BEFORE THE COMMISSIONERS ON BEHALF OF THE DUNEDIN CITY COUNCIL

UNDER the Resource Management Act 1991

IN THE MATTER Of Variation 2 to the Dunedin City Council's 2 GP

STATEMENT OF EVIDENCE OF DR JEAN-LUC PAYAN ON BEHALF OF OTAGO REGIONAL COUNCIL

Dated 30 November 2021

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Statement of Professional Qualifications and Experience

1. My full name is Jean-Luc Payan. I am employed by the Otago Regional Council (ORC) as Manager Natural Hazards and have been in the role for approximately 5.5 years. My role responsibilities include the investigation, response and management of natural hazards in Otago. Prior to this position, I was employed by the ORC as an Investigations Engineer in the Natural Hazards Team from October 2008 to June 2016.

2. I hold the qualification of PhD in hydrology specialising in hydrological modelling from the French Institute of Forestry, Agricultural and Environmental Engineering (AgroParisTech, Paris), and of Master of Engineering in water sciences and environment from the French School of Water and Environment Engineering (Strasbourg).

3. I have over 14 years of professional experience in river management and flood hazard mitigation and natural hazards risks management in both local government and private sector. During this time:

    3.1. I have investigated and assessed the flood hazard in different parts of the Otago region including on the Taieri Plain and for the Dunedin urban streams (Water of Leith, Lindsay Creek and Kaikorai Stream). This work included several site visits of different parts of the above-mentioned catchments and areas. When required, I have developed hydraulic river models to inform the flood hazard assessment and decision-making.

    3.2. I was also involved in various investigations, analysis and modelling related to the performance and management of the Lower Taieri Flood Protection Scheme and, the East and West Taieri Drainage Schemes since 2008 and to the upgrade of the Leith Flood Protection Scheme since 2010.

    3.3. I have advised the Dunedin City Council (DCC) on natural hazards matters during the current review of the Dunedin District Plan (Second Generation District Plan, 2GP). The information included a detailed description of the flood hazard characteristics of different areas of the Taieri Plain and associated maps. I attended the 2GP hearing sessions on natural hazards in April 2017 and presented evidence in relation to Taieri Plain flood hazard. I am also participating to the 2GP appeal process on natural hazards and stormwater matters on behalf of ORC.

    3.4. I am participating, in collaboration with DCC, to the South Dunedin Future Programme. My main role is to lead the programme of

technical work focusing on natural hazards and climate change. This work aims at understanding how the physical environment is changing now and in the future in order to inform (short and long term) decision-making for the appropriate adaptation of the South Dunedin and Harbourside areas.

3.5. I am responsible of the provision of timely river flow and lake level forecast and likely natural hazard consequences during rainfall events across Otago. I was heavily involved in and assisted the response to recent heavy rainfall events, in particular the July 2017 and November 2018 events and associated flooding that affected the Otago region and the Taieri floodplain in particular. This work involved flood forecasting, information distribution and post event data collection and assessments.

Code of Conduct

4. I confirm that I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court's Practice Note of 2014 and agree to comply with it. I have complied with the Practice Note when preparing my written statement of evidence, and will do so when I give oral evidence.

5. The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in the evidence to follow.

6. Unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope

7. The scope of this evidence relates to following matters:

7.1. Justification for the need for proper, effective and site-specific stormwater management (quantity) for subdivision, use and development of land

7.2. Comment on the appropriateness of the stormwater management approach in Variation 2 to ensure effective stormwater quantity management

Material considered

8. In preparing this evidence, I have reviewed the following documents:

8.1. Variation 2 to the Second-Generation District Plan (2GP),

8.2. The s42A report prepared by Emily McEwan and Paul Freeland,

8.3. Statement of evidence of Jared Oliver for Dunedin City Council,

8.4. Statement of evidence of Jacinda Baker for Dunedin City Council

8.5. Statement of evidence of Michelle Mifflin, Manager Engineering at the Otago Regional Council, and,

8.6. Statement of evidence of Anita Dawe, Manager Policy and Planning at the Otago Regional Council.

Justification for the need for proper, effective, and site-specific stormwater management (quantity) for subdivision, use and development of land

9. Subdivision, use and development of land, particularly of greenfield sites, impact stormwater runoff: in general, those activities can result in higher peak flows, larger runoff volumes and faster runoff.

