BEFORE THE CANTERBURY REGIONAL COUNCIL

UNDER THE	Resource Management Act 1991
AND	
IN THE MATTER	of application CRC190445 by the Christchurch City Council for a comprehensive resource consent to discharge stormwater from within the Christchurch City area and Banks Peninsula settlements on or into land, into water and into coastal environments

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STATEMENT OF EVIDENCE OF

THOMAS GEOFFREY PARSONS FOR CHRISTCHURCH CITY COUNCIL

Dated 15 October 2018

CHRISTCHURCH CITY COUNCIL
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INTRODUCTION

1. My full name is Thomas Geoffrey Parsons. I have been engaged by the Christchurch City Council (**Council**) to give evidence in relation to the application for a comprehensive stormwater network discharge consent (**Application**). In 2013 I provided evidence to the Styx SMP consent hearing on the hydraulic modelling used to assess the potential impacts of future development on the predicted flood levels in the Styx River and adjoining floodplain (CRC131249).

2. I hold a BE (Hons) (Civil) degree from Canterbury University and am a chartered member of Engineering New Zealand (CPEng, CMEngNZ, IntPE). I have been a chartered member of the Engineering New Zealand since 2013. I have also been an individual member of Water New Zealand since 2013.

3. I have been employed as a Technical Director of Innovate Consulting for the last 5 years and throughout this period I have been contracted to Council in dual roles of Senior Surface Water Engineer and Technical Manager of the Land Drainage Recovery Programme (LDRP). I have been involved with operational and emergency response activities during some of the flood events over this period.

4. Previously I had been employed by three other organisations within New Zealand and the United Kingdom over 10 years. During this time, I specialised in hydraulic modelling and surface water engineering.

5. I have been involved with professional committees within this period by sitting on the Rivers Group (WaterNZ / EngineeringNZ) and Modelling Special Interest Group committees (WaterNZ). I am a recent member of the Sustainability Society (a technical interest group of EngineeringNZ).

6. I have been engaged by Council to provide advice on the following topics:

   6.1 The current state of water quantity in Christchurch, how water quantity issues are investigated and addressed, the Land Drainage Recovery Programme (**LDRP**), Council current infrastructure programme and the multi-hazard investigation that is currently underway;

   6.2 The difference between land drainage and this application;

6.3 Development of the Ōtākaro Avon River SMP water quality mitigation scenarios and what has significantly changed within the Ōtākaro catchment since the 2015 application;

6.4 The process for and challenges with retrofitting stormwater quality mitigation devices and reducing the water quality impacts of existing development;

6.5 Development of the alternative water quality mitigation scenarios presented as comparators to the proposed Best Practice Infrastructure (**BPI**) scenario as described in the evidence of Mr. Van Nieuwkerk and Mr. Harris and utilised as comparators to the BPI mitigation scenario that will be required to deliver to the proposed consent Condition 16, Table 2; and

6.6 Response to submissions and the S42A Officers Report.

7. I confirm that I have read and agreed to comply with the Code of Conduct for expert witnesses contained in the Environment Court Practice Note (dated 1 December 2014). I confirm that the issues addressed in the statement of evidence are within my area of expertise. I have not knowingly omitted to consider facts or information that might alter or detract from the opinions expressed.

SUMMARY OF EVIDENCE

8. The purpose of this evidence is to provide detail on Council's current approach to post-earthquake water quantity issues and to outline the development of the alternative mitigation options within this application.

9. Council is currently investing heavily in stormwater quantity mitigation infrastructure through the LDRP (such as new pump stations and stormwater detention basins), developing new tools for assessing flood risk and progressing new investigations into flood management across large areas of the city in order to support decision making on projects within the LDRP. This presents two key challenges for development of the SMPs[1], being:

[1] There is considerable uncertainty with long term sea level rise predictions (Ministry for the Enviornment, 2017) however there is general agreement of likely sea level rise over the duration of the proposed consent set out within the Application. As such, I have not identified sea level rise uncertainty as a key challenge. In addition to this there are no attribute target levels set within the area of potential sea level rise within Schedule 7 making it of lesser immediate importance to the Application and as presented in the evidence of Mr Harrington sea level rise impacts are outside the scope of the consent.

9.1 The setting of an infrastructure baseline from which the SMPs identify new works to manage water quantity given the current parallel infrastructure programmes in design and delivery; and

9.2 Some fundamental decisions for flood management within the city are not entirely within Council's control, specifically being the Ōtākaro Avon River Regeneration Plan.

10. It is my opinion that the attribute target levels proposed within Schedule 7 are likely to be achievable. The target levels need to be read carefully as there are important differences with the target levels between catchments that have arisen through the preceding consenting processes. There are some limitations within Schedule 7, most notably being the single measurement point identified for each catchment; however, as described by Mr. Harrington, this does not preclude the assessment of further points during the development or review of the SMPs. For future clarity and ease in interpretation I recommend changes to Schedule 7 and I have provided a revised table for consideration (**Appendix A**).

11. The SMP amendment process provided for within the proposed conditions will allow modifications to the BPI scenario. This may be required as the water quality mitigation scenarios presented within the Application documents do not present what will actually be built over the duration of the consent but rather they show that there are potential stormwater management responses (both infrastructure and policy) that deliver the stated contaminant removal outcomes within the consent conditions. As a result, the focus should not be on the proposed infrastructure response but on the resulting reduction in contaminants being discharged through stormwater across the city.

12. It is my opinion that some flexibility in the consent conditions is necessary to respond to the opportunities as they arise and allow for the challenges described above. This will help drive better, more cost effective outcomes for the Christchurch community and the local environment. For example, if source controls are able to be implemented then the contaminant removal percentages given in Table 2 of Condition 16 may be achieved with an infrastructure response less than the BPI scenario. Alternatively, if source controls are not able to be implemented and the Ōtākaro / Avon River Corridor Regeneration Plan does not provide for stormwater quality mitigation measures, then Council may not be able to meet the reduction targets set in Table 2 or will have to consider other, potentially costlier, mitigation

options. Flexibility is provided for in the infrastructure response but not in the contaminant reduction percentages. This revised infrastructure response, whilst being adaptive management, would take time to investigate and deliver, putting Council at risk of breaching the consent conditions or necessitate a variation to the consent. This could be avoided with the inclusion of the term 'reasonable endeavours' into Condition 16, which I recommend. In my opinion, throughout that process there does need to remain a focus on the benefits to the receiving environment.

13. Notwithstanding the above, it is my view that the proposed BPI water quality mitigation scenario presented within the Application is plausible, realistic and deliverable within Council's current processes for delivery of infrastructure (i.e. are likely to be feasible and close to what will actually be constructed over the life of the consent on the assumption that water quality treatment mitigation measures will be supported by the Ōtākaro / Avon River Regeneration Plan). Other more extensive water quality infrastructure scenarios would present considerable implementation challenges for Council.

