IN THE MATTER: of the Resource Management Act 1991 (**RMA**)

AND

IN THE MATTER: Proposed Plan Change 2: Pukehangi Heights to the Rotorua District Plan under Part 5, Sub-Part 5 – Streamlined Planning Process and Schedule 1 Part 5 of the RMA

STATEMENT OF EVIDENCE OF KATHLEEN THIEL-LARDON ON BEHALF OF BAY OF PLENTY REGIONAL COUNCIL – STORMWATER

18 September 2020

STATEMENT OF EVIDENCE OF KATHLEEN THIEL-LARDON

INTRODUCTION

1. My full name is Kathleen Thiel-Lardon.

2. I am employed by Bay of Plenty Regional Council (Regional Council) as a senior environmental engineer. I have held this role since September 2015.

Qualifications and experience

3. I hold a Diplom-Ingenieur / Master's Degree in Science majoring in civil engineering. I obtained this qualification from the University of Rostock (Germany) in 2005.

4. My degree has been assessed by the New Zealand Qualifications Authority as equivalent to a Bachelor of Engineering with Honours degree from a New Zealand university, Level 8, in May 2007.

5. I have been registered as a chartered professional engineer in New Zealand since 22 December 2011, and I am a chartered member of Engineering New Zealand (formerly MIPENZ) since December 2011.

6. I am a registered International Professional Engineer since 11 July 2019.

7. I have approximately 14 years' experience working as an engineer.

8. As a senior environmental engineer at the Regional Council, my responsibilities include:

   (a) Undertaking professional engineering design and investigations for river schemes, drainage, coastal and soil conservation activities;

   (b) Implementing appropriate engineering projects;

   (c) Providing technical advice to Council groups, outside organisations and the community for regional plans, strategies, policy development and processing of resource consents, including flood risk assessments and mitigation; and

(d) Providing supportive technical leadership to, and reviewing the work of, the Regional Council's junior engineering staff.

9. Prior to being employed by the Regional Council as a senior environmental engineer, my work experience included:

(a) Working as Senior Project Manager for one year for Beca Limited. This role involved me providing technical advice to various local government agencies for the preparation of 30-year Infrastructure Strategies and Asset Management Plans relating to the three water services which are made up of drinking water, wastewater and stormwater.

(b) Working as Engineer for two years for our family business, Professional Management Services 2009 Limited. This role involved me managing engineering projects, including sub-division developments and the preparation of a Catchment Management Plan for Western Bay of Plenty District Council's Central and Eastern Catchments.

(c) Working as Team Leader Engineering for three years for Spiire Limited (formerly CPG New Zealand Limited). This role involved me managing a team of engineers and managing engineering projects Spiire was involved with, including sub-division developments, capital works projects relating to the three water services and the preparation of a Catchment Management Plan for Western Bay of Plenty District Council's Western Catchments.

(d) Working for five years as a project engineer for CPG New Zealand Limited (formerly Duffill Watts Group / Duffill Watts and King Limited). This role involved me carrying out engineering work on a number of projects, many of which related to the three water services.

(e) Working for three years as a surveying technician for a regional council in Germany.

10. I have been involved with the Rotorua Lakes Plan Change 2 (Pukehangi Heights) (PC2) since June 2018. My involvement included pre-

lodgement feedback on scoping and methodology, input into Regional Councils submission and ongoing discussions after lodgement and submissions.

11. I have been involved in some discussions around Rotorua Lakes Councils Comprehensive Stormwater Consent since September 2017 as well as Rotorua Lakes Council's project to review the Flood Hazard Provisions in the District Plan and associated city-wide flood risk assessment discussions since May 2019.

12. I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014. I have complied with the Code of Conduct in preparing this evidence, and I agree to comply with it while giving oral evidence before the hearing committee. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

Assumptions and evidence considered

13. For the purposes of my evidence, I have considered the following:

    (a) Regional Council's Kaituna Asset Management Plan (Operations Report 2003/09), dated October 2003;

    (b) Regional Council's Rivers and Drainage Asset Management Plan 2018-2068, dated July 2018;

    (c) Rotorua Urban Area Stormwater Catchment Management Plan - Working Draft – for Consultation, dated 19 December 2018;

    (d) Results from the Greater Utuhina Catchment Model – pre-development and post-development (Scenario 15) dated 5 to 8 September 2020;

    (e) Results from the Catchment 14 and 15 model – pre-development and post-development (Scenario 15) received 11 September 2020.

    (f) Updated Stormwater Report and further evidence provided on behalf of Rotorua District Council dated 14 September 2020.

14. For the purposes of my evidence, I have **not** considered any effects related to stormwater quality, effects on stream base flows and ecological values of the receiving environment.

SCOPE OF EVIDENCE

15. My evidence will address the stormwater effects and proposed mitigation measures for PC2, specifically:

    (a) The role of BOPRC in managing stormwater and flood risk in the Rotorua area;

    (b) Existing Flood Risk in the Utuhina Catchment;

    (c) Effects of PC2 on the stormwater management network; and

    (d) Proposed mitigation measures

    Note figures referenced in my evidence below are set out in a separate technical appendix which accompanies this brief.

THE ROLE OF BOPRC IN MANAGING STORMWATER AND FLOOD RISK IN THE ROTORUA AREA

Overview of Legislative Roles and Responsibilities

16. Regional Council operates and maintains flood protection schemes for a number of rivers, including the Kaituna Catchment Control Scheme (previously Kaituna River Major Scheme).

17. For flood risk management, Regional Council maintains records of river flows, lake levels, rainfall and past floods. These records are used to build a range of models to predict and manage future flooding in areas serviced by a scheme and to issue flood warnings.