10. Subdivision, use and development of land can adversely affect the flood hazard characteristics (inundation depth, velocity, duration, and frequency of flooding) off-site (upstream and downstream) if not managed effectively. The flood impacts associated with stormwater runoff can be localised (impacting few sections for example) but also affect large parts of catchments.

11. The severity of these impacts is influenced by several site and catchment specific parameters such as the catchment characteristics (e.g. topography, waterbodies configuration, soil types, land use, antecedent hydrologic conditions), the climatic characteristics (e.g. precipitation variability, duration and intensity) and the presence and operation of flood hazard mitigation and stormwater management infrastructure.

12. In an urban or semi-urban setting, relatively small modifications to the hydrological characteristics of a catchment (e.g. increased imperviousness, obstruction or redirection of overland flow paths or filling of land depressions) can result in large impacts on the flood hazard characteristics off-site.

13. Several small changes to the hydrological characteristics of a catchment occurring over time and/or at different locations can also result in large impact on the flood hazard characteristics (cumulative effects).

14. Increased and concentrated stormwater runoff can also exacerbate bank erosion and stability of the receiving waterbody.

15. Proper and effective management of stormwater runoff is necessary to avoid effects on people, property, and infrastructure.

16. Initial principles for proper and effective management of stormwater runoff were presented in ORC submission on 2GP variation 2 (March 2021, https://www.dunedin.govt.nz/__data/assets/pdf_file/0006/809322/809321-V2-S271-Otago-Regional-Council-04.03.2021.pdf)

17. In addition to those principles, it is critical that the management of stormwater is designed by accounting for the specificities of the site and its associated catchment(s) as explained in paragraphs 10 to 14.

18. It is also critical that the likely effects of the subdivision, use and development of land on the flood hazard characteristics off-site are assessed and understood in the early stages of proposed land development in particular prior to resource consent being granted. This will ensure that appropriate consideration has been given to the effects of the development on stormwater runoff and likely adverse effects off-site and to propose an effective stormwater management plan. I concur with the evidence provided by Jared Oliver (DCC) and Jacinda Baker (DCC) on this point (paragraphs 220 and 221 of their evidence).

19. In the following paragraphs, I have illustrated, from an operational perspective, the points presented in paragraphs 10 to 14 by describing the specificities of key catchments located in the Dunedin City District that can potentially interact with stormwater management. I have focussed on the Taieri Plain, Water of Leith (including Lindsay Creek) and the Kaikorai Stream catchments.

Taieri Plain

20. The Taieri Plain is a low-lying, relatively flat floodplain located to the west of Dunedin City (Figure 1). Parts of the floodplain were of a swampy nature prior to European settlement[1] with no or limited natural drainage.

