.

4. The intensification of housing enabled by PC14 will increase imperviousness of affected land throughout the city, which will in turn generate higher stormwater flows and increased stormwater runoff volumes.

5. If not mitigated, these higher stormwater flows and increased volumes will exacerbate flood hazards in many parts of the city and contribute to an ecological decline of natural waterway and wetland systems.

6. Some of these effects can be partially mitigated by developments providing onsite stormwater mitigation systems (storage, treatment) at their own cost, however there are physical limitations as to the range of storms that can be effectively mitigated, particularly on smaller development sites.

7. The dispersed nature of intensification enabled by the large, rezoned areas proposed in PC14 will make it more difficult for the Council to target its capital spending than would a smaller, and more focused, intensification proposal.

8. If uptake of Medium- and High-Density development zoning is widespread, the Council will be in the position of needing to reactively increase its spending on stormwater infrastructure to maintain the minimum levels of service of its stormwater networks, manage flooding and to prevent ecological decline of its natural waterway and wetland systems.

9. The Council does not yet have a comprehensive set of quality, detailed, flood data which would allow it to identify areas effectively and equitably across the city which are suitable for a flood effects Qualifying Matter beyond those flood- related Qualifying Matters currently proposed (High Flood Hazard Management area and Flood Ponding Management Area). This scale of modelling is expected to be available within 3 years.

INTRODUCTION

10. My full name is **Robert Brian Norton**. I am employed by the Council in the role of Senior Stormwater Planning Engineer in the Asset Planning – Stormwater and Waterways unit. I have held this position since April 2010. I am responsible for implementation of the Council's Stormwater Management Plans through its capital programme, administration of the Council's Comprehensive Stormwater Network Discharge Consent and for providing technical review and advice on building, subdivision and land use consent applications.

11. As part of my role at the Council, I have been asked to provide technical advice on the Council's stormwater network planning, flooding and water quality in the context of proposed PC14. I provided technical advice to Council planners on the potential use of Qualifying Matters for stormwater and flooding and I co-wrote the Three Waters Memo attached as Appendix 46 to the section 32 report[1] (Three Waters Memo) on proposed Qualifying Matters to focus intensification within 800 metres of public transport routes.

12. In preparing this evidence I have:

    (a) Read the relevant parts of the Council's s32 Qualifying Matters Evaluation Report.

    (b) Reviewed a summary of key themes of submissions.

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

QUALIFICATIONS AND EXPERIENCE

14. I hold a Bachelor of Science degree in Civil Engineering from the University of Washington in Seattle, USA.

[1] PC14-QM-s32-Low-Public-Transport-Accessibility-Areas-Three-Waters-Memo-s32-Appendix-46.PDF (ccc.govt.nz).

15. I have 24 years' experience as a civil engineer specialising in stormwater planning, flood management and site development. During this time I have worked with local government in King County (Washington State, USA), with private consultancies, and presently with Christchurch City Council.

16. I have been involved in the development of various Council standards and guidelines relating to stormwater management. I have also been involved in several plan changes, Council and Environment Court hearings that relate to stormwater and flood management, consenting and development.

CODE OF CONDUCT

17. 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.

18. I confirm that, while I am employed by the Council, the Council has agreed to me providing this evidence in accordance with the Code of Conduct.

SCOPE OF EVIDENCE

19. My statement of evidence addresses the following matters:

    (a) Stormwater and Flooding Mechanisms and Characteristics;

    (b) Effects of Development on Stormwater Ponding and Flooding;

    (c) Proposed Objectives and Policies;

    (d) Proposed Development Scenario and Qualifying Matters;

    (e) Why No Stormwater Network Constraint Qualifying Matter?

    (f) Existing Regulation of the Network Under the Comprehensive Stormwater Network Discharge Consent;

    (g) Low Public Transport Accessibility Area Qualifying Matter; and

    (h) Responses to Submissions.

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

STORMWATER AND FLOODING MECHANISMS AND CHARACTERISTICS

21. Christchurch is a flat, low-lying, coastal city with shallow groundwater making it geographically and hydraulically challenging to provide stormwater services. The stormwater services the Council provides include stormwater drainage, flood management, water quality treatment and emergency management.

22. The stormwater network consists of two types of assets; below ground and above ground.

23. The below ground assets of sumps, pipes, manholes and pump stations has a limited, fixed capacity that can only cope with the more frequent rainfall events. The below ground network is typically sized to convey a 20% Annual Exceedance Probability (**AEP**), or "5-year" rainfall event. A 20% AEP event 20% chance of occurring each year.

