BEFORE THE INDEPENDENT HEARING PANEL APPOINTED BY THE QUEENSTOWN LAKES DISTRICT COUNCIL

UNDER	the Resource Management Act 1991 (RMA)
IN THE MATTER	of the Te Pūtahi Ladies Mile Plan Variation in accordance with section 80B and 80C, and Part 5 of Schedule 1 of the Resource Management Act 1991.

STATEMENT OF EVIDENCE OF JOHN FRASER GARDINER
29 September 2023

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Introduction

1 My name is John Fraser Gardiner.

2 I am a Director of Candor[3] consultants. I have been in this position since 2011 and am responsible for overseeing all facets of the business with a particular emphasis on the civil engineering functions.

3 I have been involved in the Te Pūtahi Ladies Mile Masterplan (**Masterplan**) and Te Pūtahi Ladies Mile Plan Variation (**TPLM Variation**) from the initial engagement of the Ladies Mile Consortium by QLDC on 7 August 2020. The Ladies Mile Consortium (**LMC**), is a group of consultants being Candor[3], Brown and Company Planning and Studio Pacific Architecture.

4 As the Director of Candor[3], I was the lead engineer on the LMC project team, where my role was to ensure that the development of the Masterplan and TPLM Variation documents were underpinned by sound best practice engineering solutions, while having regard to the comprehensive and integrated nature of the master-planning that the LMC team were tasked to undertake.

5 I have been asked to provide evidence relating to the 3 Waters component (and in particular stormwater) of the TPLM Variation by Queenstown Lakes District Council (**QLDC** or **Council**). I also make some comment about the earthworks required to implement development across the area subject to the TPLM Variation (the **TPLM Variation Area**).

Qualifications and experience

6 I have a Bachelor of Civil Engineering from Auckland University, am a Chartered Professional Engineer and am a member of Engineering New Zealand.

7 I have 34 years experience working as a civil engineer on many hundreds of land development and civil engineering projects, both in New Zealand and offshore. I have specialised in large scale land development and have worked on several of New Zealand's largest development projects including Dannemora (approx. 4100 sites), Stonefields (approx. 1700 sites), Pegasus Town (approx. 2700 sites) and Lakeside, Te Kauwhata (approx. 1700 sites).

Code of conduct

8 I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. Accordingly, I have complied with the Code in the preparation of this evidence, and will follow it when presenting evidence at the hearing. Unless I state otherwise, this assessment is within my

area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Scope of Evidence

9 My evidence addresses the following civil engineering matters related to the development of the TMPL Variation Area including:

(a) An overview of the context and constraints of the TPLM Variation Area from a land development engineering perspective;

(b) Stormwater management, including:

(i) An overview of the general approach to stormwater management in New Zealand;

(ii) A summary of the TPLM Variation Area context as it relates to stormwater management;

(iii) The development of a stormwater solution proposed through the Masterplan;

(iv) The stormwater solution proposed through the notified TPLM Variation;

(v) The submissions relating to stormwater management and the desire for an integrated solution and the further options considered for stormwater management;

(vi) The recommended stormwater solution; and

(vii) Response to other stormwater related submissions.

(c) Earthworks

10 In terms of water supply and wastewater, these matters are addressed in the evidence of Amy Prestidge from WSP.

11 I have reviewed the following documents in preparing my evidence:

(a) Candor[3]'s Final Three Waters Report Rev B (included as Appendix 3A(ii) of the section 32 report for the TPLM Variation);

(b) Candor[3]'s memorandum of April 2022 (included as Appendix 3A(iii) of the section 32 report for the TPLM Variation);

(c) QLDC's letter to landowners of 28 March 2022;

(d) Otago Regional Council (**ORC**) titled "An investigation into the Wakatipu Basin Aquifers" in July 2014;

(e) Geosolve's Preliminary Soakage Report ref GeoSolve Ref: 200353.01 May 2021;

(f) Geosolve's Preliminary Geotechnical Assessment ref GeoSolve Ref: 200353 December 2020; and

(g) The submissions which relate to stormwater issues.[1]

Executive Summary

12 In my opinion, there is no technical reason associated with either stormwater or earthworks that mean the TPLM Variation Area cannot be rezoned for urban purposes.

13 When the original TPLM Masterplan was developed it was proposed that there were be an integrated stormwater system with two primary stormwater devices. This was removed from the notified TPLM Variation, with stormwater to be addressed by developers.