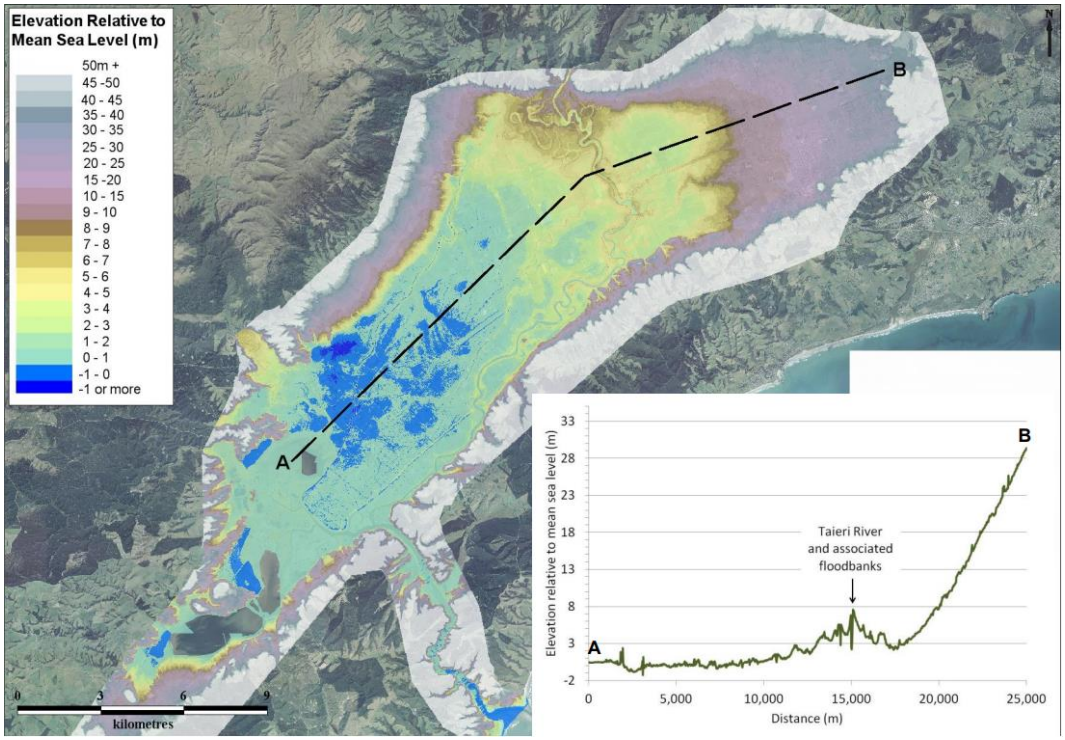

Figure 1. Elevation of the Taieri Plains (main image) and cross section A-B from south-west to north-east (inset). Land elevation is in metres, relative to mean sea level (ORC, 2013)

[1] Natural Hazards on the Taieri Plains, Otago – March 2013

21. The flood hazard on the floodplain is widespread and varies across the plain. Refer to ORC 2013[2] and ORC 2015[3] for a detailed description of the hazard across the plain.

22. The floodplain is surrounded by relatively steep hills who can receive large amounts of rain during long periods (over 24 hours typically).

23. Stormwater runoff generated by the hills has generally limited ability to flow once it reaches the floodplain. It combines with rainfall accumulation on the floodplain resulting in ponding of water in low lying areas for long periods of time (several hours to days typically, Figure 2).

Figure 2. Example of extensive ponding due to Owhiro Stream overtopping its banks and combining with runoff from the hills - Taieri Plain 22 July 2017 – Gladstone Road South and South Island Main Trunk Railway in the foreground. Owhiro Stream in the foreground looking upstream

24. In parts of the floodplain, such as on the East Taieri, the runoff from the hills is conveyed to the main rivers and streams through a network of natural overland flowpaths or swales, drains and depressions (Figure 3). This network although not specifically designed for this purpose, provides an important function to convey, temporary store and attenuate stormwater runoff. It is vulnerable to blockage or redirection by structures (such as bunds, fences, buildings) or earthworks affecting the flood hazard characteristics (Figure 4).

[2] Natural Hazards on the Taieri Plains, Otago – Otago Regional Council, March 2013
[3] Flood hazard on the Taieri Plain – Otago Regional Council, August 2015