14. I have read the following documents when preparing this evidence:

14.1 Resource Consent Application and the water quantity sections of the Assessment of Effects on the Environment (June 2015);

14.2 Amended Application Letter (July 2018);

14.3 Ōtākaro / Avon Stormwater Management Plan (Christchurch City Council, 2015);

14.4 Assessment of Current and Future Stormwater Contaminant Load for Christchurch (Golders, 2018);

14.5 The draft evidence of Mr. Harrington, Mr. Norton, Mr. Dickson, Mr. Harris and Mr. Van Nieuwkerk;

14.6 The Section 42A Officers reports, including appendices 3 and 4, written by Mr. Law and Ms Irvine and Mr. Surman; and

14.7 The submissions of:

(a) A and K Rodrigues

(b) B Robertson

(c) G Sharlick and J Burney

(d) J Burney

(e) K Snook

(f) P and R McGuigan

(g) P Hargraves

(h) Snook Family Trust

STORMWATER QUANTITY

The Current State of Water Quantity

15. Christchurch is a low lying, flood-prone city. Stormwater, drainage and flood protection schemes have been constructed in the city over decades (Wilson, 1989). It is clear that well-functioning and effective stormwater management is fundamental to our current urban land use as the social impacts of flooding are significant (Christchurch City Council, 2014).

16. The stormwater network is complex. The network typically includes a network of sumps, pipes, drains, storage basins and pumps that collect flows from urban areas and discharge it to the waterways or to ground. This primary network only has a limited capacity, typically it can convey flows generated in up to a 20% AEP rainfall event[2]. In events less frequent than this there will be surface water storage in streets and on property along with initiation of overland flow paths (i.e. the secondary network). Design of new subdivisions allows for overland flows being lower than floor levels up to flows generated during 2% AEP rainfall event (Christchurch City Council, 2017c) (New Zealand Government, 2017). Approvals for discharges for new subdivisions is described more fully in the evidence of Mr. Norton. In addition,

[2] A definition of AEP is provided within the consent conditions, being: the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 40 cubic metres per second has an AEP of 2%, it means there is a 2% chance (i.e. one-in-fifty) of a peak flood discharge of 40 cubic metres a second or larger being equalled or exceeded in any year. AEP is the inverse of return period expressed as a percentage.

floor levels for new buildings and extensions are also controlled within the District Plan to a higher 0.5% AEP standard in large areas of the city (Christchurch City Council, 2018a)[3]. The secondary network is an integral and necessary part of a functioning stormwater network (as long as it does not endanger people or property) as it is not cost effective to design a primary network with capacity for extreme rainfall events.

17. This primary and secondary network capacity is not available in all areas due to a variety of reasons, including: historic incapacity, standards changing with time, increased demand / imperviousness (infill development / intensification) and impacts of the CES. There are many areas at risk of flooding in extreme rainfall events and these will not inherently be addressed through the conditions proposed within the Application (as set out in Schedule 7) as the proposed conditions provide targets to manage to the effects of discharges from the stormwater network – the purpose of this application being consent for stormwater discharges, not drainage management itself[4]. However, Council is actively investing in flood risk reduction infrastructure across large parts of the city (as described below) through programmes that are not proposed to be managed through the Application and there will also be water quantity benefits from installation of water quality mitigation measures (as described below).

18. Recent storm events have highlighted many areas at risk of flooding (Christchurch City Council, 2014) (Christchurch City Council, 2018b) and Council's understanding of flood risk is progressing over time (refer to flood model development section below). The total number of properties at risk of above floor flooding in Christchurch is not currently easy to accurately calculate across the city given the requirement for surveyed floor level information and detailed flood level predictions. As such, in my opinion it is not suitable to include this measure as an attribute target level within Schedule 7 of the proposed consent conditions.

19. There are parts of the city that are below median tide level, as illustrated within the Figure 9 of the Ōtākaro / Avon SMP (Christchurch City Council, 2015) as submitted within the Application documents. Suburbs across the city that are in-part low lying include: Aranui, Woolston, Southshore, South New Brighton, Avondale, Brooklands and Linwood. The stormwater network in these areas typically includes backflow prevention (e.g. flap gates and duck-bill valves), flood defences (e.g. stopbanks and

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[3] The provisions within the District Plan relating to flood risk are described in more detail within the evidence of Mr Harrington.

flood walls), stormwater pumping and other engineering structures. Blue-sky flooding (coastal inundation outside of storm events) would be far more common in Christchurch without this infrastructure.

Future flood risk

20. Increases in flood risk are predicted as a result of climate change and sea level rise (Ministry for the Enviornment, 2017) (The Parliamentary Commissioner for the Environment , 2015) (Tonkin + Taylor, 2017). Areas at significant flood risk today will be at increased risk in the future without interventions[5]. There are considerable uncertainties with future sea level rise predictions and this has led to a change in approach to flood management within the recent Ministry for the Environment (MfE) guidance on Coastal Hazards and Climate Change for Local Government (Ministry for the Enviornment, 2017). This guidance has provided a new framework for planning and responding to climate change[6]. However, the uncertainties with sea level rise predictions are low in the next 25 years as the forecast sea level increases are already 'baked in' through past emissions (Intergovernmental Panel on Climate Change, 2014).

21. The scope of the consent is to manage the effects of stormwater discharges into and out of the stormwater network from urban development. Sea level rise is independent of these discharges however there are three areas of impact:

    21.1 Direct increases to tidal flood risk. This is outside the scope of the consent and not discussed further;

    21.2 Change in receiving environment effects of stormwater discharges. Greater areas will be dominated by tidal flood risk (which will potentially have reduced sensitivity to incremental discharges due to the relative changes in level). There will also be areas where fluvial flood risk (i.e. flooding from the rivers) will increase due to tidally influences. These areas are likely to see increased sensitivity to stormwater discharge quantities; and

    21.3 Reduction in stormwater system capacity due to higher water levels at the network discharge point reducing the period over which gravity networks can discharge effectively.

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[4] The Huritini / Halswell could be considered an exception as it refers back to 1991.

22. The SMPs will need to explore potential future flood risk, the impacts of climate change and the impacts on the existing drainage network. However, over the period of the proposed consent duration sea level rise predictions are modest (as compared to later in the century). This signals that sea level rise will become increasingly important in future consents.

23. Council is currently investing heavily in flood management in both the day-to-day and infrastructure rebuild programmes as provided for within the LTP (Christchurch City Council, 2018). These programmes are supported by ongoing investigation programmes that will identify and promote improvements in flood plain management across the city now and into the future. These will address, across large areas, current and future flood risks that might be experienced over the period of the consent through application of Council's design standards and policies (with the exception of much of the earthquake rebuild) (Christchurch City Council, 2017c) (Christchurch City Council, 2011). As described further below, this presents some challenges during development of the SMPs.