14 In my opinion, it would be preferable if an integrated stormwater system were adopted to help ensure that the Guiding Principles for stormwater originally set out in the Masterplan can be achieved. In my opinion, it would be appropriate to allow up to 4 stormwater devices to be implemented across the TPLM zone.

15 Effectively this approach requires integration of a stormwater solution across the TPLM Variation Area and construction of centralised stormwater management devices but limits the number of devices to mitigate future issues for the community and Council in terms of maintenance over the long term. At the same time the approach provides developers with more flexibility than the original option in the draft Masterplan which indicated where the stormwater devices would be located.

16 In my opinion an integrated approach can be adopted which relies on soakage to ground and avoids direct discharges of stormwater to Lake Hayes in all events up to and including a 1 in 100 ARI event.

17 The land proposed to be subject to development is relatively flat and the quantum of earthworks required to effect any development will therefore be minimal. I can

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[1] Threepwood Farm Residents Association and the Threepwood Custodians Limited (submitter 33), Friends of Lake Hayes Society Incorporated (submitter 39), Amanda Styris (submitter 40), Miranda Spary (submitter 43), Lloyd and Debbie Anderson (submitter 48), Kim Netzler (submitter 50), Romain Kuhm (submitter 64), Sarah and Blair O'Donnell (submitter 67), Otago Regional Council (submitter 83), Sanderson Group and Queenstown Commercial (submitter 93), Louise McQuillan (submitter 98), Te Rūnanga o Ngāi Tahu, Papatipu Rūnanga (submitter 100), Maryhill Ltd (submitter 105), Travis Sydney (submitter 110), Janie and Rob Lee (submitter 112), Gordon Griffin (submitter 114), Kirsty and Justin Crane (submitter 115), Louise and Philip Keoghan (submitter 120).

see no technical reason that the land form cannot be reshaped to allow for development and to manage stormwater overland flows.

Context and constraints of the TPLM Variation Area from a land development engineering perspective

18 The TPLM Variation Area covers an area of approximately 136ha and is anticipated to deliver up to 2,400 new dwellings, a primary school, a secondary school, sport and recreation facilities and a town centre.

19 The area is shown in the **Figure 1** below and is bounded by Slope Hill to the north, the existing developments of Shotover Country and Lakes Hayes Estate to the south, Threepwood farm to the east and existing lifestyle blocks to the west. The Frankton – Ladies Mile State Highway 6 (**SH6**) runs through the middle of the TPLM Variation Area. Lakes Hayes is circa 750m east of the proposed boundary of the TPLM Variation Area.

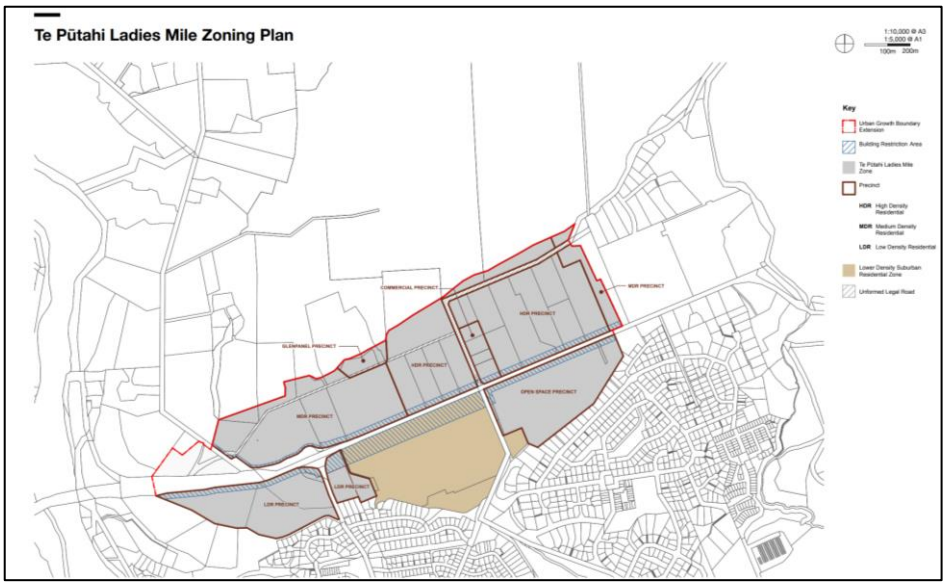

Figure 1: Extent of Te Pūtahi Ladies Mile rezoning

20 The land that is subject to the TPLM Variation sits on a flat terrace that lies immediately below Slope Hill immediately to the north. The land generally falls in a south-west to north-east direction at a grade of approximately 1%. Areas with steeper slopes, ranging up to approximately 10%, are present at the toe of Slope Hill. Slope Hill itself is characterised by gradients of 20% of more with some areas exceeding 33%. **Figure 2** below shows the distinction between the flat land which is represented by blue colours, the steeper land of Slope Hill to the north represented by red/orange colours and the steep terrace between TPLM Variation Area and Lake Hayes Estate and Shotover Country to the south also represented by red/orange colours.