24. The above ground assets include overland flow paths, road kerbs and channels, waterways and most stormwater treatment facilities (e.g., basins, ponds, wetlands). The above ground network will often be designed to cope with larger storm events up to the 2% AEP ("50-year") event, sometimes larger. This above ground network performs many functions, including:

    (a) Conveying surface runoff to the below ground network;

    (b) Providing storage through ponding in parks, streets and other areas;

    (c) Conveying stormwater flows when the capacity of the below ground network is blocked or its capacity exceeded; and

    (d) Passing flows discharging from the below ground network into rivers, the estuary and the coast.

25. The function of the above ground network is vital to the overall network performance and is often misunderstood. For example, ponding on streets is common and is necessary to reduce downstream flooding and to enable a smaller, cheaper below ground network. Flood management is challenging in Christchurch as it is flat and low lying. Pipes, drains and waterways only have limited capacity, so the city also relies on above ground flow paths and flood ponding to deal with storm events that overwhelm the underground network capacity. Council designs the network

to direct stormwater and flooding towards parks and roads and away from properties and homes.

26. Many parts of the city currently experience issues with frequent stormwater ponding and flooding as a legacy of poor historical development practices. These practices include development of low lying or flood prone land, insufficient or insufficiently protected overland flow paths and sizing of infrastructure that does not meet modern demands.[2]

27. The nature of the stormwater ponding and flooding issues generally varies by location within their catchment. Upper catchment flooding tends to be caused by insufficient capacity of the stormwater network to drain short duration, high intensity rainfall events. Lower catchment issues tend to relate to flooding from rivers and their tributaries during longer, high volume rainfall events. Steep hillside catchments have issues relating to erosion, slope stability, "under-runners" (caused by the erosion of subsurface soil layers), drain blockages and high velocity overland flows. The impacts of extreme rainfall overwhelming the primary stormwater network is highlighted by event of March 2014 that resulted in widespread flooding of many parts of the city.[3]

28. Typically, there is little warning in advance of flooding in the city, particularly in the upper catchments, and the Council has only limited resources available to deploy during a storm event. Depending on the scale of the event, there may be limited measures able to be taken, even with some advance meteorological warning. This makes management of runoff from new development and appropriate sizing of the network essential to reducing the adverse effects of development on stormwater drainage. Having appropriate District Plan controls is an essential tool in reducing flood risk with time, but the Council has other legislative tools as well.

EFFECTS OF DEVELOPMENT ON STORMWATER PONDING AND FLOODING

29. Flooding can have broad impacts on property owners.[4] The frequency, extent, duration and severity of flooding increases with development because higher impervious surface coverage increases stormwater runoff

[2] These issues have been explored in a recent report to Council on stormwater (CCC 2017): https://christchurch.infocouncil.biz/Open/2023/04/CNCL_20230405_AGN_8402_AT_WEB.htm (Item 17).
[3] The Mayoral Flood taskforce reports provide a record of the extent and nature of flooding across the city and describe different flood mechanisms in different catchments (CCC 2014): https://ccc.govt.nz/services/water-and-drainage/stormwater-and-drainage/stormwater-projects/reports.
[4] Climate Change and Health in Waitaha Canterbury, Te Whatu Ora https://www.cph.co.nz/wp-content/uploads/ClimateChangeHealthWaitahaCanterbury.pdf.

and impedes rainwater soaking into ground. Council's *Onsite Stormwater Mitigation Guide* provides a brief description of the negative effects of unmitigated development on stormwater.[5] That information is not replicated here for brevity but is recommended for those less familiar with stormwater and stormwater management.

30. The engineering design for the sizing of stormwater network systems (both below and above ground) contains assumptions of imperviousness of the catchment as a function of zoning density. Council's Waterways, Wetlands and Drainage Guide (WWDG, 2003 and updates) provides the following parameters for impervious surface coverage in hydrologic and hydraulic design, derived from studies of aerial photographs of representative neighbourhoods:

Table 21-6: Zone average effective pervious and impervious area percentages. Refer to the Christchurch District Plan maps, (See Table 21.5 for zone abbreviations).

Table 21-6: Pervious and Impervious Area% and %Contribution

District Zone	*Pervious Area% pv%*	*Pervious Contribution %PvContrib*	*Impervious Area% im%*	*Impervious Contribution %ImContrib*
Residential: RS	50%	30%	50%	90%
Residential: RSDT	35%	25%	65%	90%
Residential: RNN	30%	25%	70%	100%
Residential RMD	20%	25%	80%	100%
Residential: RH	55%	50%	45%	90%
Business (industrial/commercial)	10%	50%	90%	100%

31. A sizing of a stormwater pipe network in a Residential Suburban zone, for example, has been calculated on the premise that its catchment has an overall imperviousness of 50%. If that catchment is rezoned to Residential Medium Density (with an assumed imperviousness of 80%), and is fully developed as such, the pipe system built for an RS neighbourhood will therefore be undersized. The area will experience increased reliance on the overland network, leading to increased surface flooding of roads and land for a range of storm events unless the capacity of the stormwater network is increased.