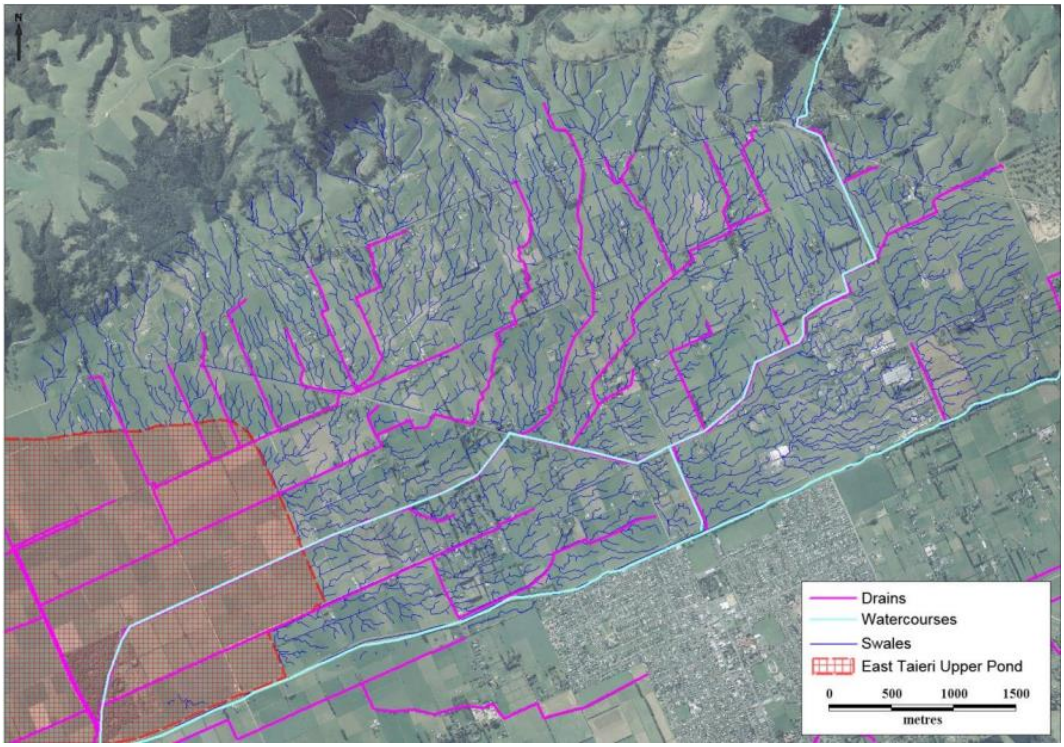

Figure 3. Watercourses, drains and swales on the East Taieri Plain. Swales also cross the plain on the south side of the Silver Stream (including through parts of Mosgiel), although these features are not shown (ORC, 2013)

Figure 4. Example of drains and overland flowpaths on the Taieri Plain observed in July 2007. Blockage being removed from a drain

25. Intensification of farming and urbanisation (e.g. Mosgiel area) have resulted in the modification of the natural drainage systems and in the construction of flood mitigation infrastructure now part of the Lower Taieri Flood Protection Scheme (LTFPS) and the West and East Taieri Flood Protection Schemes

(WTDS and ETDS respectively). Refer to Michelle Mifflin's evidence for a description of these schemes and infrastructure.

26. The LTFPS consists of a series of flood banks, spillways, gates, and ponding areas that assist the orderly passage of flood water across the Taieri floodplain (Figure 5). It is important to note that the LTFPS relies on the availability of large storage areas (the East Taieri Upper Pond and the East Taieri Lower Pond) in addition to an extensive network of floodbanks.