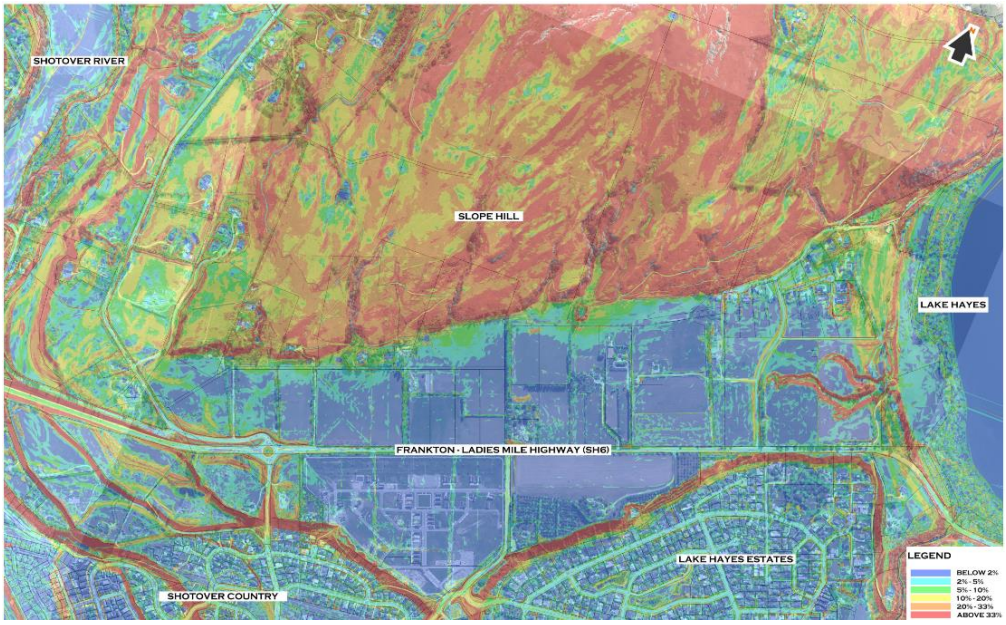

Figure 2 Land gradients across and adjacent to the TPLM Variation Area.

21 The TPLM Variation Area is located in a central position in close proximity to the Frankton area which is a major growth centre for Queenstown (refer to **Figure 3** below for context location). The TPLM Variation Area is also in the vicinity of major infrastructure such as the Wakatipu wastewater treatment plant and the Transpower substation, with upgraded 33kv lines running along SH6 and Lower Shotover Road. Water supply for the general area is sourced from bores at Shotover Country, although new water storage reservoirs are required to service growth in the wider Ladies Mile area. These matters are addressed in further detail in the evidence of Amy Prestidge of WSP. Overall, the central location of the TPLM Variation Area is such that the infrastructure to service the area is reasonably close at hand and in my view will be able to be extended to provide services in accordance with QLDC standards (which area addressed further below and in Ms Prestidge's evidence).