Council's Infrastructure Response to Water Quantity

24. The water quantity and quality SMPs projects currently in the LTP (Christchurch City Council, 2018d) are listed in two service plans: *Stormwater* and *Flood Protection and Control Works*. These plans give the reasons why Council undertakes particular activities, what they entail and the levels of service that the Council will provide to the community. The capital programme within the LTP arising from Service Plans and projects falls within the following two broad categories:

24.1 *Day-to-Day:* projects that have an origin within standard Council processes; and

24.2 *Infrastructure Rebuild*: projects to restore infrastructure following the Canterbury Earthquake Sequence (**CES**) that began in 2010. These projects are effectively level of service recovery.

25. Day-to-day projects can originate from a wide range of normal 'forward-looking' Council processes such as, asset renewals, Council resolution, and long term planning. Long term planning and investigations into water quantity issues can be

[5] To a degree this is offset by increases in floor levels through application of the district plan rules that will be triggered as the current building stock is renewed.
[6] A dynamic adaptive pathways planning approach is promoted within the new guidance.

triggered by, and respond to, customer complaints, future growth forecasts, new District Plan zoning, predicted climate change demands and flood risk analyses. Network upgrades can also be triggered in response to the asset renewals programme and wider Council strategies, such as the Surface Water Strategy 2009-2039 (Christchurch City Council, 2009) and the upcoming Integrated Water Strategy and Adaptation Plans.

26. Infrastructure rebuild projects are focused on reinstating infrastructure and restoring the benefits of the networks following the CES and are ‘backwards-looking’.

27. The CES had a significant impact on flood risk within Christchurch. The LDRP is Council’s ongoing programme to evaluate these impacts and presents options to address them. Individual projects that are approved by Council are then delivered within the LDRP. This approval can be through the LTP (Christchurch City Council, 2018d) process or via specific reporting to Council seeking approval to draw down funding against the programme. More detail is provided on the LDRP below.

28. Council also delivers stormwater network services through both day-to-day and infrastructure Rebuild projects and processes that are evaluated against the level of service targets set within the LTP documents. The levels of service are described in the service plans for Stormwater Drainage and Flood Protection and Control Works (Christchurch City Council, 2018d). There are many levels of service that consider water quantity, however, the key level of service is 14.1.1 within Section 3 of the Flood Protection and Control Works Service Plan that is to reduce risk of flooding to property and dwellings during extreme rain events. A target of 50 houses per year is set within the current LTP (Christchurch City Council, 2018d). This is a significant, long-term commitment by Council in reducing flood risk across the city. This is evidenced by the result achieved in financial year 2017/2018, where the LDRP alone reduced predicted 2% AEP flood levels to below floor level for an estimated 81 houses at a cost of approximately $76million. In order to deliver these benefits on an ongoing basis Council will need to continue its investigation, design and delivery programmes (both day-to-day and infrastructure rebuild).

29. The Flood Intervention Policy (**FIP**) is an earthquake related policy adopted by the Council under the Local Government Act that benefits homeowners with properties at extreme flood risk that has been increased by the CES (Christchurch City Council, 2017b). This policy includes three forms of assistance, house raising, on property defence and voluntary property purchase. The policy is typically applied once LDRP

investigations into potential flood management schemes are complete and agreed by Council. The effect of the policy will be to reduce the number of properties at risk of above floor flooding. This policy and the LDRP are delivered independent of, and in parallel with, the SMP infrastructure programmes.

30. I highlight these Council activities as they show Council's long term commitment to managing flood risks across the city. These activities are not controlled by the proposed conditions, nor should they be as they are not in response to the effects of urban stormwater discharges (i.e. they are outside the scope of the Application), however they will reduce the sensitivity of the receiving environment to increases in discharge quantities and may help the Council to achieve some of the objectives of the discharge consent.

The Land Drainage Recovery Programme (LDRP)[7]

31. The LDRP is Council's response to earthquake impacts on open waterways and drains. These impacts include direct damage to waterways (such as bank slumping, culvert separation and bed heave), loss in waterway capacity due to changes in topography (from flattening of hydraulic grade) and changes in flood risk within the catchments upstream of the waterways. The LDRP excludes repair of piped networks as this was within the scope of the SCIRT[8] programme (Christchurch City Council, 2018c).

32. The LDRP includes catchment investigations, repair of damaged assets, restoration of waterway capacity and construction of new infrastructure to address change in flood risk arising from the CES. The total programme is estimated at approximately $1.2 billion and is likely to span decades. The programme will have invested approximately $150 million by the end of FY 2018/19. LDRP capital works were initiated in FY 2014/15 (Christchurch City Council, 2018c).

33. Projects within the programme are prioritised by a range of factors including alignment with other Council programmes and environmental benefit, but primarily by the number of primary habitable dwellings estimated to be at risk in predicted design rainfall events.

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[7] More information on the LDRP can be found online (https://cccgovtnz.cwp.govt.nz/services/water-and-drainage/stormwater-and-drainage/stormwater-projects) or within the summary report also available on line (https://cccgovtnz.cwp.govt.nz/assets/Documents/Environment/Water/Flooding-Land-Drainage/LDRP-Summary-Report-2018.pdf).

[8] The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) was the organisation funded by Central Government and Council that rebuilt $2.2 billion in horizontal infrastructure following the CES (Stronger Christchurch Infrastructure Rebuild Team, 2018).

34. The goal and vision of the programme are described in the LDRP Summary report that is available on Council's website (Christchurch City Council, 2018c). Generally, the programme aims to repair damage to waterways and to restore 'pre-earthquake' levels of flood risk. In the design of the individual projects it is not possible to exactly meet the 'pre-earthquake' flood risk standard across all exceedance probabilities and durations. There will be 'unders and overs'. For example, in order to restore pre-earthquake flood risk to the Flockton Street area it was necessary to reduce flood risk adjoining Dudley Creek downstream of the basin to below 'pre-earthquake' levels.

35. It is recognised within the management of the LDRP that there is a need to initiate works prior to the completion of full programme definition and that the programme needs to respond to external factors, e.g. further earthquakes or changing regulatory environments such as the formation of Regenerate Christchurch. This leads to uncertainty in what the nature of the stormwater network will be upon completion of the LDRP. The programme will address change in flood risk across many areas, but not all, and in order to do so new infrastructure will be commissioned and new management approaches adopted. As not all potential projects within the programme have been approved or designed it is not possible, at this point, to forecast the future stormwater network following completion of the programme.

36. As a result of the reactive nature of the programme, the long duration of the programme and the variance in flood risk outcomes from 'pre-earthquake' it is difficult for the Council to forecast within an SMP the infrastructure requirements to most effectively and efficiently provide for both stormwater management objectives, which are within the scope of this proposed consent, and LDRP objectives, which are outside the scope of this consent, to address any increases in flood risk due to future development. This highlights the importance of updating the SMPs throughout the consent period and the need to treat them as living documents.

37. The LDRP represents a very large investment by Council over the 25 year duration of the consent[9], which is outside of the proposed SMP infrastructure programme; however, Condition 22 and Schedule 7 do not attempt to differentiate between activities delivered by the SMP infrastructure programme and the LDRP. This means that all of Council's programmes and plans can be used to deliver against the attribute target levels set within Schedule 7. This is particularly pertinent for the

[9] Approximately $230 million identified within the 10 years planned by the LTP, which will equate to over $600 million if the budget is maintained over the 10 year to 25 year period.

attribute target levels that reference post-CES environmental conditions as the LDRP will, in all likelihood, not adversely affect flood levels at these locations.