32. As a result of these potential impacts of unmitigated development, the Council seeks to control development through the application of a range of tools and powers. These tools and powers are described below.

33. There are two main purposes for controlling development:

[5] https://ccc.govt.nz/assets/Documents/Services/Wastewater/Onsite-Stormwater-Mitigation-Guide.pdf.

(a) to manage the effects of new development; and

(b) to manage the effects on existing development. **Table 1** below provides examples of typical effects and the mechanisms used to control them.

Table 1 Stormwater Effects of, and on, Development

Of / On	Stormwater Effect	Control	Typical Mitigation Onsite	Typical Mitigation Offsite
Of	Increased runoff	Stormwater bylaw [6]	On-site storage or disposal into land	Communal storage basins
	Contaminant discharge	Stormwater bylaw	Treatment devices	First flush basins or treatment wetlands
	Reduced waterway capacity	District Plan and Stormwater bylaw	Limit filling	Diversions or channel upgrades
	Filling of the floodplain	District Plan and Stormwater bylaw	Limit filling	Compensatory storage
On	Flooding of property	District Plan (limited)[7]	n/a	Stopbanks, disposal into land, pumping or storage
	Flooding of habitable dwelling	Building Act and District Plan	Floor level setting	

34. Well planned and managed greenfield development can, under certain circumstances, have a beneficial effect by reducing flood risk by raising ground levels of the new development and in some cases extending benefits of the stormwater management infrastructure (quality and/or quantity) by connecting nearby older, unmitigated catchments.

35. It is far more difficult to manage the cumulative stormwater quantity effects of infill and brownfield redevelopment sites. The Council has guidelines for onsite storage on individual small sites (as discussed below), however onsite storage on small sites is only effective for shorter duration, lower volume rainfall events. In longer duration rainfall events there will still be downstream impacts even with small site mitigation, as the large volumes of stormwater and very low flowrates generated make it impractical to store and control in these circumstances.

36. Due to the complex nature of catchment responses, it is not practicable to design engineering interventions (other than large scale ground infiltration)

[6] The Stormwater and Land Drainage By-Law 2022.
[7] Stormwater design standards for new greenfield subdivisions on flat land require protection from existing floodplain through filling of land and stormwater network capacity up to a 1 in 5 year (or a 20% AEP) rainfall event and confinement of stormwater within the road corridor in events up to a 1 in 10 year (or a 10% AEP) rainfall event, providing some control of on-property flooding. (See section 5.6.4 of Council's Infrastructure Design Standards (**IDS**): https://ccc.govt.nz/assets/Documents/Consents-and-Licences/construction-requirements/IDS/Infrastructure-Design-Standard/Part-5-Stormwater-Land-Drainage.pdf).

that completely mitigate all effects of development through a wide range of storms. This is because:

(a) The release of water even after a significant time can coincide with flood peaks further down the network, increasing those peak flood levels;

(b) While flows can often be mitigated with onsite storage, the total *volume* of stormwater discharged from a site always increases with increased impervious surface coverage, even with provision of storage; and

(c) Mitigations have a fixed capacity and effects will cease to be managed once that capacity is exceeded.

37. PC14 permits widespread redevelopment potential across the city. Future stormwater patterns will change because of this intensification, as will Council's proposed infrastructure response and climate change impacts on rainfall and sea levels. If development uptake is highly concentrated in a particular area, upstream of other flood prone areas, adverse impacts on existing properties within the flood prone area are more likely, even with onsite mitigation of development sites. The ability for the Council to intervene in those areas will vary and, in some cases, may be economically infeasible.

38. It is not possible to predict all potential stormwater impacts across the city due to the numerous permutations of possible development scenarios and intensification patterns.

39. A very high proportion of the city is situated upstream of a known or modelled flood risk area.[8] Any coarse limitation on development intended to mitigate potential impacts of stormwater flooding based on current information would not be highly targeted, and, in my opinion, would not meet the threshold of evidence set for establishing a Qualifying Matter. Targeted controls may be considered in the future once there is sufficient data to support their implementation, as discussed below.

[8] The floor level management area in the existing District Plan is indicative of areas at flood risk in an extreme (50 to 200-year) event. If controls were placed on development upstream of the Flood Management Area this would cover most of the city. Future data will consider more frequent storm events than that used to derive the Flood Management Area (i.e.; 10-year events), which I consider to be more appropriate for applying development controls through a Qualifying Matter.