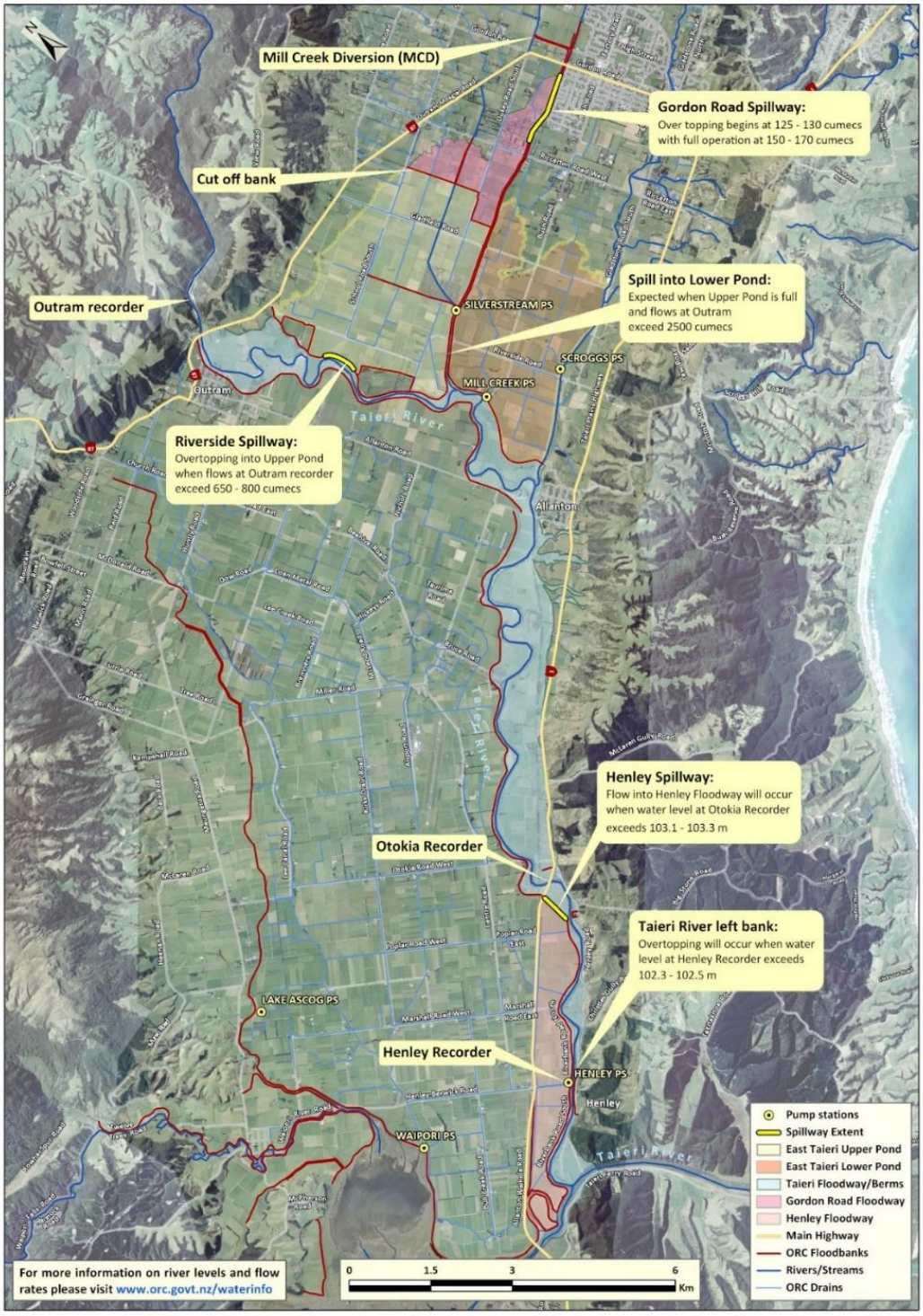

Figure 5. Infrastructure part of the Lower Taieri Flood Protection Scheme, West Taieri and East Taieri Drainage Schemes.

27. As explained in Michelle Mifflin's evidence, the LTFPS generally operates independently of the WTDS and ETDS: the LTFPS is designed to provide variable level of flood protection across the floodplain and the drainage schemes are designed to provide land drainage at a rural standard. By their nature and location, the schemes however interact during heavy rainfall events.

28. In general, the ability of the drainage schemes to operate fully during heavy rainfall event is reduced due to the quantity of water and to high water levels in rivers and streams.

29. For example, the outlet of Owhiro Stream (part of the ETDS) into the Taieri River is controlled by the Owhiro Stream Gated Outfall Structure (OSGOS). This structure is designed to prevent flow from the Taieri River entering the East Taieri Lower Pond, while providing the capability for the Owhiro Stream to discharge by gravity into the Taieri River whenever water levels in the river are lower than those in the stream. When the structure is closed this part of the ETDS cannot discharge which restricts the Owhiro Stream, its tributaries and associated drains to flow (backwater effects). During heavy rainfall events, water starts to overtop and reach the East Taieri Lower Pond.

30. Similar interaction between the LTFPS and ETDS also occurs on the true right (north) bank of the Silver Stream: the East Taieri Upper Pond collects most of the runoff conveyed by the ETDS network and overland flowpaths (Figure 3).

31. It is critical to control the amount of water spilling into the LTFPS ponding areas due to those interactions with the drainage scheme in order to ensure sufficient storage is available to reduce flooding from the main Taieri River, which is the main purpose of the ponding areas.

32. As subdivision, use and development of land will generate higher peak flows, larger runoff volumes and faster runoff, understanding and ensuring that their impacts on the WTDS, ETDS and LTFPS and in particular on the ponding areas are properly managed is critical to ORC.

Water of Leith, Lindsay Creek and Kaikorai Stream

33. The catchment characteristics and flood hazard associated with the Water of Leith, Lindsay Creek and Kaikorai Stream are described in ORC 2014[4].

34. Much of the floodplain areas (downstream parts) of those catchments is used for residential, commercial, and educational purposes and is traversed by important lifeline infrastructure (including the Dunedin hospital, state highways, and electricity and telecommunications links).