38. I fully support the adaptive management ability in SMP development and SMP review, as the Council's development of infrastructure in the LDRP for brownfield areas is not currently fully known and will have a significant impact on the design of the stormwater network. This adaptive approach will enable future revisions of the SMPs to be able to provide a greater level of detail on Council's proposed method for addressing water quantity issues as there will be greater definition around other Council infrastructure programmes. Due to this it is my opinion that the SMPs are the most appropriate location to define additional water quantity attribute target level locations (i.e. additional points beyond the single points provided within Schedule 7).

39. As a further illustration of change over the period since the 2015 application, Council has agreed to progress a $72 million dollar package of works within the Ōpāwaho / Heathcote River catchment to address flood risk adjoining the river (Christchurch City Council, 2017d). This package of works was not explicitly identified within the LDRP or the LTP in 2015 but has since been investigated, designed, approved, and construction has been initiated. This package of works includes major upstream storage basins, dredging of reaches of the lower river and consideration of low stopbanks along parts of the Ōpāwaho. These works will form a new 'platform' or 'base case' from which a future SMP could propose additional works, but more importantly, it clearly illustrates Council's commitment to meeting its current level of service target for reduction in the number of properties at risk of flooding. This process has been led through the LDRP, which is independent from this application but is highly likely to achieve the same outcomes as might otherwise be promoted through a SMP with a reduction in the water levels at Ferniehurst likely to meet the requirements of the attribute target flood level set within Schedule 7 (as indicated by preliminary modelling of the upstream storage basins).

40. One of the desired outcomes of the Ōtākaro Avon River Surface Water Plan (as supplied within the Application) is that flood risk is reduced or, at least, returned to pre-earthquake levels. The current formulation of the LDRP and Council LTP levels of service will achieve this aim, assuming that funding for the LDRP is maintained over a number of subsequent LTPs.

Flood Model Development

41. Council's existing hydraulic models at the time of the 2015 application were of sufficient quality to support the Application and subsequent District Plan processes, however they were of mixed levels of detail. In order to inform future planning within the LDRP and to inform future planning processes (such as future updates to the SMPs) the Council initiated a project to update and enhance these models (excluding Banks Peninsula). The objective of this was to add a suitable level of detail to the models to:

41.1 Allow a thorough understanding of earthquake impacts on flood risk;

41.2 Create a standard set of models across the city;

41.3 Develop a tool suitable as a design tool for engineering design projects; and

41.4 Inform Council regulatory and planning processes.

42. This project has delivered improved models for the Sumner catchment and is soon to deliver for the Avon catchment. The Heathcote, Styx and Halswell models are at an earlier stage of development. It is not yet currently clear if sufficient budget will be made available to complete the Halswell and Styx model upgrades. These updated models will provide greater confidence in the predicted flood levels and allow the re-evaluation of the target water levels set within Schedule 7 of the proposed consent conditions. This is reflective of the cyclic nature of model development and as a result flood level predictions the absolute target levels will change with future model modifications. As a result I would not recommend a fixed or absolute water level to be used as an attribute target level within Schedule 7. In the interim the exiting models can be used to evaluate compliance with the proposed consent conditions (i.e. for testing the effects of future development) but will provide lower confidence in absolute flood level predictions.

43. These updated models will enable testing of a wider range of return periods and durations than previously considered with the existing models. This will enable understanding of flood risk to extend much further away from the main river stems. Revised planning for the LDRP and LTP will be required following completion of the project as it is highly likely that new projects will be required to address the newly gained understanding of flood risk, particularly in the upper catchments. Future land use and mitigation options will need to be tested to confirm Council's understanding

for planning purposes. Once this model interrogation and planning is complete Council will be able to update the relevant SMPs.

44. This methodology is signalled within the proposed consent conditions with a programme for update of the SMPs. This cyclic planning process is important as it enables up to date learning to influence environmental and social outcomes that are sought through implementation of the consent and associated consent conditions.

Council's Multi-Hazard Analysis

45. There are many parts of Christchurch that are at risk of multiple natural hazards (Christchurch City Council, 2017a). The impacts of non-flood hazards can alter flood risk, for example, future earthquakes could change the city's topography, or sea level rise will increase groundwater levels (The Parliamentary Commissioner for the Environment, 2015). Understanding these hazard interactions is important to decision making on how to best address water quantity issues over a time horizon of much longer than the proposed consent duration of this application; 100 plus years as opposed to 25 years. A 100 year time frame is important as it relates to the likely durability of the infrastructure being considered.

46. Council is progressing a Multi-Hazard Analysis within the LDRP in order to inform decisions on floodplain management within a multi-hazard environment (Christchurch City Council, 2017a). This work will be used to guide the LDRP infrastructure response and aid Council across a wide range of functions, such as floor level setting, district plan zoning and civil defence and emergency management. Potential outcomes from this study could include construction or re-construction of flood defences and development of new policies on floodplain management that are likely to form a new backdrop for future water quantity interventions.

47. In my opinion this work illustrates Council's ongoing commitment to investigating and addressing water quantity issues outside of the scope of the current application. This work will also inform future SMPs and aid in the development of more refined water quantity scenarios.

Other Significant Programmes and their Relationship to the Application

48. There are two other projects of significance currently underway, being, the Ōtākaro Avon River Corridor Regeneration Plan and the Southshore South New Brighton Regeneration Strategy.

49. These two projects do / will consider current and future flood risk, possible interventions and ways to adapt to sea level rise. The Ōtākaro Avon River Corridor Regeneration Plan may have been released for public consultation by the time of the hearing of this consent and is likely to promote stormwater quality and quantity devices as envisaged within the Ōtākaro / Avon SMP. The consultation on the plan to date has also signalled the inclusion of new stop banks that are located further away from the rivers edge (Regenerate Christchurch, 2018). The Council will have to give effect to the Regeneration Plan within the District Plan (New Zealand Government, 2016), thus there are current uncertainties with planning for water quantity and quality in the lower reaches of the Ōtākaro / Avon as the ultimate decision on the future use of the land within the regeneration Plan area for stormwater management purposes will be in the hands of the Regeneration Minister. If the Minister were to decide against utilising the land for the purposes of stormwater management then the available options for the Council to meet the targets set in Condition 16, Table 2 will be dramatically limited. This current uncertainty also precludes the setting of attribute target levels in the areas adjoining the lower reaches of Ōtākaro as they could be influenced by decisions on the Regeneration Plan through the setting back of the stop banks away from the river's edge.

50. The other significant planning process currently underway is the Southshore South New Brighton Regeneration Strategy. This strategy may lead to a Regeneration Plan. If this eventuates Council will again be required to give effect to the Plan. This has far less impact on the Application as there are no measurement points for water quantity attribute target levels about Ihutai set within Schedule 7. The absence of a target is valid given the potential for rising sea levels to dominate the outcome.