40. Although the widespread intensification afforded by PC14 will have overall impacts on stormwater servicing and flooding I consider that flooding effects of PC14 may be tempered by rules allowing building typologies with a greater number of storeys, allowing more dwellings to be constructed in a smaller impervious surface footprint than the same number of single storey units.

PROPOSED OBJECTIVES AND POLICIES

41. A strategic objective for PC14 is to have a *"A well-functioning urban environment that enables all people and communities to provide for their social, economic, and cultural wellbeing, and for their health and safety, now and into the future…".* The definition of a well-functioning urban environment includes *"urban environments that, as a minimum:… (f) are resilient to the likely current and future effects of climate change."*

42. Flood risk has material impacts on communities[9] and this will increase because of climate change due to increased extreme rainfall intensities as described in the Intergovernmental Panel on Climate Change (**IPCC**) 6th Assessment Report, quoted below:

> *Extreme rainfall is projected to become more intense (high confidence), but the magnitude of change is uncertain (Evans and McCabe, 2013; Bao et al., 2017) (Table 11.3). The insured damage in New Zealand from more intense extreme rainfall under RCP8.5 is projected to increase 25% by 2080–2100 (Pastor-Paz et al., 2020). In urban areas, extreme rainfall intensity is projected to increase pluvial flood risk (high confidence). In New Zealand, 20,000 km^2 of land, 675,000 people, and 411,000 buildings with a NZD$135 billion replacement value are exposed to flood risk (Paulik et al., 2019a).*[10]

43. Sea levels will also rise because of climate change. There will be impacts on the drainage network with increasing sea levels reducing the ability for stormwater networks to discharge via gravity. This will have far reaching impacts up the stormwater network. Without intervention, it is highly likely that stormwater network capacities will reduce as sea levels rise due to reduced hydraulic grade in the network.[11] This will lead to more frequent

[9] Climate Change and Health in Waitaha Canterbury, Te Whatu Ora https://www.cph.co.nz/wp-content/uploads/ClimateChangeHealthWaitahaCanterbury.pdf.
[10] IPCC 6th Assessment report (IPCC 2022), (chapter 11): https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-11/.
[11] Hydraulic grade reduces as the outfall tailwater levels lift relative to ground levels further up the network leading to spilling from the network at lower flow rates. This issue was explored in the Ōtākaro Avon Stormwater Management Plan (CCC 2015), (section 3.3): https://www.ecan.govt.nz/document/download?uri=3448247.

surface water ponding, deeper flooding and consequential impacts on health, safety, and community wellbeing.

44. A well-functioning urban environment will account for this increase in rainfall intensity and the impacts of sea level rise. As the urban environment is broader than a single development site, the objective should allow for consideration of the offsite impacts of development, including those made worse by climate change.

45. Therefore, in my opinion the proposed climate change provision within the objective is necessary and appropriate to achieve community wellbeing, health and safety as a result of flooding.

PROPOSED DEVELOPMENT SCENARIO AND QUALIFYING MATTERS

46. As discussed above the permissive spatial extent the Medium Density Residential Standards (**MDRS**) development potential could lead to localised stormwater management/flooding issues. Any outcome which reduces the spatial extent of MDRS development provides the Council with greater certainty, allowing for a planned infrastructure response without oversizing infrastructure at unnecessary cost. This is discussed in the Three Waters Memo.

47. In comparison to Full Intensification Scenario the PC14 Scenario allows for a reduced area of development and, in general, a better stormwater management outcome. In my opinion it is appropriate to limit intensification through the following Qualifying Matters, as they will limit the impacts of development on those areas already affected by stormwater ponding and flood risks, particularly those matters related to stormwater and flood management (and hence enhance community wellbeing, health and safety):

    (a) High Flood Hazard Management Area;

    (b) Flood Ponding Management Area;

    (c) Waterbody Setback; and

    (d) Coastal Hazard zones.

48. If higher intensification were permitted in these areas, then the well-functioning urban environment objective is likely to be compromised as a higher number of residents would be subject to health and safety impacts of flooding. Development in these areas would also increase the economic

impacts of flooding, reduce accessibility and likely reduce future resilience to current and future effects of climate change.[12]

49. The High Flood Hazard Management Area is an appropriate Qualifying Matter as development in this area could increase risk to life. The purpose of rules for this area in the current District Plan (which aligns with the Canterbury Regional Policy Statement (**CRPS**)'s "high hazard areas"[13]) is to limit development in areas of fast flowing or deep flood water. In my opinion this Qualifying Matter achieves that purpose.

50. The Flood Ponding Management Area is an appropriate Qualifying Matter as development in this area is currently restricted by the District Plan to limit co-location of people and flooding but also to protect the natural flood storage volume in these areas. As described above these flood storage areas are critical to stormwater management and have wider network benefits.