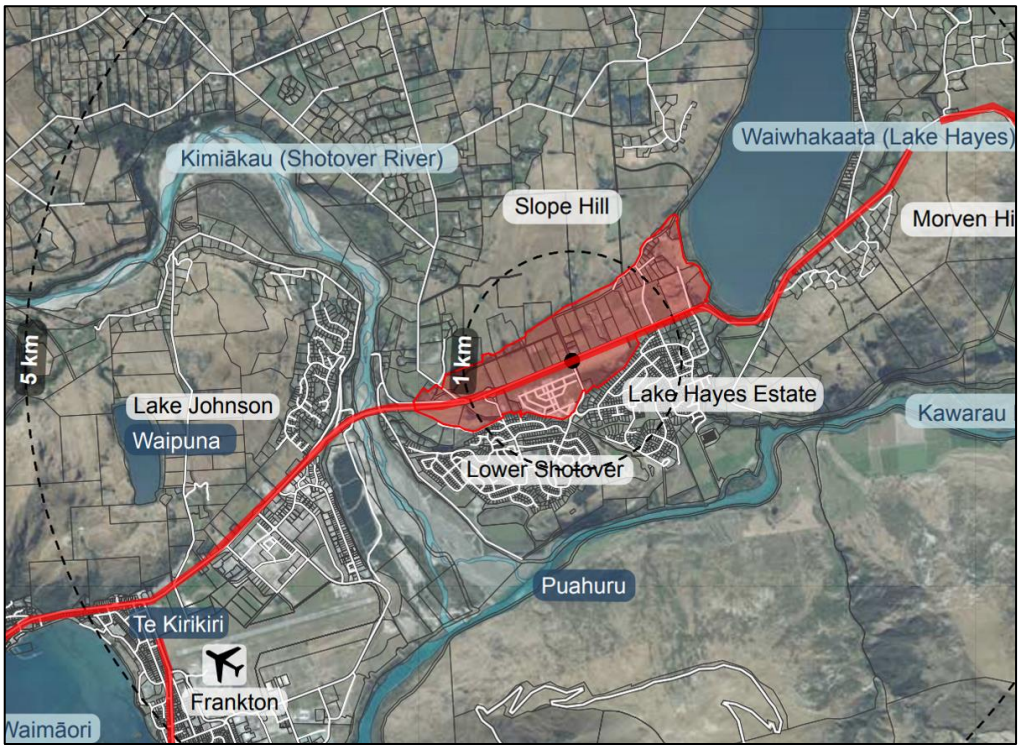

Figure 3 Location Map

Prior Works on TPLM Variation Area

22 Prior to being engaged by QLDC to work on the TPLM Variation Area Candor3 were engaged by the owner of Lot 2 DP 463532 being the Glenpanel Limited Partnership to carry out works on their property with a view to seeking zoning and consenting through the HAASHA process.

23 Scheme plans were prepared for the property along with reasonably detailed engineering assessments including drainage layouts and long sections of pipework.

24 Stormwater was identified as a key issue at this time and considerable work was done to identify a solution for this property together with surrounding properties.

25 The solution proposed for the Glenpanel Limited Partnership land was a series of attenuation / soakage basins alongside SH6. At that time it was anticipated that a 75m setback would be required which provided more space for basins alongside SH6 than the current TPLM Masterplan requires.

26 It was also proposed that the existing 1050mm diameter pipe in Howards Drive be extended under SH6 with the spare capacity in the pipe being utilised as an overflow from the attenuation / soakage basins.

27 Some of the work and thinking completed for the Glenpanel Limited Partnership has been utilised as a foundation for the work carried out for QLDC over the wider TPLM Variation Area.

Stormwater Management in New Zealand

28 The management of urban stormwater runoff across New Zealand has seen a significant shift in the past few decades. The approach in designing stormwater systems has evolved to incorporate environmental, social, and cultural benefits in addition to purely technical factors. Through the application of collaborative and inter-disciplinary planning and design processes, these stormwater management opportunities include:

(a) Mimicking the natural water cycle

(b) Enhancing water quality

(c) Enhancing landscape and natural character

(d) Incorporating Te Mana o te Wai

(e) Promoting community wellbeing and safety

(f) Promoting water conservation

(g) Minimising infrastructure lifecycle costs

(h) Managing flood risk

(i) Consideration of climate change

29 Consideration of the wider aspects of stormwater management is generally referred to as Water Sensitive Urban Design (**WSUD**). There can be multiple benefits of WSUD including healthier ecosystems, enhanced natural character, improved infrastructure operational resilience, and better mental and physical community wellbeing. The TPLM Variation stormwater management objectives and the stormwater management approach have generally been developed in accordance with the WSUD approach.

A summary of the TPLM Variation Area context as it relates to stormwater management

30 Candor[3] led the engineering assessment which informed the development of the Te Putahi Ladies Mile Masterplan and TPLM Plan Variation documents.

31 A copy of the full Three Waters Report that was prepared in support of the Masterplan is included (included as Appendix 3A(ii) of the section 32 report for the TPLM Variation). A further memorandum was prepared in April 2022 (included as

Appendix 3A(iii) of the section 32 report for the TPLM Variation) to support the Three Waters Report which outlined the different stormwater management options explored as a means of managing the primary and secondary stormwater flows for the TPLM Variation Area.