51. The adaptive management flexibility provided within the proposed consent conditions is subject to the fixed reductions required by Condition 16 Table 2. In the modelling that led to the Council proposing those reductions predictions had to be made concerning availability of land in the Regeneration Plan areas for stormwater mitigation purposes. As the regeneration planning outcomes are not within Council control the Council may need to seek a variation to the consent if the regeneration processes do not support the construction of water quality mitigation features.

52. At the time of writing the Ōtākaro / Avon SMP there was uncertainty with the potential outcomes from the SCIRT rebuild programme and this was identified as a principle issue (Christchurch City Council, 2015). Since development of that plan the SCIRT programme has ended, however uncertainties and opportunities within the other programmes described above, still exist.

Scope of the Application and Water Quantity Targets

53. Council, when constructing new flood management infrastructure, tests the works against flood level at the points of interest and does not necessarily seek to differentiate the sources of the individual flood waters (other than for the purposes of identifying mitigation options). The most appropriate time for establishing these points of interest is during the investigations phase (i.e. during the development of the SMPs). At this point the catchment issues are identified and appropriate attribute target levels can be set.

54. With greenfield development Council typically uses reasonable endeavours to mitigate the hydraulic effects and in some instances seeks a beneficial outcome in the downstream waterways (e.g. Awatea Basin). From a technical or hydraulic modelling perspective, it is generally not possible to design viable water quantity infrastructure to 'ensure' that there are no adverse impacts in all locations for all rainfall events and durations, hence the requirement for some increases in flood levels (as provided for within Schedule 7). This is more notably the case for brownfield infill development that is spread across a large catchment as there is rarely sufficient downstream land available to make large stormwater detention basins viable.

55. That said, for actual storm events, where the natural variability in rainfall and catchment condition is significant (e.g. antecedent soil moisture condition, weed growth or base flow) any water quantity effects from greenfield development (with appropriately designed, maintained and operated mitigation measures) away from the discharge point are unlikely to be separable from the other contributing factors in a measurable way. The natural catchment variability, in many instances, is likely to be greater than any real world impacts of the development. This is particularly the case for small storm events.

56. Widespread and low level permitted urban intensification (e.g. paving of back lawns) will place a strain on existing networks and could give rise to unintended or adverse

outcomes. Across a range of storm events there may be some flood reduction benefits achieved through the construction of water quantity features (Christchurch City Council, 2015) (DHI Water and Environment Ltd, 2014). Outside of the benefits of the water quality infrastructure, management constraints will be required to limit the downstream impacts of small scale infill development (as provided for in the District Plan). I support the targets for flood level increases that are included in Schedule 7 as more restrictive thresholds may not be workable. I also support the reasonable endeavours threshold included in proposed Condition 22.

57. This application seeks to manage the effects of water quantity through requiring the consent holder to use reasonable endeavours to mitigate the water quantity effects of the discharge and sets target flood levels against which the extent of mitigation of effects will be measured (Condition 22 and Schedule 7). Care should be taken when reading the attribute target levels in Schedule 7 as proposed in the July 2018 conditions. There are subtle differences between the way the target levels are worded with some of the target levels referring to water levels at specific dates and others referring to the impervious areas at specific dates. These differences have arisen as the proposed limits are replicated from the respective SMPs (and their consents already granted), which have been developed over time. In my opinion it is not inappropriate to have these differences in attribute target levels as they have been established during the development of the individual SMPs which identify specific issues of concern and develop attribute target levels in response to these. The Otukaikino and Banks Peninsula target levels refer only to the approach to mitigation and are not discussed further.

58. However, for ease of future interpretation and application of the consent I recommend that Schedule 7 be modified so that <u>all</u> the attribute target water levels that include physical measurement locations reference the impervious area at a given date. I also recommend modifying the assessment criteria to allow for any change in critical duration between scenarios (as the critical duration can alter with development and mitigation). I have provided a suggested updated table as **Appendix A**. The aim of these modifications is to target the assessment at the scope of the Application, i.e. the effects of urbanisation on stormwater discharge. My intention with the changes that I recommend in **Appendix A** is to retain in substance the same targets that were proposed in the Application. My recommended changes are for the sole purpose of improving clarity regarding the measurement required by Schedule 7.

59. In my opinion those recommended modifications will reduce the risk that future assessment of compliance with Schedule 7 is made difficult by the advent of sea level rise, significant change in the measurement point waterway or a future earthquake (that might change topography). The modifications also make clear that the impacts of mitigations that have been installed between the assessment date and the baseline date are allowed for in the assessment. My recommended comparison is between the modelled flood level at the time of the assessment against a baseline scenario that only alters the impervious area and allows for any mitigation measures or new network between the scenario dates, thus providing the most explicit assessment of the impacts of the development and mitigations up to that point.

60. Schedule 7 provides single measurement points within each catchment. These points are located at the long term measurement locations (as noted in paragraph 28 of Appendix 3 of the s42A report being the report of Mr Law). This provides for detailed statistical analysis however these sites are not always located at the areas of greatest flood risk. As described above the mitigation approach adopted by Council needs to respond to issues as they arise within each catchment. The most appropriate time to identify points of concern is during the development or update of the SMPs. If additional measurement points were added to Schedule 7 there is a risk that they could cease to be of concern (as flood risk may have been addressed through a separate Council programme) and would unnecessarily add to Council's administrative burden. I therefore no not agree with the recommendations in Appendix 3 of the s42A report at paragraphs 29 to 40 that there be more measurement points specified in the consent conditions but I do support there being any additions to the conditions needed to make clear that the Council ought to consider that when developing or changing an SMP.

61. The location of the measurement point relative to sea level is also highly important. If the measurement points were within the area of influence of rising sea levels then Council could be considered to have failed to achieve the target levels even if, hypothetically, development and infrastructure were not to change from the date of the consent becoming operational. Hence, the absence of a measurement point within Ihutai.

62. Schedule 7 addresses infrequent / large flood flows but not more frequent events. This was raised as a concern within paragraphs 23 and 44-46 of Appendix 3 within the s42A Officer's Report. This is not a gap as the Council has statutory duties

under both the Christchurch District Drainage Act and the Land Drainage Act to manage nuisances that arise through management of its stormwater network and any issues of that nature that arise can be dealt with outside of this Application. More frequent events that are not classified as a nuisance can be identified and addressed as part of developing or changing an SMP and this is the most appropriate time to do so, for the same reasons as provided above regarding measurement points (para 60).

63. It is my view that Council should be able to manage flooding to within the attribute target levels if the current levels of investment and planning regulations are maintained throughout the life of the consent.

64. Overall, Council's approach to stormwater quantity management includes many programmes, policies, rules and plans. These tools are used by Council to manage flood risk. Many of these activities are outside the scope of the application but they will aid in meeting the objectives of the Application.