18. In relation to managing stormwater and flood risk, the Regional Council follows the Ministry for the Environment (MfE) recommendations in its guidance[1] on managing the effects of natural hazards, which includes as particularly relevant to PC2:

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1 MfE August 2008 "Meeting the Challenges of Future Flooding in New Zealand" and MfE May 2010"Preparing for future flooding: A guide for local government in New Zealand"

(a) Taking a long-term risk management perspective, including climate change, residual risk and having a 'no regrets' precautionary approach to risk and uncertainty;

(b) Respect environmental limits, and protecting the life-supporting capacity;

(c) Avoid making decisions that will make it more difficult for you or others to manage climate change flood risks in the future in particular that limit future adaptation; and

(d) Be based on the robust evaluation of options, costs and benefits over time and across the community.

Catchment and Site Context

19. The plan change area lies within the Utuhina Catchment a Tertiary (3rd order) Catchment of the Kaituna River catchment. The Kaituna River catchment area covers approximately 1,250 square kilometres (125,000 ha), including the catchments of the Upper Kaituna (Lakes Rotorua and Lake Rotoiti) and the catchment of the Lower Kaituna River ***(Figure 1)***.

The Kaituna River catchment, including the subject site, is serviced by the Kaituna Catchment Control Scheme. The scheme has been established under the Soil Conservation and Rivers Control Act to prevent damage by floods and prevent and mitigate soil erosion.

<u>Utuhina Catchment and Flood Protection Assets</u>

20. The Utuhina catchment area covers approximately 60 square kilometres (5955 ha). Several tributaries join the Utuhina Stream, including the Mangakakahi Stream and Otamatea Stream ***(Figure 2)***.

21. The Bay of Plenty Catchment Commission reports[2] identified approximately 220acres (89ha) of land being flooded in the Utuhina Catchment in 1967 (approximately 57ha connected to the Lower Utuhina floodplain), resulting in the design of flood protection assets. ***(Figure 17)***

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[2] Bay of Plenty Catchment Commission c 1969 - Kaituna River Major Scheme: Volume 5 - Plans Lakes Rotorua and Rotoiti and Upper Kaituna River Major Scheme: Volume 4 - Draft Report Lakes Rotorua and Rotoiti (A.P.Griffiths).

22. The majority of Utuhina flood protection assets are located in the lower part of the catchment downstream of State Highway 5 (Old Taupo Road) ***(Figure 3)***. They consist of stopbanks (compacted earth structures) along the left bank (western side) and the right bank (eastern side), and sections of concrete floodwall along the right bank downstream of Lake Road, where there was insufficient width available to build stopbanks. The protection assets were established between 1975 and 1989 in a piecemeal fashion as and when owner agreements were reached. Difficulties in securing landowner agreements for some sections of the Utuhina Stream led to the original designs never being completed.

23. Furthermore, the Kaituna Asset Management Plan (Operations Report 2003/09) identified structural concerns of the floodwall due to geothermal vents passing under the wall. The wall does not appear to be well-founded, few sections have a lean and a broken and/or deteriorated toe. These floodwall assets have been written off as they have no further use to the scheme. Affected landowners do not pay the higher targeted rates.

24. Significant changes in land-use have also occurred since the scheme was originally designed, resulting in additional runoff and volume being generated as well as floodplain encroachment. ***(Figure 4 to 7)***

25. An attempt to raise the stopbanks was made in In 2008/09. However, stopbanks were only raised where physically possible due to site constraints. As such, the scheme has still functional limitations.

26. Regional Council's Rivers and Drainage Asset Management Plan 2018-2068 provides for a level of protection to the floodplain from fluvial (riverine) flooding for the lower Utuhina (downstream of SH5) for up to 55m3/s of peak flow plus 500mm freeboard. This was estimated to be the 1% Annual Exceedance Probability (AEP) flood with no climate change allowance in 2014 and was tested utilising a Mike Flood hydraulic model (River Edge Consulting Limited, 2014) for the lower Utuhina reach. The existing flood protection scheme is currently not meeting this Level of Service, and as such, the flood carrying capacity could be described as over-allocated. In addition, it will be very difficult to increase the level of service of these assets over their current

performance due to the built-up nature and the geotechnical challenges presented by the existence of geothermal vents.

27. The low lying properties on the Lake frontage also receive flood mitigation benefits from the Kaituna Scheme through the control of the lake level.

28. A detention dam is situated on Mangakakahi Stream in Linton Park. I will refer to this detention dam as “the Mangakakahi Dam” in my evidence. The Mangakakahi Dam was designed and constructed by Rotorua Lakes Council in 1998 to control flood risk along the lower portion of the Mangakakahi Stream and does not form part of the river scheme managed by Regional Council. ***(Figure 8)***

29. The Pukehangi Plan Change area is located upstream of the existing urban area and is bordered by the Mangakakahi Stream to the North and the Utuhina Stream to the South.

30. The Pukehangi Plan Change Area currently has overland flow paths that directly flow from the upper catchment to the Mangakakahi Stream and the Otamatea Stream. Some sheet flow is directed towards the Utuhina Stream. ***(Figure 9-10)***

Greater Utuhina Catchment Model

31. Regional Council identified in its Long Term Plan (LTP) a project (Utuhina Capacity Review and Flood Risk Project) to consider the best approach to achieve the design flood protection standard, including assessing the flood risk for this catchment and investigating into catchment-wide mitigation options.

32. This project was introduced to Rotorua Lakes Council in July 2016 recognising that both Councils will have to work collaboratively with the community and iwi to provide for comprehensive flood risk management in this catchment.

33. As part of this project, Regional Council engaged Mr Philip Wallace of DHI Water & Environment Limited (now of River Edge Consulting Limited) to undertake a data GAP analysis and to extent the 2014 hydraulic flood model upstream of the urban environment and include the Mangakakahi Stream and Otamatea Stream. The Regional Council

is yet to receive the full modelling report, and peer review the results. This process has been delayed by the modelling runs processed for Rotorua Lakes Council to test the Pukehangi Plan Change impacts. ***(Figure 11)***

34. In parallel, Regional Council engaged Mr Peter West of Blue Duck Design Limited to design a Non-Linear Reservoir (NLR) hydrological model that can be used to provide a range of design storms and to be used as a Flood Forecasting tool. ***(Figure 12)***

35. Together the hydrological and hydraulic models are called the Greater Utuhina Catchment Model (GUCM). These two models were built and calibrated for current land-use and current climate change scenarios. It must be noted that these models were not purposefully built for the assessment of PC2 effects, but have been adjusted to aid a better catchment-wide understanding of the impact of PC2. Please refer to the evidence of Mr Wallace and Mr West for the Regional Council for further detail.