32 Section 5.2.5 of the Three Waters Report contains a detailed analysis of the existing site assessment that was used to develop the stormwater management objectives and stormwater management approach as part of the Masterplanning exercise for what is now the TPLM Variation Area. A summary of the site appraisal is included as follows.

33 As illustrated in **Figure 2** above, the area subject to the TPLM Variation is located on the flat land, with Slope Hill forming a steep backdrop immediately to the north.

34 The geology and soils of the TPLM Variation Area vary in composition considerably and have a large part to play in how the catchment reacts to rainfall (and therefore how it will be expected to generate stormwater once it is developed for urban purposes).

35 A preliminary geotechnical assessment was initially undertaken by Geosolve as part of developing the Masterplan (the Geosolve report is attached to the section 32 report as Appendix 3A(iii)).

36 The Geosolve geotechnical assessment identified that the existing ground profile for the majority of the Masterplan area (and therefore also the TPLM Variation Area) (i.e. the Flats) is expected to comprise topsoil, loess silt, localised alluvial silt, and deltaic/alluvial sand, gravel, and silt deposits. Localised alluvial fan depositional material and schist bedrock at depth is expected at the toe of Slope Hill itself. Slope Hill itself is comprised schist with a thin layer of topsoil.

37 Historical soakage testing data across the general TPLM Variation Area was reviewed in preparing Geosolve's initial report. This historic data measured the soakage rates across the flatter areas of the TPLM Variation Area vary between 7.2mm/hr and 360mm/hr.

38 Actual site testing was undertaken at 5 locations by Geosolve (as shown in **Figure 8** below) during the detailed consideration of the stormwater options. This testing provided soakage rates of 68.4mm/hr to 666mm/hr with one errant reading in borelog TP14 being ignored.

39 Because Slope Hill is predominantly schist with a thin layer of topsoil there is minimal soakage to ground in rainfall events. As a consequence of the impermeable nature of Slope Hill combined with its steep topography, significant amounts of runoff flow from Slope Hill to the TPLM Variation Area through a

network of existing gully features in rainfall events. A number of cut off drains exist along the base of Slope Hill which divert the runoff from Slope Hill to various farm ponds. From the farm ponds water generally drains away through the permeable sub soil layers that exist across the farm flats. While various landowners that I have talked to state that the runoff from rainfall directly onto the farm flats, together with the surface water flow from Slope Hill, currently infiltrates into the ground without any overland flow there is the possibility that excess runoff might be generated in very large rainfall events. Photographs of the Threepwood access road flooding in a large rainfall event are presented in several submissions which suggest that this does happen to some degree.

40 Based on the existing topography, any excess rainfall in the areas north of SH6, which cannot infiltrate into the ground, will flow towards Lake Hayes. However, there are no streams or channels within the TPLM Variation Area and any excess water flows towards Lake Hayes will be sheet flow in nature rather than channelised flow (although there are channels further east from the TPLM Variation Area as you get closer to Lake Hayes).

41 Water quality in Lake Hayes is degraded due to pastoral land uses and elevated levels of phosphorus which have been the subject of numerous investigations and reports. However, as I address below, stormwater discharges from any development within the TPLM Variation Area into Lake Hayes is of concern to a number of parties (including tangata whenua) and under the notified TPLM Variation provisions is to be avoided.

42 Currently, any excess rainfall from the areas south of SH6 that exceeds the capacity of existing pipework or the ability of the land to absorb water quickly enough passes through to the Shotover River and Lake Hayes Estates and discharges to the Kawarau River.

43 The Windemeer aquifer lies underneath the TPLM Variation Area and in a report by the Otago Regional Council (**ORC**) titled “An investigation into the Wakatipu Basin Aquifers” in July 2014, it was determined that the aquifer water table is expected to sit at approximately RL 320m next to Lake Hayes and RL 310m at Shotover River and Kawarau River.

44 This aligns with the findings from the Geosolve report, which located the groundwater at approximately 39m to 51m below the TPLM Variation Area ground level. This suggests that the flow in the aquifer is away from Lake Hayes in the opposite direction to the fall of the landform across the TPLM Variation Area.

45 The inflow from Lake Hayes to the aquifer is expected to be minimal due to the likely presence of a low permeability layer comprising silt lake sediments. The

ORC report noted at paragraph 32 above states “As Lake Hayes’ contact with the Windemeer Aquifer is believed to be interrupted by low permeability, silt lake sediments, the flow of lake water, from a mean elevation of 329m AMSL into the aquifer, is considered to be minimal”.