Land Drainage and this Application

65. There is no clear distinction in definition between 'land drainage', 'stormwater drainage' and 'flood protection' that I am aware of within the current legislation[10]. However, the Land and Water Regional Plan (**LWRP**) (Canterbury Regional Council, 2017) does provide definitions for drains, drainage system and drainage water (Table 1):

Table 1 Definitions extracted from Section 2.9 of the LWRP

Drain	includes any artificial watercourse that has been constructed for the purpose of land drainage of surface or subsurface water and can be a farm drainage channel, an open race or subsurface pipe, tile or mole drain, or culvert.
Drainage system	means a surface or subsurface pipe or channel or canal system that has been constructed for the primary purpose of: 1. collecting or draining water and contaminants from agricultural or rural land and ancillary structures; or 2. controlling or permanently lowering the water table; and which conveys and discharges that water and contaminants to land or surface water. It excludes any system that has been constructed for the primary purpose of collecting, conveying or discharging stormwater.
Drainage water	means water and contaminants arising from the drainage of water from the soil profile, or excess surface water from agricultural or rural land. It excludes stormwater and sediment-laden water which are separately defined.

[10] My view is formed after consideration of the Local Government Act 2002, the Christchurch District Drainage Act 1951 and the Land Drainage Act 1908. Other Acts, bylaws, guidelines, specifications or codes may provide this definition.

66. I infer from the LWRP that 'land drainage water' is synonymous with 'drainage water' as it pertains to the comments in Appendix 4 of the s42A Officer's Report (being the memorandum of Ms. Irvine and Mr. Surman).

67. I note that 'Land Drainage' is excluded from the scope of the Consent (Condition 1) and the definition of stormwater network within the consent excludes networks designed specifically to intercept groundwater and discharge it into surface water, as noted by Mr. Surman in his note dated 5/9/2018 included within Appendix 4 of the s42A Officer's Report. Any of these activities will require separate resource consent from Environment Canterbury.

68. As an aside, the title of the LDRP included the words 'land drainage' to show the alignment of the programme with flood risk management and repair of infrastructure assets rather than to align with the definition inferred within the LWRP (Canterbury Regional Council, 2017). However, this does not mean that projects within the programme ignore the five other values of landscape, ecology, culture, heritage and recreation. The six values are applied with a wholistic design approach considered, and often implemented within projects delivered within the programme. For example, over 2,500 trees have been planted within LDRP projects over the land 3 years. The programme has created new wetlands and basins that have ecological, recreational and drainage benefits. An exemplar of this is Te Oranga Waikura (Linwood Lower Fields) which is an urban forest inside a stormwater basin and was delivered through a LDRP project (Christchurch City Council, 2018).

69. I also note that Mr. Harrington has provided a response to the issues of flows discharging to Huritini / Halswell River that are discussed in the s42A report of Ms Irvine and Mr Surman (Section 1).

DEVELOPMENT OF THE ŌTĀKARO AVON SMP STORMWATER QUALITY MITIGATION SCENARIOS

70. The Ōtākaro / Avon SMP includes a 'Stormwater Treatment Toolbox' (see section 4.2 of the SMP). The toolbox provides a range of infrastructure types that are prioritised in Table 2 of the SMP. The SMP then considers a range of potential water quality mitigation scenarios based upon various applications of the 'Stormwater Treatment Toolbox'. The water quality mitigation scenarios and their costs are outlined in Section 6.2.4 of the SMP (Christchurch City Council, 2015).

71. The importance of the toolbox is to highlight the range of possible treatment devices that could be used to deliver the water quality benefits that are required of the consent conditions. It also illustrates that the infrastructure that will be delivered by the end of the consent period can feasibly be varied from the preferred BPI water quality mitigation scenario.

72. Derivation of the individual infrastructure components utilised a Geographical Information Systems (GIS) data modelling based approach (Parsons & Christensen, 2014). The potential infrastructure response components were then assembled in differing priorities based upon opportunities for alignment with other Council programmes but all options assume a base of treatment within greenfield and redevelopment areas.

73. The water quality mitigation scenarios seek to maximise the benefits to the environment in a cost effective manner but still promotes investment in the order of $100 M in new infrastructure over 35 years in order to achieve an overall reduction in contaminants entering the receiving environment. There have been some notable changes within the Ōtākaro catchment since the 2015 application, being:

73.1 Progress has been made on the Ōtākaro Avon River Corridor Regeneration Plan. There has been signalled within the consultation material to date the inclusion of water quality features. Notwithstanding the final decision on the Plan being outside of Council's control, as discussed above, there may be an opportunity to include a large water treatment device on the land adjacent to Horseshoe Lake (which is included in the BPI water quality mitigation scenario);

73.2 The Cycleways programme has advanced and will not be an opportunity to deliver water quality infrastructure, as had been signalled in the Ōtākaro / Avon SMP; and

73.3 Upgrades to the capacity of Dudley Creek have been completed through the LDRP that have delivered a return to pre-CES levels of flood risk within the Flockton Street area. The effects of this will need to be addressed in the next update to the Ōtākaro / Avon SMP. The timing of the first update is the subject of the evidence of Mr. Harrington.

DEVELOPMENT OF THE ALTERNATIVE CITY-WIDE STORMWATER QUALITY MITIGATION SCENARIOS

74. As noted above, this application is founded on an assessment by the Council of what can be achieved if the Council uses Best Practice Infrastructure (BPI).

75. A simplified version of the methodology applied in the Avon catchment was applied across the area within the Christchurch Contaminant Load Model (**C-CLM**). The purpose of this was to inform additional water quality mitigation scenarios for the city and to explore the potential alternatives for increased infrastructure responses beyond the BPI water quality mitigation scenario. The benefits of increased infrastructure response scenarios are to reduce the concentration of contaminants discharging from the network. The scenarios and their benefits, are discussed within the evidence of Mr. Van Nieuwkerk and the economics of the scenarios is discussed within the evidence of Mr. Harris. The derivation of the water quality mitigation scenarios and their cost estimation are described below.

76. The purpose of the exercise was to present conceivable alternatives to the proposed BPI approach to water quality management but not to establish the feasibility of individual scenario components. At the catchment level or city level the analysis is intended to show the overall relationship between cost and the benefits for a range of mitigation options but not to prove what the final infrastructure outcome would be for an individual water quality mitigation scenario.

77. The BPI water quality mitigation scenario is described in the evidence of Mr. Van Nieuwkerk. This scenario represents a potential infrastructure scenario that can deliver the water quality improvements as described in Condition 16 Table 2. Broadly this option represents Council's current planned infrastructure response as set out in the LTP and SMPs. I built upon this scenario in the alternative water quality mitigation scenarios described in this section.

78. I developed two scenario components: proprietary filtration devices and rain gardens. I combined these individual components to form the additional water quality mitigation scenarios that extend the BPI scenario.

79. Locations for potential proprietary filtration devices were established through:

79.1 Inspection of the existing stormwater network and identification of stormwater outfalls 600 mm or larger in diameter (or a number of smaller outfalls in close proximity to each other of roughly similar combined capacity to a 600 mm diameter pipe);

79.2 Consideration of the upstream catchment and likely interception of flows at the location; and

79.3 Discarding outfalls that are located within private land or in areas where construction might be impractical (i.e. very busy roads or steep slopes).