35. The associated floodplains are relatively narrow with steep hills in the upstream parts of the catchments. These characteristics result in the Water

[4] Flood hazard of Dunedin's urban streams – Otago Regional Council, June 2014

of Leith in particular to having the potential to behave, in times of flood, as a mountain torrent[5].

36. Large amounts and intense precipitation can affect the catchments resulting in the fast generation of high flows (within few hours of the onset of rain).

37. Damaging floods occurred in the catchments in the past affecting parts of Dunedin. Damages impacted houses, bridges, and other channel structures. Severe bank erosion can also be observed after floods.

38. For the Water of Leith and Lindsay Creek, during large flood events, the steep upper reaches can produce large volumes of debris. Debris accumulations around bridges or other instream structures, although partly mitigated by debris traps constructed by ORC, are likely to result in full or partial blockage of the creek channels. Floodwater would then back up behind the debris and this could lead to floodwater spilling onto the floodplain.

39. High flow velocities in the streams can cause bank erosion affecting properties and structures close to the channel or resulting in premature overtopping and inundation of the floodplain.

40. It is also important to note that those creak and streams, in particular Lindsay Creek and sections of Kaikorai Stream have a relatively narrow channel particularly susceptible to blockage (full or partial) (Figure 7). All the three rivers have a history of overtopping their banks with some sections of Lindsay Creek having limited capacity below what usual for today's urban areas[6] (Figure 6).

[5] Flood hazard of Dunedin's urban streams – Otago Regional Council, June 2014
[6] Lindsay Creek Flood Mitigation – Works Programme, Costs and Benefits – Engineering and Hazards Committee, Otago Regional Council, January 2013 and Lindsay Creek Flood Hazard Report, Otago Regional Council, April 2001

Figure 6. Example of section of channel limited capacity - Lindsay Creek in the vicinity of Palmer Quarry Bridge, looking upstream during a moderate high flow event in July 2017. Flow is less than 20cumecs

Figure 7. Example of a narrow section of Lindsay Creek and house located immediately next to the main channel of Lindsay Creek

41. River-control works of various scale have progressively been undertaken within the channel Water of Leith, Lindsay Creek and Kaikorai Stream with a formal flood protection scheme in place for the Water of Leith only (Leith Flood Protection Scheme).

42. As subdivision, use and development of land will generate higher peak flows, larger runoff volumes, faster runoff and exacerbate bank erosion, understanding and ensuring that their impacts on the flood hazard off-site, channel capacity and stability and flood protection scheme are properly managed is critical to ORC and the community.

Comments on the appropriateness of the stormwater management approach in Variation 2 to ensure effective stormwater quantity management

43. As explained in my evidence, it is important that the proposed approach for stormwater management in Variation 2 recognises the need to manage stormwater in a way that ensures, for both the current climatic conditions and climatic conditions based on climate change predictions, personal safety, minimises the risk of surface water flooding to acceptable levels, protects public and private property from inundation, ensures the resilience of infrastructure, and minimises adverse effects to the environment from stormwater runoff.

44. The approach should specifically recognise the need for a risk-based assessment to determine to what extent measures are needed to manage flows downstream of the land. It requires that the proposed stormwater mitigation and management measures will not create or exacerbate adverse effects that are more than minor off-site. This includes consideration of cumulative effects.

45. Rule 9.9 X contains most of the principles for proper and effective management of stormwater runoff presented in ORC submission on 2GP variation 2 (paragraph 16). However, some modifications are requested. Refer to Anita Dawe's evidence for the requested changes.

Conclusion

46. Subdivision, use and development of land, particularly of greenfield sites, impact stormwater runoff.

47. Proper and effective management of stormwater runoff is necessary to avoid effects on people, property, and infrastructure.

48. The challenge of proper and effective management of stormwater runoff is site and catchment specific.

49. It is critical that the management of stormwater is designed by accounting for the specificities of the site and its associated catchment(s).

50. It is also critical that the likely effects of the subdivision, use and development of land on the flood hazard characteristics off-site are assessed and understood in the early stages of proposed land development in particular prior to resource consent being granted.

Jean-Luc Payan

Dated: 30/11/ 2021