36. A 72 hour centrally located nested storm profile was used to generate the design storms.

37. The design storms, adjusted to incorporate future climate change predictions to 2130 (3.68-degree temperature increase), were generated by the NLR hydrological model and ran through the GUCM hydraulic model for the existing urban environment. Please refer to the evidence of Mr Mark Ivamy for the Regional Council for further detail on Climate Change.

38. The NRL hydrological model was then adjusted to account for the future urban environment and re-run through the GUCM hydraulic model. Please refer to the evidence of Mr West for further detail.

EXISTING FLOOD RISK

Summary

39. The Utuhina Catchment has a long history of flooding, with both Councils having committed projects to identify options for mitigating existing flood risk. Hydrological and hydraulic performance of the Utuhina Stream, Mangakakahi Stream, Otamatea Stream, and their

tributaries and associated catchments within the urban extent is reasonably well understood, based on the modelling investigations that have been carried out. The existing flood risk can be described as follows:

(a) The existing flood protection scheme is currently not meeting its intended Level of Service and floodwaters are predicted to spill out of the stream channel and to overtop flood defences.

(b) Fluvial (riverine) flooding is affecting critical infrastructure, such as Edmund Road, Ford Road, Sunset Road and State Highway 5 (ponding behind and overflowing the embankments) as well as a number of buildings during the current climate events.

(c) The flood carrying capacity of the lower reaches of the Utuhina, Otamatea, and Mangakakahi Streams can be described as over-allocated in its current stage. This means this catchment has reached its environmental limit, and there is no room to accommodate additional runoff and increased peak discharges within the existing environment.

(d) Significant fluvial flooding is affecting critical, cultural and social buildings, and a large number of residential, commercial and industrial buildings as well as critical infrastructure when climate change is considered. Based on the built environment (functional compromised buildings), flood risk is considered high. Some roads are also considered unsafe for vehicles and people to pass.

(e) Approximately 1700 buildings are susceptible to fluvial flooding in the Utuhina Catchment (the majority downstream of PC2 area), based on the extent of flooding where flood depths exceed 100mm in response to a 0.2% AEP 2130 event. Approximately 250 buildings are “functionally compromised” based on the extent of flooding where flood depths exceed 500mm in response to a 1% AEP 2130 event. More buildings are expected to be “functionally compromised” in the industrial area as buildings are generally built with slab-on-ground concrete floors.

(f) Stormwater management constraints and overland flow path issues exist, resulting in additional buildings being susceptible to flooding.

(g) Overland flow paths are originating upstream of PC2 land that are likely to result in flooding if not managed appropriately as part of the detailed design.

Existing Environment – Streams and Floodplains

40. The analysis of the 10% AEP current climate event shows that the Utuhina Stream is contained within its channel. However, both the Otamatea and Mangakakahi Stream are likely to overflow its banks due to constrictions at road crossings and at the Mangakakahi Dam. Overtopping of road embankments is evident at Edmund Road, Ford Road and Sunset Road. ***(Figure 21)***

41. The Mangakakahi Stream is likely to overflow State Highway 5 in response to the 2% and 1% AEP current climate event. These events are also expected to result in spilling of floodwaters into the industrial area near Riri Street and minor spilling in the Lower Utuhina. ***(Figure 22 and 23)***

42. Efficient road crossings[3] within the urban extent should allow for the passage of the 10% AEP event without heading up and the 1% AEP with heading up to a maximum 0.5m below the road surface to allow for the flood carrying capacity of the stream and safety. As detailed in paragraph 40 and 41, the flood carrying capacity is compromised.

43. The existing receiving environment of the Lower Utuhina, Otamatea, and Mangakakahi Streams has no room to accommodate additional runoff and increased peak discharges from PC2.

44. For the 1% AEP 2130 event the following is noted:

(a) Significant spilling into the floodplain is evident throughout the urban extent. A number of roads including State Highway 5 are inundated by floodwaters, some greater than 500mm deep. The flood protection assets in the Lower Utuhina are ineffective. ***(Figure 24)***

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[3] Bay of Plenty Regional Natural Resources Plan 2008, NZTA Bridge Manual 3rd Ed 2018

(b) The velocities within the stream channels are generally below 2m/s. Within the Mangakakahi floodplain, there are localised areas of high velocities (greater than 2m/s) in the upper urban area. ***(Figure 25)***

(c) The modelling shows that the duration of floodplain spillage with floodwaters above 50mm is generally around 9 to 12 hours in the Lower Utuhina with pockets of land ponding for more than 48 hours. State Highway 5 is inundated for approximately 6 hours and Edmond Road is inundated for up to 12 hours with ponding behind the embankments lasting longer than 48 hours. The Mangakakahi Dam ponds for 48 to 72 hours in some parts. ***(Figure 26)***

Existing Flood Risk - Primary and Secondary Hazard Analysis (fluvial flooding only)

45. To quantify existing flood risk for riverine flooding in this catchment, I have used the base case model results from the GUCM and have applied the risk assessment methodology set out in Appendix L of the RPS for the built environment. I have not assessed Lifeline Utilities or Health and Safety.

46. It must be noted that actual flood risk for this catchment is likely to change due to pluvial flooding as a result of existing stormwater management constraints and overland flow path issues outside the modelled floodplain that have not been considered in this analysis due to the lack of data available at the time of the assessment.