80. I did not undertake a feasibility assessment on each location and nor did I account for geotechnical constraints / ground conditions, service relocations, site contamination, depth to invert, need or size of pumping (although pumping is assumed to be required in cost estimates) or hydraulic impacts. These or other factors could prevent construction of any individual device, however, as noted above the purpose of the exercise was not to show what 'will be built' but what might be achieved from different levels of infrastructure response.

81. I assessed potential rain garden locations through a simplified approach to that applied in the Ōtākaro / Avon SMP. The simplifications primarily related to the reliance on proximity searches rather than topographic data when deriving catchments for individual rain gardens. This simplification reduces the accuracy of individual rain garden catchments but not the overall outcome. This was validated by applying the simplified approach to the Avon catchment and comparing outcomes to the original approach. The difference in total cost was approximately 10% higher for the revised approach which is well within the accuracy of the assessment.

82. In addition, no assessment has been done of the feasibility of construction of rain gardens on steep slopes (with or without soakage to ground). Given the high uncertainties with feasibility and cost, I excluded raingardens in steep areas of the Port Hills in the assessment.

83. I then combined individual components in different water quality mitigation scenarios. The benefits of five different water quality mitigation scenarios were assessed by Golders (Golders, 2018). The costs for two of the scenarios were derived with the economics evaluated. The findings of these evaluations are the

subject of the evidence of Mr. Van Nieuwkerk and Mr. Harris. The two scenarios I supplied to Mr Harris for use in the economic evaluation were:

83.1 Full Treatment (**FT**): this represents widespread coverage across the built environment within the city of any single water quality scenario component. Simplistically this represents wide coverage of treatment via a single device (rain garden *or* proprietary filtration device *or* large community facility). This is roughly equivalent to Mitigation Scenario F from the Ōtākaro / Avon SMP (Christchurch City Council, 2015); and

83.2 Maximum Treatment Plus (**MT+**): this water quality scenario represents wide coverage of devices in series across the built environment within the city to form a treatment train (rain garden *and* proprietary filtration device / other large community facility).

84. The prioritising of rain gardens within the FT water quality mitigation scenario is based upon catchment contaminant generation of zinc:

84.1 Priority 1: catchments with zinc loading of greater than 0.2 kg/ha/yr were targeted within the first 5 years;

84.2 Priority 2: catchments with zinc loading of between 0.1 kg/ha/yr and 0.2 kg/ha/yr within years 6 – 10; and

84.3 Priority 3: catchments with zinc loading of less than 0.1 kg/ha/yr within years 11 – 35.

85. For prioritisation of the proprietary filtration devices I applied qualitative assessment of upstream catchment and buildability.

86. For the purposes of the model I assumed that the additional treatment devices proposed within the MT+ water quality mitigation scenario beyond the FT water quality mitigation scenario would be built in parallel with the priority 3 works. As a result the first 10 years of the two water quality mitigation scenarios are identical. If the MT+ scenario were to be pursued then prioritisation of device construction would more likely be driven by discharge water quality regardless of the construction of a treatment train, or otherwise.

87. The CAPEX costs for the individual devices were established using the same cost curves and district plan zoning as developed for the Ōtākaro / Avon SMP. The cost curves are based upon upstream treated impervious area and the methodology for establishing the total cost estimates. The assumptions and limitations that are set out in the Ōtākaro / Avon SMP apply to the development of the additional water quality mitigation scenarios (Christchurch City Council, 2015). The District Plan has been updated since the Ōtākaro / Avon SMP was developed and this is a limitation of this analysis.

88. It is possible to conceive of more extensive water quality infrastructure scenarios. These might include adding proprietary filtration devices at the outlet of large community facilities or to purchase land to allow additional facilities. These types of scenario are unlikely to be viable for Council and, in the instance of extensive land purchases, could have significant societal impacts. Another alternative could be a more rapid construction programme, e.g. constructing all the FT water quality mitigation scenario infrastructure within the first 10 years. This would increase the present day construction costs, but again, this is may not be viable for Council.

89. The two water quality scenarios combined with the BPI scenario highlight the diminishing returns and increasing costs associated with more extensive scenarios as described in the evidence of Mr. Harris.

90. This assessment is effectively an options level assessment. I consider that assumptions made in both the FT and MT+ water quality mitigation scenarios are optimistic. Site constraints and construction practicalities could preclude construction of a proportion of the devices. If the requirement to achieve these mitigation scenarios was embedded within the final consent conditions (i.e. more stringent requirements were set within Condition 16, Table 2) then Council is likely to have to consider more treatment locations than presented within the individual scenario, which could come at a higher cost. In addition to this, Council would need to initiate a substantial investigation and design programme beyond what it is currently resourced to undertake.

91. Regardless of the water quality mitigation scenario adopted the infrastructure constructed at the end of the consent will vary from what is presented within the particular water quality mitigation scenario. New opportunities and technologies may arise throughout the period of the consent which could achieve similar benefits and meet the objectives of the consent and individual site constraints will necessitate

modifications to the location of treatment facilities. However, the additional treatment scenarios provide a useful comparison to the BPI scenario.

THE PROCESS FOR AND CHALLENGES WITH RETROFITTING STORMWATER QUALITY MITIGATION DEVICES AND REDUCING THE WATER QUALITY IMPACTS OF EXISTING DEVELOPMENT

92. Broadly there are three types of stormwater quality mitigation devices: private devices (large and small), large community facilities and small public devices. Each have their own processes and challenges (paragraphs 153-164 of the s42A Report provide the Officer's view on this matter). Typically small public devices are constructed within the street and are sized to treat a small contributing area. Large community facilities treat large contributing areas and typically have a large footprint, however proprietary filtration devices, which are a technology that have a relatively small footprint per treated hectare and can be applied to treat large catchments, can sometimes be installed within a road corridor.

93. Private devices are required to manage new development in accordance with SMPs or Schedule 3 (as discussed in the evidence of Mr. Norton). The process for ensuring this occurs is through the triggering of resource consents by the District Plan rules. The challenges with doing so will be met by the individual developers for both small and large sites.

94. Large community facilities / devices are signalled through the LTP, service plans and SMPs. These devices often go through protracted approvals processes potentially including: specific Council and Community Board approvals, resource[11] and building consent processes, public consultation, gazetting, land access / acquisition processes (through the LGA, Resource Management Act 1991, LDA, CDDA or Reserves Act 1977), archaeological authority approvals, utility provider approvals, etc. Many of these approvals can be gained without significant adversity if Council owns the land. Large devices often take many years from conception to commissioning and are often planned many years in advance.