51. Controlling development within the Water Body Setbacks as a Qualifying Matter is appropriate as the setbacks are necessary for maintenance and management of the network and for floodplain storage. Development is inappropriate in these areas as it could have severe impacts by impeding flooding flow paths or impairing the Council's ability to manage and maintain the watercourse.

52. Controlling development in Coastal Hazard Management Areas as a Qualifying Matter is in my opinion appropriate because it will have similar or greater impacts[14] on people and property as flooding from stormwater sources.

53. For completeness the Flood Management Area in the current District Plan is also flood related but I do not consider this is an appropriate control on intensification for two reasons:

    (a) The flood scenario used for deriving the area includes all flood depths modelled in a 0.5% AEP rainfall event (i.e. a 1 in 200 year event, including appropriate climate change and sea level rise at the time of

[12] *Resilient Greater Christchurch, Greater Christchurch Urban Development Strategy Partnership* https://greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Resilient/Resilient-Greater-Christchurch-Plan.pdf.
[13] Canterbury Regional Policy Statement 11.3.1.
[14] Saline water flooding has greater potential to damage property and infrastructure due to corrosive effects.

modelling) and the most severe impacts of flooding are currently controlled by the setting of minimum floor levels in this zone; and

(b) The area includes a freeboard allowance which is projected horizontally from the flooded areas, generating an area of control significantly larger than the modelled flooding area itself, which is appropriate for floor level setting but not necessarily as a control on intensification. A Qualifying Matter based upon the full extent of the Flood Management Area would be disproportionate to the impact of actual flooding across a significant proportion of the area.

54. The controls on intensification proposed to occur in Qualifying Matter areas compared to the Full Intensification Scenario are in my opinion necessary and appropriate to achieve the objectives[15] of the District Plan (including objectives proposed in PC14). I support the outcomes of the current District Plan within the locations where the Qualifying Matters apply as they allow for an appropriate balance of flood risk and development outcomes.

WHY NO STORMWATER NETWORK CONSTRAINT QUALIFYING MATTER?

55. There are two primary reasons why a stormwater network constraint Qualifying Matter was not proposed as part of PC14, in addition to the Qualifying Matters discussed above:

(a) The existing tools and powers (see below) that Council has in place are sufficient to manage some of the impacts; and

(b) The extent of hydraulic modelling that would be required to support the evidential threshold for a Qualifying Matter across the whole network could not be prepared in time for the plan change (see below).

56. The Council has a range of tools and powers available to manage the effects of, and on, development, and to manage the network, including:

(a) Building Act powers to set minimum building platform levels and floor levels;

[15] 3.3.6 Objective - Natural Hazards, 13.3.14 Objective – Incompatible Activities.

(b) District Plan zones and associated rules to control subdivision and filling in the floodplain, to set floor levels and to limit development and earthworks within the waterbody setback;

(c) Stormwater and Land Drainage Bylaw 2022 (the **Stormwater Bylaw**)[16] powers to control discharge quantity and quality from a site through approval to connect to the network;

(d) Stormwater Bylaw powers to control works in and around flood hazard areas and overland flow paths;

(e) Christchurch District Drainage Act powers to remove obstacles from the network (i.e., earthworks, dumping of material, fences and structures); and

(f) Local Government Act powers to manage the stormwater network and to build new infrastructure.

57. There are a range of processes used to apply these tools, including approvals and condition setting under resource consents, subdivision consents, building consents, and approval to connect to the Council stormwater network.

58. Written approval to connect to the Council stormwater system is used to manage the effects of intensification and balances the need for infrastructure upgrades. At the time of application for building or land-use consent the potential effects on the network are considered by the Stormwater and Waterways Asset Planning Team and the written approval is a separate process to those consents. The need for an approval to connect to the stormwater network is identified through a building consent or a resource consent application but is a separate process.

59. Stormwater mitigation for small development sites is triggered during the stormwater approvals process depending on the extent of new development and whether the site is a flat or hill site (**Table 2**).

[16] The Council website provides a summary of the bylaw: https://ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/stormwater-and-land-drainage-bylaw-2022/.

Table 2 Small site stormwater quantity mitigation triggers

Hill sites (>5° slope)	All hill sites are required to install rain tanks or other suitable mitigation devices when new development (or intensification) takes place.
Flat, urban areas	Mitigation is required only if: 1. The additional impervious area added is greater than 150 m^2; and 2. The resultant impervious area covers more than 70% of the total site area.