47. The Hazard Susceptibility Area (HSA) is defined as the maximum spatial extent of a particular hazard. For riverine flooding in the Utuhina catchment, this has been taken as the extent of flooding where flood depths exceed 100mm in response to a 0.2% AEP event for the existing urban environment with future rainfall (2130 climate change). Buildings that are partially or entirely within the HSA were counted and categorised as either social or cultural buildings, buildings of miscellaneous use or critical buildings. Approximately 1700 buildings are susceptible to fluvial flooding in the Utuhina Catchment (the majority downstream of PC2 area). ***(Figure 27)***

48. The extent of the HSA was also used as the extent of the Natural Hazard Zones (NHZ) and the Hazard Assessment Area (HAA) to allow for a catchment-wide assessment.

49. To determine the consequence in the built environment, I have then counted the buildings that are "functionally compromised" during the 1% AEP event for the existing urban environment with future rainfall (2130 climate change). In line with Bay of Plenty Regional Council's Natural Hazard Risk Assessment User Guide, a compromised building functionality for flood hazards occurs as soon as floodwater depth exceeds building ground floor level. Due to unknown floor levels, I have used a quantifier of "functionally compromised" in reference to a building when the predicted depth of flooding at the building footprint equals or exceeds 500 mm. Approximately 250 buildings are "functionally compromised". ***(Figure 28)***

50. It must be noted that buildings in the industrial zone are likely to be "functionally compromised" during lower flood depth as these are generally built with slab-on-ground concrete floors. It is possible that a 100mm flood depth may enter such buildings. As such, the building count might be underestimated in this area. ***(Figure 29)***

51. The consequence level was assigned based on the percentage of buildings within the HAA that were functionally compromised In accordance with Table 21 (consequence table) of the RPS-Appendix L.

52. The risk level has then been determined using the risk matrix contained in the RPS-Appendix L. ***(Figure 36)*** For the primary analysis the risk has been determined as medium, triggering the need to undertake the secondary analysis.

53. I have then undertaken the secondary analysis using the 2% AEP and 0.2% AEP event for the existing urban environment with future rainfall (2130 climate change). Including the secondary analysis the risk level has been determined as high. ***(Figure 30, 31 and 34)***

54. For comparison purposes, I have also assessed the risk for the 1% AEP event for the existing urban environment with the current climate and the 1% AEP event for the future urban environment with future rainfall (2130 climate change) for the primary analysis only. It must be noted I have

used the same HSA for this comparison. The current climate is determined as low risk and the future urban environment results in a high risk. ***(Figure 32, 33 and 35)***

Existing Flood Hazard Vulnerability Thresholds (fluvial flooding only)

55. Human interaction with the floodplain and the associated exposure to the flood hazard within the floodplain can create hazardous conditions. Fast-flowing shallow water or slow-flowing deep water can equally present a hazard. As such, considering the flood depth and velocity in combination (D × V product) is recommended to assess Vulnerability Thresholds.[4]

56. The maximum D × V product for the 1% AEP current climate event identifies that the majority of fluvial flooding would generally be safe for vehicles, people and buildings. Some unsafe areas exist along the stream edges, but generally do not affect roads or buildings. ***(Figure 37)***

57. For the 1% AEP 2130 event the maximum D × V product identifies that a number of roads become unsafe, including Edmund Road, Riri Street, Ford Road, Sunset Road, Wrigley Road, Malfroy Road, Depot Street, Geddes Road, Karaka Street, Whittaker Road, and Ariariterangi Street. However, during the design storm, none of the existing buildings are vulnerable to structural damage. ***(Figure 38)***

Existing Landslide Susceptibility

58. The area below Pukehangi Road is generally classed to have a very low risk to landslides, apart from some areas immediately downstream of Pukehangi Road that are classed as low to moderate. Low to moderate risk also exists adjacent to the Lower Utuhina and a tributary of the Otamatea Stream at Ewert Street. Moderate to high risk exists adjoining the Managakakahi Stream approximately 250m downstream of Pukehangi Road. ***(Figure 39)***

Existing Environment – Stormwater Catchments

[4] Australian Institute for Disaster Resilience - GUIDELINE 7-3 Technical flood risk management guideline: Flood hazard

59. In support of the Comprehensive Stormwater Consent application, Rotorua Lakes Council has provided a Catchment Management Plan (CMP) in January 2019, which I have drawn on for the following section.

60. The Utuhina Stream Catchment includes Rotorua Lakes Councils urban catchments 11, 12, 13, 14, 15, 16 and 17. ***(Figure 13)***

(a) Catchment 11: Stormwater flows are directed through geothermal lakes into Utuhina Stream. Some erosion issues have been identified, but no specific flooding issues are stated in the CMP for this catchment. Flood maps from Rotorua Lakes Council are not available.

(b) Catchment 12: The low gradients and high stream levels in the Utuhina Stream causes poor hydraulic performance of the stormwater system resulting in ponding in Elizabeth Street area, Whakatau Street area and the lower end of Miller Street. This catchment has also been identified as a significant contributor to overflows at the Wastewater Treatment Plant due to the infiltration of stormwater into the wastewater system. This catchment is also likely to receive crossflow from Catchment 8 adding to flooding issues.

(c) Catchment 13: This catchment has some stormwater network capacity and ponding issues at John Paul College. Sediment and debris issues in the open drains, as well as the Utuhina Stream, have resulted in flooding in the past. Flood maps from Rotorua Lakes Council are not available.

(d) Catchment 14: This catchment experiences significant capacity issues at the culverts under Sunset Road and Ford Road. There are also known groundwater issues with seasonal springs occurring in some sections of Tawavale Street.

(e) Catchment 15: This catchment has some stormwater network capacity and overland flow path issues at the corner of Clayton Road and Mountain Road. The high stream levels in the Mangakakahi Stream causes poor hydraulic performance of the stormwater system and flooding at Riri Street just downstream of the Mangakakahi Dam.