95. The greatest challenge for locating large public devices is having sufficient area to place them. Acquisition of land for this purpose is often fraught with challenges and can be particularly expensive and take a very long time. For this reason, large

[11] These can include both local and regional authority consents depending on a wide variety of factors, including: land zoning, reserves act requirements (for works in some parks), presence of contaminated land, district and regional plan overlays, groundwater interception, surface water diversion, etc.

community facilities are not often practicable in retrofit of existing urban areas, however they are still favoured above other treatment options as they can deliver across a wide range of values (as illustrated by the prioritisation given to these devices within the Ōtākaro Avon River SMP treatment toolbox (Christchurch City Council, 2015)).

96. Small public devices are often the only practicable option for existing developed urban areas. They have their own approvals challenges as they occupy space in the road corridor with inherent challenges with street parking and traffic safety, however, if they can be considered at the same time as road reconstruction or road narrowing then the approvals can be more streamlined. Overall, they are easier to approve but can have design challenges given existing services, ground conditions and groundwater levels that do not make them feasible in all areas. Given their distributed nature they can also be more costly to design, maintain and in some scenarios, construct.

97. Due to the above challenges and constraints, it is not practicable to retrofit water quality treatment devices across an entire catchment in a cost effective way. That said, retrofit of water quality devices has occurred in some catchments. Soakage to ground has been used in some western areas and stormwater devices have been built across the city. Some of the most notable recently built or currently under construction are: the Bells Creek Stormfilter and the Upper Heathcote Basins (Wigram Basin, Curletts Basin, and Eastman Wetlands). These schemes will retrospectively treat large areas of existing development (Golders, 2018). Council has already provided water quality treatment to large areas within the city. Approximately 15% of the built environment within the city is already covered by treatment of some description. Inclusion of the devices to be built within the next 5 years lifts this to approximately 25% and within 35 years it will be approximately 40% under the BPI scenario as discussed in the evidence of Mr. Van Nieuwkerk.

RESPONSE TO SUBMISSIONS

98. A number of submissions have been received with regards to stormwater quantity from community groups and residents from the Styx River catchments. I agree with the draft evidence provided by Mr. Harrington in response to these submissions. I would further note that:

98.1 The proposed conditions within Schedule 7 from the Application relating to water quantity match the existing catchment consent conditions and the level of risk that is accepted within the current consents held by Council will be continued with the proposed consent[12]. The only difference will be the varied consent duration with the old Pūharakekenui / Styx River consent due to expire in 2049 and, if granted, the new consent will expire in 2043; and

98.2 Further information is now available to inform future hydraulic modelling within the catchment. The hydraulic modelling used to inform the consent was described in my evidence from 2012. This evidence highlighted the calibration of the hydraulic model at that time. There have been additional wet weather and flood events that have occurred in the intervening period and flooding is raised as a concern within all the submissions listed above in paragraph 15.7. The model has not been re-calibrated since the original model development but has been tested against the June 2013 event. Testing of this event showed that the model was underpredicting peak water levels when compared against the recorded data by approximately 150 mm at Lower Styx Road (**Appendix B**). Given the modest size of this event it is likely that the instream conditions were materially affecting water levels at that point in time (i.e. they varied from the calibrated conditions) as described in the evidence of Mr. Harrington. This will need to be addressed in future model updates that will reconsider model calibration. Model updates are most likely to occur following a significant event or as part of updating the SMP (in accordance with the proposed condition 6(i)). I further note that the area of the lower flood plain provides a vast amount of flood storage and that this dominates flood level predictions in the lower river. In addition, this flood plain is well defined by a terrace on the western extent to changes in flood level are unlikely to materially alter the flood extent.

RESPONSE TO SECTION 42A OFFICERS REPORT

99. I agree with Mr Harrington's draft evidence in response to the Section 42A Officer's Report of Mr Laws.

[12] Should my proposed revision to Schedule 7 be adopted then similar outcomes can be expected as the intent of the conditions remains unchanged.

Thomas Geoffrey Parsons

15 October 2018

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Appendix A

My proposed clarification of schedule 7: Receiving Environment Attribute Target Levels for Water Quantity

<table>
<tr><th colspan="4">Attribute Target Level</th></tr>
<tr><td colspan="4">Modelled Catchments</td></tr>
<tr><td colspan="4">Flood levels for the 2% AEP for the assessment year critical duration event shall not increase more than the Maximum Increase listed below when compared to the modelled 20% AEP for the baseline year impervious scenario critical duration, as determined using CCC flood models. The baseline year scenario and assessment year scenario shall be identical except for changes to the impervious area, mitigation measures and the inclusion of any new network(s) that has arisen between the dates of the two scenarios and within the city limits. All non-variant scenario parameters shall be as at the assessment year scenario. The critical duration shall be assessed at the location of the attribute target level.</td></tr>
<tr><td>Receiving Environment</td><td>Attribute Target Level Location</td><td>Baseline year</td><td>Maximum Increase (mm)</td></tr>
<tr><td>Ōtākaro/ Avon</td><td>Gloucester Street Bridge</td><td>2014</td><td>50</td></tr>
<tr><td>Pūharakekenui/ Styx</td><td>Harbour Road Bridge</td><td>2012</td><td>100 +/- 20%</td></tr>
<tr><td>Ōpāwaho/ Heathcote</td><td>Ferniehurst Street</td><td>1991</td><td>30</td></tr>
<tr><td>Huritini/ Halswell</td><td>Minsons Drain confluence</td><td>2016</td><td>0</td></tr>
<tr><td colspan="4">Non-modelled Catchments</td></tr>
<tr><td>Receiving Environment</td><td>Attribute Target Level</td><td>Basis for Target</td><td>Notes</td></tr>
<tr><td>Otukaikino</td><td>Discharges from all new greenfield development into the Christchurch City Council network are mitigated using the "Partial Detention" strategy outlined in the Pūharakekenui/ Styx SMP</td><td>As measured through the CCC discharge authorisation compliance process for Resource and Building Consents</td><td>CCC does not monitor or model flooding in the Otukaikino River. Flooding occurs primarily due to backwater effects in the Waimakariri River. Therefore, a best practice approach to mitigation of development will be implemented.</td></tr>
<tr><td>Banks Peninsula (Various)</td><td>Discharges from all new greenfield development within settlement areas of Te Pātaka o Pākaihautū/ Banks Peninsula into the Christchurch City Council Network are mitigated using the "Extra-Over Detention" strategy</td><td>As measured through the CCC discharge authorisation compliance process for Resource and Building Consents</td><td>Receiving environments within Te Pātaka o Pākaihautū/ Banks Peninsula Settlements are primarily coastal. The strategy behind "Extra-Over Detention" is to mitigate peak flows from development sites back to pre-development flow rates in order to mitigate effects of flooding and waterway channel erosion. Therefore, a best practice approach to mitigation of development will be implemented.</td></tr>
</table>

Note: The Minsons Drain confluence with the Huritini/Halswell River represents the southerly extent of inputs from Christchurch City catchments, but also contains discharges from Selwyn District. Inputs from catchments outside of the city shall be isolated in the CCC stormwater model for compliance assessment purposes.

Appendix B

Styx River Model June 2013 model validation test