60. As set out in the Council's Onsite Stormwater Mitigation Guide, which is used for development of small sites, it is typical for Council officers to require $5m^3$-$10m^3$ of onsite stormwater storage per $100m^2$ of increased impermeable area (depending on the site size and other hydraulic circumstances) unless there is a collective Council stormwater facility that has been designed to manage stormwater within the catchment. On-site treatment of the "first flush" of stormwater runoff from trafficable hardstand is required for the sites adding $150m^2$ or more hardstand and more than 5 carparks unless a Council stormwater treatment facility has capacity in the downstream network. Sites larger than $5,000m^2$ require specific engineering design of their stormwater mitigation systems and typically are required to achieve either hydraulic neutrality[17] or "full flood attenuation"[18], depending on the receiving environment.

61. The water quantity mitigations outlined in the Onsite Stormwater Mitigation Guide are generally effective at reducing discharges from developments for storms up to around 6 hours duration. For longer duration storms, rainfall intensities are too low to effectively control via gravity-driven storage systems. Other, more complex systems involving float valves or electronic controls would be required to fully mitigate storms longer than about 6 hours duration. While possible to implement, I consider the cost, complexity, maintenance requirements and probability of failure for such systems increases significantly. For larger sites, the feasibility of controlling longer duration storms[19] improves.

[17] Hydraulic neutrality means sufficient storage and control to ensure that the post-development site does not discharge a higher flow rate of stormwater to the network when compared to the pre-developed site. Council officers require flow control for all storms up to and including the critical 2% AEP storm for the receiving environment.
[18] Full flood attenuation means capture of the full 2% AEP storm volume with slow release over a minimum of 96 hours. Full flood attenuation is required by the Council's Comprehensive Stormwater Network Discharge Consent CRC231955 for greenfield development in the Pūharakekenui/Styx River for greenfield development in the Huritni/Halswell River and Ōpāwahao/Heathcote catchments within their respective Stormwater Management Plans.
[19] "Longer duration" means those storms which are critical for Christchurch's largest catchments. Pūharakekenui/Styx is 48 hours, Ōtākaro/Avon is 18 hours, Ōpāwahao/Heathcote River is 27-36 hours and Huritini/Halswell is 60 hours.

62. The stormwater approval process also controls construction phase discharges to reduce the effects of sediment discharges on waterways. Standard conditions such as those below are included in the Council's written approval for discharge:

(a) An approved Erosion and Sediment Control Plan shall be implemented on the development site prior commencement of earthworks activities.

(b) The concentration of total suspended solids (**TSS**) in construction phase stormwater discharges as measured where the site discharges into the Council stormwater network shall not exceed 50 milligrams per litre.

(c) The discharge of stormwater during site construction shall be via best practicable erosion and sediment control measures to minimise erosion of land and the discharge of sediment-laden stormwater into the Council stormwater drainage network and the receiving environment.

63. Bylaw approvals may also be required if a proposal includes works near a watercourse or overland flow path for flood waters (separate from the resource or building consent process). The Bylaw also controls building near or over a Council stormwater pipeline.

64. The second reason for not proposing a Stormwater Network Constraint Qualifying Matter is because the Council does not have complete coverage of suitable flood data for the purpose. The Council has hydraulic models of all the major catchments within the urban area: Pūharakekenui/Styx River, Ōtākaro/Avon River, Ōpāwahao/Heathcote River, Huritini/Halswell River and also areas draining directly to Ihutai/Avon-Heathcote Estuary and the coastal suburb of Sumner. Highly detailed modelling, far superior to that developed historically, has recently become available for parts of the city. However, some parts of the city (Pūharakekenui/Styx River and Huritini/Halswell River) only have earlier, less detailed models that do not meet the same standard of newer models.

65. The Council's recent models are built to a high standard and have fine detail within those catchments. The complexity of the models means that updating them is done infrequently, typically, every 5 years. The quality and complexity of the models makes them precise but not necessarily

accurate until they have been thoroughly calibrated. As is typical across the country, there are a limited number of water level and flow monitoring sites in each catchment and the further a monitoring station is from the site the less confidence there is in the model results. This does not mean that they are inappropriate for planning purposes but an understanding of the limitations of the data is appropriate when considering planning controls.

66. The Council is in the process of updating the Pūharakekenui/Styx, Ōpāwahao/Heathcote and Huritini/Halswell models. The Ōtākaro/Avon model (2020 infrastructure) and Sumner models (2014 infrastructure) are sufficiently modern for planning purposes and can be run for a range of different scenarios. For example, the Ōtākaro/Avon model has been run for a range of scenarios, including:

    (a) Existing development and climate; and

    (b) Various future development scenarios aligning with the existing District Plan zones up to the forecast 2068 population growth with a range of future climate scenarios out to approximately 2120.

67. To fully understand the potential effects of PC14 on flooding patterns, additional model runs would need to be undertaken with the refined models using the Council's population growth model (or other relevant tools) to predict the uptake of intensification development.