(f) Catchment 16: Little is known about this catchment. The open drain at Amies Road has capacity issues due to silt discharge from the adjoining industrial land. There is a possibility of crossflows from Catchment 15 in large events. Flood maps from Rotorua Lakes Council are not available.

(g) Catchment 17: This catchment comprises of small stormwater systems that discharge directly to the lake. This catchment is protected from the Utuhina Stream by stopbanks. In larger events overflow is likely to occur from Catchment 16 as well as the Utuhina Stream.

61. The Hazard Susceptibility Area (HSA) due to pluvial flooding for Catchment 14 and Catchment 15 show a number of additional buildings are susceptible to flooding. Some are directly identified in the immediate downstream environment in Catchment 14. ***(Figure 45 and 46)*** However, no analysis has been made on flood risk in line with paragraph 46.

62. All streams within the urban area are being utilised as drainage paths for stormwater management. As such other urban catchments within the Utuhina Catchment (11, 12, 13, 16 and 17) could also be affected by the PC2 development. ***(Figure 13)***

Existing Environment – PC2 area and immediate adjacent land

63. The Mangakakahi Stream is bordering the PC2 area to the West and the Utuhina Stream to the East. The preliminary Flood Risk Assessment (fluvial flooding only from the GUCM) has identified that the areas adjacent to the main streams are not susceptible to flooding. However, some areas upstream of Pukehangi Road are shown as susceptible to flooding, including the Freedom Lifestyle Village site that has been included into the PC2 area post notification. It must be noted that the GUCM does only cover a very small portion of the PC2 area and it is likely that existing overland flow paths result in additional areas being susceptible to flooding on PC2 area. ***(Figure 18-20)***

64. The western part of the plan change area (approximate 84 ha plus additional 8.8ha for the freedom lifestyle village site) discharges stormwater into the Managkakahi Stream catchment upstream of the

Mangakakahi Dam and also into the Otamatea Stream catchment. These are Rotorua Lakes Council's stormwater catchments 15 and 14 respectively. Two discharge points are culvert crossings underneath Pukehangi Road that lead into tributaries to the Mangakakahi Stream and two discharges flow into the Mangakakahi Stream itself. Another discharge point is into the stormwater system at Hoyte Place and Hodgkins Place (Otamatea Stream catchment). The existing overland flow path is through private property between Pukehangi Road and Hoyte Place based on 2011 Lidar information. ***(Figure 9)*** Catchment 14 model results for the 1% AEP 2130 pre-development identifies flood depth through these overland flow path below 100mm. The model also identifies an overland flow path from Hodgkins Place to Tawavale Street through private property. Residual flood risk exists for these adjacent properties from potential blockages of existing culverts underneath Pukehangi Road.

65. The eastern part of the plan change area (approximate 76 ha) discharges stormwater into the Otamatea Stream catchment. Two discharge points are into the stormwater system at Pegasus Drive. The existing overland flow path is through private property between Pukehangi Road and Pegasus Drive based on 2011 Lidar information. ***(Figure 10)*** Catchment 14 model results for the 1% AEP 2130 pre-development identifies flood depth through these overland flow path below 150mm. Residual flood risk exists for these adjacent properties from potential blockages of existing culverts underneath Pukehangi Road. The flow currently discharging at Matipo Avenue will be redirected to Pegasus Drive.

66. There are no direct discharges proposed into the Utuhina Stream.

ASSESSMENT OF STORMWATER EFFECTS OF PC2

Context and approach to assessment

67. Control of the additional volume of runoff created by PC2 is necessary to ensure that urbanisation of the site does not result in adverse effects on the receiving environment, in this case, the Managakakahi Stream, Otamatea Stream, Utuhina Stream and Lake Rotorua itself and contributing urban stormwater catchments (11, 12, 13, 14,15,16 and 17).

68. At the moment, there is no overarching stormwater management plan that demonstrates that the proposed stormwater management is the best practicable option, taking into consideration the existing site features and the constraints of the receiving catchment as a whole.

69. Where I have enough information, I have provided an opinion on the effects of PC2 on velocity, flood depth, and flood extent for various probability events for the existing urban environment with the current climate, for the existing urban environment with climate change to 2130, and the future urban environment with climate change to 2130.

70. In order to do so, I have examined the difference maps between pre-development and post (PC2)-development (Scenario 15) model results from the GUCM that identify changes in flood depth and velocity ***(Figure 40 and 41)*** as well as the pre – and post Hazard Vulnerability Classification maps ***(Figure 37,38, 43 and 44).***

71. Limited information was available on the duration effect as model runs were unable to run sufficiently long due to time constraints. The 1% AEP 2130 event is the only run that allows information on the duration effect. I have examined the difference map from the GUCM that identify changes in flood duration for this event. ***(Figure 42)***

72. Difference maps for Catchment 14 and 15 were provided for two post-development scenarios, Scenario 15 and Scenario 16. As Scenario 16 was not modelled in the GUCM, and therefore, its effects in the lower reaches are unknown, I have not considered Scenario 16 any further.

73. Pre- and post- (Scenario 15) model results from Catchment 14 and 15 were also shared. I have produced two maps that overlay the areas that are covered by more than 500mm of flood depth during the 1% AEP 2130 and 0.2% AEP 2130 design events. ***(Figure 47 and 48)***

Summary

74. From the information available, the assessment of effects identifies that the post-development Scenario 15 will not cause detrimental effects to the receiving environment. The effects can be described as follows:

    (a) There is a general improvement in relation to peak depth in parts of the stream floodplains.

(b) There is a general improvement in relation to velocity in parts of the stream floodplains.

(c) Flood hazard and hazard vulnerability classification appear unaffected.

(d) There is an increase in the duration of flooding in some parts of the catchment. – The scale of effects is not well understood. In my opinion, the future stormwater management plan for the Development Area should include runoff reduction measures and further effects assessment on duration.

Effects on PC2 land

75. Comparison of pre- and post PC2 on PC2 land

(a) There are existing overland flow paths through the PC2 area. The proposed urban land form and overland flow path alignments have not been provided to date and as such no detail assessment of pre- and post-development comparison can be made.

Effects on Streams and Floodplains

76. Comparison of pre- and post PC2 on streams and floodplains downstream (GUCM)

(a) <u>Depth:</u> My analysis of the pre- and post-difference maps identifies that the PC2 development has a general improvement in relation to peak depth in parts of the stream floodplains apart from two isolated areas.

(i) In the 1%AEP current climate event an increase in flood depth is shown in the Utuhina Stream floodplain just upstream of the confluence with the Otamatea Stream. Mr Wallace describes this as a peculiarity of the timing of the three main catchments, as such no increase in flood depth of any concern is foreseen.

(ii) In the 0.2%AEP 2130 event an increase in flood depth is shown in a tributary of the Mangakakahi Stream floodplain just downstream of Pukehangi Road. This is a result of an increased discharge, a higher peak and larger volume post-development compared to the pre-development case. The effect is localised and confined to the gully.

(iii) Changes in flood depth less than 10mm have not been evaluated and are considered to be negligible effects.

(b) Velocity: My analysis of the pre- and post-difference maps identifies that the PC2 development has a general improvement in relation to velocities in parts of the stream floodplains. There are some isolated areas that show a negligible increase.

(c) D x V (hazard vulnerability): The maximum hazard vulnerability during a flood may not occur at the peak flow rate or the peak flood level, but on some combination of Depth x Velocity (D x V) during the flood event. As such, even with improvements in peak depth and peak velocity, any changes in timing of a flood may result in changes to the D × V values. My review of the pre- and post-development D x V maps identifies that there are no noticeable changes to the hazard vulnerability.

(d) Duration: Assessment was only undertaken for the 1% AEP 2130 scenario (GUCM). The impact of the increased runoff volume from the developed site is an elevated flow in the downstream reaches for a longer period compared to the existing condition. This is evident in the difference map along the floodplain, in particular in the reach of the Mangakakahi Stream that is subject to high and medium landslide risk and the Mangakakahi Dam with a flood duration change of more than 3 hours in parts. Edmond Road, Ford Road and Sunset Road are expected to overtop for longer (less than 2.5, 1.5 and 1 hour/s, respectively). There are some areas downstream of Mangakakahi Dam, including affected buildings at Riri Street that are predicted to increase in flood duration of up to 1.5 hours. Some affected buildings at Sunset Road are also predicted to increase in flood duration of up to 1.5 hours. In the Lower Utuhina some affected buildings are predicted to increase in flood duration of up to 1.0 hour. The changes to the overtopping of Lake Road and State Highway 5 are predicted to be less than 0.5 hours.

Effects on Stormwater System

77. Comparison of pre- and post PC2 on RLC stormwater system (Catchment 14 - Otamatea)

(a) Immediately downstream of PC2

The immediate downstream flood depth shows an improvement post-development. However, details of secondary flow path and emergency spillways leaving the site are not yet finalised. As such, I cannot determine whether or not adverse effects to the immediate adjacent properties exist. It is expected that the residual risk to these properties will be higher due to the additional runoff being generated on site.

(b) Throughout the stormwater catchment

The comparison of the pre-development and post-development flood extent for the 1% AEP 2130 and 2% AEP 2130 greater than 500mm of depth has shown that there is a negligible effect, that does not increase risk to flooding of buildings higher than 500mm above ground level.

78. Comparison of pre- and post PC2 on RLC stormwater system (Catchment 15 - Mangakakahi)

(a) Immediately downstream of PC2

Model simulations have shown that the immediate downstream flood depth shows an improvement for all but the 0.2% AEP 2130 event, where increases greater than 0.15m are expected to occur in one of the tributaries of the Mangakakahi Stream.

In addition, details of secondary flow path and emergency spillways leaving the site are yet to be finalised. As such I cannot determine whether or not adverse effects to the immediate adjacent properties exist. It is expected that the residual risk to these properties will be higher due to the additional runoff being generated on site.

(b) Throughout the stormwater catchment

The comparison of the pre-development and post-development flood extent for the 1% AEP 2130 greater than 500mm of depth has shown that there is a negligible effect that does not increase risk to flooding of buildings higher than 500mm above ground level.

79. Comparison of pre- and post PC2 on RLC stormwater system (Catchment 11, 12, 13, 16 and 17)

(a) No analysis has been undertaken for these catchments to date. An extended duration of high flows within the stream could hold up stormwater discharges for longer and in return result in longer ponding. The extended duration could also result in deeper ponding if rain was still falling in these catchments.

PROPOSED MITIGATION MEASURES IN PC2

Summary

80. Mitigation has been tested for Scenario 15 and has been shown not to cause detrimental effects to the receiving environment. However, flexibility and potential off-site mitigation are envisioned as part of the PC2 mitigation package. In my opinion, flexibility for on-site mitigation is supported to allow for targeted runoff reduction measures to be applied, provided that:

(a) Downstream effects can be managed comprehensively; and

(b) Testing is undertaken for a range of appropriate conservative design storms to ensure potential adverse effects are mitigated and flood risk is not increased downstream.

81. In addition, specific performance measures and design criteria are recommended to provide certainty. Off-site mitigation and deferral to other future planning processes, such as a district-wide Stormwater Master Planning process, cannot be wholly relied on as a mitigation response due to uncertainties on how and when these can be delivered.

Tested Mitigation - Scenario 15

82. The proposed mitigation options are described in WSP stormwater report as Scenario 15 and Scenario 16. Both options rely on a conceptual representation of dry attenuation basins (ponds and dams) at the same location. Only scenario 15 has been tested through all three models available. Scenario 16 has not been tested in the GUCM, and as such effects on streams and floodplains are not fully understood.