68. I do not consider it appropriate to have a Stormwater Network Constraint Qualifying Matter that does not cover the full extent of the city and/or is based upon data of highly varied quality as this could result in uncertain built outcomes. I do not expect that the current flood data set would meet the requirements for a Qualifying Matter, however I expect that this will be achieved in the future as models across the city are built to the necessary standard. The Council is actively considering future controls on development for stormwater purposes once a complete and high-quality set of modelling data is available.

69. A Qualifying Matter limiting intensification may provide for similar or better outcomes for managing the stormwater network as the existing processes described above. Also, I consider the inclusion of a related provision assessing stormwater network constraints through PC14 would provide greater certainty to applicants.

70. Unfortunately, first-time applicants are frequently unaware of the requirement for written approval to connect to the network, with the associated mitigations often required. As such, inexperienced applicants sometimes need to adjust their plans due to requirements of the stormwater connection approval (i.e., the provision of onsite rainwater storage tanks).

71. The Council makes efforts to mitigate this through early advice from planning staff as part of a building consent or resource consent pre-application process however, the extent and nature of the requirements often cannot be fully understood until an assessment by the Stormwater and Waterways Asset Planning Team is undertaken under full application. As such, there would be some benefit in having the requirement in the District Plan where it can be identified early by the applicant's experts. However, if resource consent application is no longer required by the District Plan for intensification redevelopments, inexperienced applicants will likely not become aware of mitigation requirements until time of building consent.

72. The advantage of the stormwater approval process approach is that it provides the ability to make engineering judgement at the time of application based upon the best information available at that time and can adapt to technological advance and changes within each catchment as development processes.

73. Consideration is being given to developing new District Plan overlays to control development in areas containing significant overland flow paths and/or frequent nuisance flooding (i.e.; 10% AEP or 1 in 10 year flood extent). This will be considered further once sufficient hydraulic modelling is completed to provide uniform, quality, results across the city. A new overlay could be created to limit development near overland flow paths and areas of high flood risk (that are not otherwise identified by the Flood Ponding Area or High Hazard overlays). The new data is expected to be available within the next 3 years and could be utilised to control all forms of development, rather than just those proposed within PC14.

EXISTING REGULATION OF THE NETWORK UNDER THE COMPREHENSIVE STORMWATER NETWORK DISCHARGE CONSENT

74. The Council holds a resource consent from Environment Canterbury for discharges from the Council's stormwater network. There are conditions of that consent which require Council to control discharges from the network

to limit the impact on flooding and the environment. In practice, the Council is required to construct stormwater treatment facilities and flood management infrastructure to mitigate future and existing development impacts. Any increased development beyond what was conceived at the time the consent was issued will place an increased infrastructure burden on the Council to meet the conditions of consent. As explained in the Three Waters Memo, this means that the Council may need to build more stormwater infrastructure, sooner.

75. Even with the potential for reduced imperviousness across the city (as compared to the existing District Plan rules) resulting from taller buildings permitted by PC14, the proposed increase to the MDRS zone is very broad. This means future intensification could be concentrated in areas difficult to mitigate, leading to increased runoff, increased flooding, increased infrastructure demand and increased costs to the Council.

LOW PUBLIC TRANSPORT ACCESSIBILITY QUALIFYING MATTER

76. In this section I comment on the stormwater benefits of the proposed Low Public Transport Accessibility Area (**LPTAA**) Qualifying Matter discussed in the section 42A report of Mr Ike Kleynbos.

77. Broadly, any Qualifying Matter that reduces the extent of MDRS zone is advantageous for infrastructure (stormwater) planning for the reasons outlined above. Any reduction in MDRS-enabled development will increase confidence in stormwater outcomes and allow for a more targeted response from Council. Even if the areas of development control proposed by the Qualifying Matter do not exclude catchments upstream of flood vulnerable locations, Council will be able to act with greater certainty and with clearer intent.

78. A significant proportion of the LPTAA is proposed over residential areas on hill land. Hill land has unique stormwater issues related to geography and soil types[20]. Generally, flooding on hill land is more likely to cause serious land damage due to higher velocity erosive flows and is more likely to generate high volumes of sediment due to the presence of highly dispersive soils[21]. Hill land is also a uniquely difficult environment to store large volumes of water for retention or treatment purposes due to steep

[20] Waterways, Wetland and Drainage Guide Part B, Chapter 7.3 – Hill Waterways: Loess Deposition and Erosion Characteristics.
[21] "loess"; unstratified, geologically recent deposits of silty or loamy material composed largely of silt-size grains that are loosely cemented by calcium carbonate.

topography and inherent risks of holding large volumes of water in dam-like structures. This makes collective stormwater mitigation more costly and complex when compared to flat land. Any qualifying matter that reduces intensification (and disturbance) of hill land will be beneficial in terms of both water quality (flooding) and water quantity (sediment discharges, particularly during construction works).