83. Figure 2.3 and 2.4 of the WSP report shows the post-development hydrological catchment routing and discharge points. Using existing infrastructure crossings and maintaining these discharge points has been a key consideration of the mitigation option to prevent further downstream effects. However, the report also identifies that the location, size and sub-catchment approach presented could change during detail design. For example, this could result in discharges that are currently flowing into the Mangakakahi Stream or its tributaries being taken to the Otamatea Stream or vice versa in the western part of PC2. As such, the cumulative effects assessment undertaken to date cannot be relied on to ensure the development is managed comprehensively not to increase flood risk downstream.

84. The WSP report makes the following recommendations, which I agree with for the stated reasons below:

(a) <u>A specific Stormwater Management Plan for the proposed development.</u> – In my opinion, an overarching stormwater management plan is required that demonstrates that the proposed stormwater management is the best practicable option, taking into consideration the existing site features and the constraints of the receiving catchment as a whole.

(b) <u>Adopting a water sensitive design approach across the whole plan change area.</u> - In my opinion, stormwater management for the PC2 area need to include runoff reduction measures to reduce the impact of an extended duration of flooding.

(c) <u>Assessments of the existing overland flow paths, downstream of the plan change area to determine suitability for passage of the over-design event.</u> – In my opinion, the residual risk to the immediate downstream property owners will increase due to the additional runoff being generated by PC2. It needs to be identified that the emergency flows can safely pass within the road corridor and through private property.

Whether Off-side mitigation is appropriate for PC2

85. Flexibility and potential off-site mitigation are envisioned as part of the PC2 mitigation package. While I can agree to flexibility within the development site provided that downstream effects can be managed comprehensively and appropriately, I cannot agree that off-site mitigation should be considered appropriate for PC2 for the following reasons:

    (a) The flood response of this catchment is complex, and the existing flood risk level is high.

    (b) No detailed assessment of opportunities available throughout the catchment for mitigation of the already existing flood risk and mitigation of already permitted developments within the existing urban environment has been completed to date.

    (c) Without having done any in-depth assessment, limitations are evident within the Mangakakahi Stream, Otamatea Stream and Lower Utuhina:

        (i) Otamatea Stream: Following the PC2 development the Otamatea Catchment is almost entirely urban in nature. There is no upstream catchment that can be used for mitigation. During the 1% AEP 2130 event several roads are overtopped, some considered unsafe. Within the urban extent there are only two recreational reserves of sufficient size that have the potential to help reduce existing flood risk. Robust testing would be required to assess effects on the wider catchment. ***(Figure 49)***

        (ii) Mangakakahi Stream: The Mangakakai Stream has an upstream catchment that has the potential to help reduce existing flood risk. However, finding feasible options for detention dams will be difficult due to upstream steep grades and associated landslide susceptibility. Areas that are gentler in grade tend to accommodate rural buildings in close proximity to overland flow path and streams. There might be some opportunities within the existing urban extent. However, due to the floodplain encroachment below the Mangakakahi Dam there is limited ability to improve capacity. Increased storage within the Mangakakahi Dam and upstream of the dam between Goldie Street and Edmund Road seems feasible. Robust testing would be required to assess effects on the wider catchment. ***(Figure 50 and 51)***

(iii) Lower Utuhina: There is limited opportunity to improve flood protection assets due to the built-up nature and the geotechnical challenges presented by the existence of geothermal vents. Furthermore, modelling of the 1% AEP event current climate identifies that the Mangakakahi Stream is overflowing State Highway 5 due to capacity limitations. Also, any stormwater runoff from local catchments would either need to be pumped or stored behind the stopbanks until water levels recede. There are no obvious feasible opportunities for flood risk reduction in the Lower Utuhina, triggering the need to look catchment-wide.

86. In my opinion, the existing flood risk, the constraints and environmental limits within the downstream environment, and the limitation of opportunities within the Mangakakahi Catchment upstream of the urban extent highlights the importance for on-site mitigation.

87. In line with MFE Guidance, any opportunities that do exist in this catchment to increase flood mitigation capacity needs to be preserved to deal with the effects of climate change, the existing urban environment and future infill within the catchment. Options that limit further adaptation in the future should not be locked in.

88. In my view following on-site mitigation, there should be no increase in velocity, flood depth and flood extent in the downstream catchment in order to avoid making flood risk mitigation for existing and future (within current urban extent) environment harder. This should be tested for a

range of appropriate conservative design storms. For the avoidance of doubt, the term no increase has embedded a 10mm tolerance for flood depth.

89. However, any residual impacts on streams after implementing mitigation may require other solutions such as instream erosion protection works.

Appropriateness of relying on other Future Planning Processes as a vehicle for mitigating effects of PC2

90. The evidence of Mr Mark Pennington identifies that Rotorua Lakes Council are in preliminary stages of preparing a district-wide stormwater masterplan to identify integrated flood management solutions to facilitate future urban growth while also addressing existing floodable areas where possible.

91. The Utuhina Capacity Review and Flood Risk Project led by Regional Council is a joint authority management response to the flooding issues specific to the Utuhina catchment. The project was established to assess existing flood risk, evaluate options and develop a comprehensive flood risk management plan through collaboration between both Councils, Iwi, stakeholders (such as scheme beneficiaries and targeted ratepayers) and the wider community.

92. Both of these planning processes above are considered long-term processes that require extensive community consultation and robust evaluation of options, costs and benefits as well as technical and planning analysis and will be subject to LTP and annual plan constraints for both Councils.

Why it is essential to prescribe performance standards and design criteria for PC2

93. If insufficiently mitigated the potential adverse effects of the Plan Change could include:

    (a) An increase in velocity, flood depth, and flood extent resulting in:

        (i) Increasing stream bank erosion and channel instabilities from faster flows or higher flood levels;

(ii) Larger areas that are flooded above the key flood hazard threshold for depth and velocity (D × V) for people, property and infrastructure that may lead to (or contribute to) loss of life, personal injury, damage to property, disruption of day-to-day life to individuals and businesses, and the provision of community infrastructure.

(iii) Increasing infiltration of stormwater (inundation of gully traps) to the wastewater system due to higher flows;

(iv) A decrease of cultural wellbeing due to loss of nationally significant taonga such as cultural buildings; and

(v) A decrease of emotional wellbeing of affected downstream landowners and business owners.

(b) An increase in duration resulting in:

(i) Holding up stormwater discharges to the streams due to elevated and longer duration backwater;

(ii) Increasing stream bank erosion and channel instabilities from extented periods of elevated flows;

(iii) Increasing infiltration of stormwater to the wastewater system from extented inundation of gully traps and the potential of wastewater overflows; and

(iv) Increasing the length of time buildings and structures (such as the Mangakakahi Dam, bridges/culverts, road embankments, flood walls and stopbanks) might be flooded above the key flood hazard threshold for depth and velocity (D × V) that may lead to (or contribute to) a reduced performance of the asset or failure of the asset and longer exposure to hazardous conditions.

94. A significant amount of time has been spent to calibrate the GUCM and define a suitable design storm that can represent this complex catchment as addressed in the evidence of Mr Peter Blackwood, Mr West and Mr Wallace.

95. A similar amount of consideration has been given by Regional Council's stormwater experts to the Soil Conservation Service (SCS) rainfall-runoff method used by Mr Liam Foster.

96. In order to provide sufficient certainty to future designers and to ensure that the intended objectives of the Plan Change can be achieved, Regional Councils stormwater experts have collectively designed specific performance measures and design criteria that the future Stormwater Management Plan should adhere to.

97. Without such controls, any designer will not be able to rely on the specifically designed and tested parameters for this specific catchment and instead rely on more generic standards which might not be appropriate and could misrepresent the effects.

98. Regional Council's Hydrological and Hydraulic Guidelines and Stormwater Guidelines from 2012 are due for updating and being currently reviewed. Amongst other things, this includes a review on how to describe appropriate design temporal rainfall profiles in line with Mr Blackwood evidence.

99. The existing Rotorua Engineering Code of Practice[5] is outdated. It should not be relied on for setting design standards, for example, the Code requires the secondary flow path from surface water to be protected for the 2% AEP event[6] not the 1% AEP that should be considered under NZS 4404:2010[7] and the primary analysis for flood risk under the RPS Appendix L. It is understood that the Code is currently being reviewed.

RECOMMENDED CHANGES TO PC2

100. In my view, the potential effects listed in paragraph 93 are particularly relevant to this plan change and the impact on the downstream environment. In my opinion, the suggested amendments to PC2 as set out in the evidence of Mr Nathan Te Pairi are appropriate and necessary to mitigate these potential effects.

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[5] Rotorua Civil Engineering Industry Standard 2000 Version 2004

[6] Chapter 1.15 Protection of Property from Inundation from Surface Water and Appendix 15 W1 Subdivision and Development Standards

[7] New Zealand Standard – Land Development and Subdivision Infrastructure

101. The complexity of the catchments warrants specific performance measures and design criteria to provide sufficient certainty for future designers. I therefore support inclusion into PC2 of the suggested amendments made by Mr Nathan Te Paire.

CONCLUSION

Existing Flood Risk in the Utuhina Catchment

102. The existing downstream environment shows significant constraints in regards to existing flood risk throughout the urban environment.

103. A number of road crossings are undersized, resulting in ponding and overtopping the embankments including critical infrastructure, such as State Highway 5.

104. The existing flood protection scheme is currently not meeting its level of protection to the floodplain from fluvial (riverine) flooding for the lower Utuhina (downstream of SH5) for up to 55m3/s of peak flow plus 500mm freeboard.

105. As such, the flood carrying capacity of the lower reaches of the Utuhina, the Otamatea, and the Mangakakahi Streams can be described as over-allocated. This means there is no room to accommodate additional runoff and increased peak discharges within the existing environment.

106. Taking a long-term risk management perspective, including climate change and residual risk identifies that this catchment is considered high risk.

Effects of PC2 on the stormwater management network

107. Hydrological and hydraulic performance of the Utuhina Stream, Mangakakahi Stream, Otamatea Stream, and their tributaries and associated catchments within the urban extent is reasonably well understood, based on the modelling investigations that have been carried out.

108. Three models, the Greater Utuhina Catchment Model, Catchment 14 (Otamatea) and Catchment 15 (Mangakakahe), were used to test the effects of PC2.

109. The effects on Rotorua Lakes Councils urban catchments 11, 12, 13, 16 and 17, which are part of the Utuhina Stream Catchment remains untested.

110. Based on the information available, the testing of post-development on-site mitigation Scenario 15 has identified no detrimental effects on the receiving environment from increased flood depth and velocity.

111. There are some effects of unknown scale from an extended duration that have not been fully considered. A future effects assessment will be required.

Proposed mitigation measures.

112. Flexibility for on-site mitigation is encouraged to allow for targeted runoff reduction measures to be applied, provided that downstream effects can be managed comprehensively, and testing is undertaken for a range of appropriate conservative design storms to ensure potential adverse effects, including cumulative effects, are mitigated, and flood risk is not increased downstream.

113. Any opportunities that do exist in this catchment to manage flood risk are required to provide for the effects of climate change, the existing urban environment and future infill within the catchment. Options that limit further adaptation in the future should not be locked in.

114. The reduction of existing flood risk needs to be based on the robust evaluation of options, costs and benefits over time and across the community and will be subject to LTP and annual plan constraints for both Councils. As such off-site mitigation and deferral to other future planning processes, such as a district-wide Stormwater Master Planning process, cannot be wholly relied on as a mitigation response due to uncertainties on how and when these can be delivered.

115. Regional Councils stormwater experts have collectively designed specific performance measures and design criteria for the future Stormwater Management Plan to provide sufficient certainty to future designers and to ensure that the intended objectives of the Plan Change can be achieved.

DATE 18 September 2020

KATHLEEN THIEL-LARDON