RESPONSE TO SUBMISSIONS

79. Several submissions[22] seek to amend PC14 to include rules requiring provision of onsite stormwater mitigation to mitigate the effects of new development on flooding, including water sensitive urban design.

80. I consider that the Council is already able to require these types of mitigations through the tools outlined above, rendering specific rules in the District Plan relatively redundant (or repetitive and potentially contradictory and harder to amend). Such rules in the District Plan are likely in my opinion to be less specific than the present measures and unable to deal with the wide spectrum of catchment characteristics and receiving environments within the city. I therefore do not support these changes as sought by the submitters.

81. Several submissions[23] raise concerns around the effects of PC14-enabled intensification on stormwater and flooding. Some seek Qualifying Matters and/or other restrictions on density of development in areas which are affected by flooding or areas that intersect with the Flood Management Area. While generally I consider there is merit to restricting development where it contributes to areas affected by flooding, the Council has not proposed a Qualifying Matter for the reasons discussed in my evidence above. Furthermore, flooding is caused by cumulative discharges from within the entire upstream catchment, making it difficult to spatially constrain. Therefore, any Qualifying Matter overlay designed to target areas of the city that *contribute* to a known 50-year or 200-year flood hazard area would be widespread and heavily limiting, which is not aligned with the legislative intent (to enable intensification).

[22] Hallatt #290, Manthei #200, Finn #832, Gray #908.
[23] Horrell #11, Trim #37, Perkins #94, Smetham #112, Riccarton Bush – Kilmarnock Residents' Assoc. #188, Black #246, Mahoney #329, Toka Tū Ake EQC #377, Claridge #480, Cusack #580, de Jongh #583, Brorens #644, McLauchlan #653, Murison #668, Dale #679, Dovey #680, Murison #692, Murison #693, Bennetts #793, Kerr #868, Rutledge #875, Ogle #876.

82. Summerset Group Holdings Limited (Submission #443) have requested that the natural hazards and waterbody setback Qualifying Matters be removed from the Summerset Cavendish site (147 Cavendish Road). This is an area where there are presently significant stormwater infrastructure works taking place, both by the Council and by private developers (working to the Council's overall stormwater scheme). The site does not contain High Flood Hazard or Flood Ponding Area overlay and therefore would not be subject to those Qualifying Matters. The site is adjacent to a watercourse, and in my opinion should remain subject to the Water Body setback Qualifying Matter for the reasons that the setback was put in place (see above).

83. Environment Canterbury (Submission #689) have sought that the upper Halswell River catchment areas be covered by a Qualifying Matter that prevents further intensification because of inadequate stormwater infrastructure and downstream flooding effects. In my opinion the Halswell River catchment is not dissimilar to the other Christchurch rivers in terms of flooding effects and existing infrastructure provision. For a flooding effects Qualifying Matter to be introduced in Halswell and not in the Heathcote, Avon or Styx catchments would result an inequitable outcome that cannot be justified. In my opinion the relief sought in this submission should be rejected.

CONCLUSION

84. I consider the Qualifying Matters for High Flood Hazard Management Area, Flood Ponding Management Area, Water Body Setback and Coastal Flood Hazard Zones are appropriate. These Qualifying Matters alone will reduce the number of additional dwellings being constructed within areas of stormwater, coastal and flood related hazards, but will not necessarily prevent adverse flooding effects occurring as a result of increases in impervious surfaces caused by high uptake of the newly zoned Residential Medium Density areas.

85. I consider the Qualifying Matter for LPTAA is appropriate, as it reduces the overall extent of MDRS zoning, particularly in some hill areas.

86. Ideally the Council would have sufficient, high-quality data to support an additional stormwater network constraint Qualifying Matter targeting areas that contribute the worst-affected, frequently-affected and most

difficult/costly to mitigate flood prone areas. However, such data is not currently available.

87. Increases to flood risk in localised areas could result from uptake of intensification enabled by PC14, along with increased demand on the Council's stormwater network infrastructure. Existing powers exercised by the Council to control network connections will mitigate some of the adverse effects of flooding caused by intensification until such time as Council is in a position to insert a stormwater network constraint Qualifying Matter into the District Plan.

88. There will likely be increased costs to Council and the community resulting from PC14, however, the Council does not currently have sufficiently robust information to alter this outcome.

89. Overall, I support the stormwater management provisions, and associated Qualifying Matters, and the LPTAA within PC14 as a pragmatic implementation for stormwater management of the legislative requirement placed on the Council.

Dated: 11 August 2023

Robert Brian Norton