46 The aquifer water levels are shown in **Figure 4** below.

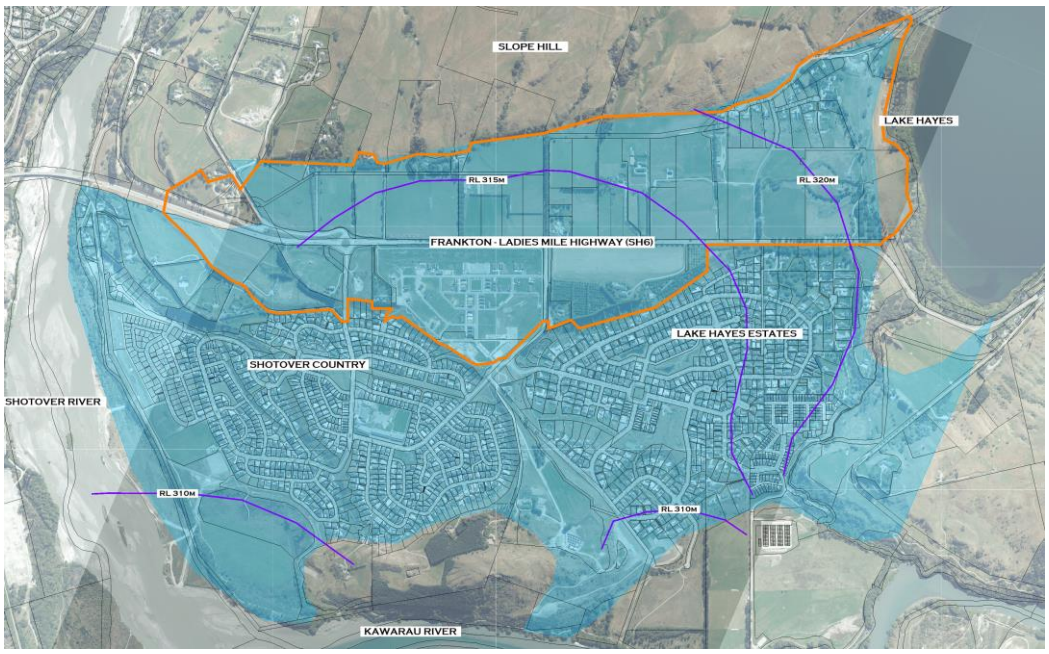

Figure 4 – Windemeer Aquifer extents and levels. Figure reproduced from Otago Regional Council Investigation into Wakatipu Basin Aquifers (July 2014)

47 The aquifer is expected to be predominantly recharged via infiltration of rainfall through ground with an estimated recharge is approximately 480,000 m^3/year.

48 There are also two other constraints that affect how stormwater from the TPLM Variation Area can be managed:

(a) Waka Kotahi will not allow runoff flows to cross SH6 in storm events.

(b) There is an existing 1050mm diameter pipe within Howard’s Drive which is capable of extension under SH6 to serve the western section of the TPLM Variation area. However, it has insufficient capacity to pass anything but a portion of runoff from large events through to the Kawarau River.

The development of the stormwater solution proposed through the Masterplan

49 The TPLM Masterplan was developed in parallel with the TPLM Variation documents in an integrated way, including consideration of engineering matters. One of the key challenges was to understand the stormwater management constraints and opportunities across the TPLM Variation area and to develop solutions that would integrate sensibly into the wider Masterplan for Ladies Mile.

50 Using principles of WSUD, the following stormwater management objectives were developed as part of the Masterplan, to integrate the existing features and natural processes with the future land use and layout:

(a) Utilise stormwater management solutions that mimic the natural water cycle and enhance water quality.

(b) Employ an integrated stormwater management approach that supports connectivity to the natural environment and gives effect to Te Mana o te Wai and community wellbeing.

(c) Manage flooding and surface water flow to safeguard the community and infrastructure in a sustainable manner.

(d) Implement stormwater management solutions that deliver lifecycle operational and economic resilience.

51 A stormwater management assessment was carried out to develop a stormwater management approach for the TPLM Masterplan area. Based on the existing site appraisal, a list of major stormwater management constraints were identified as being associated with water quantity management. These are summarised in section 5.2.5 of the Three Waters Report as follows:

(a) Delivering a sufficient level of ground infiltration to ensure the ongoing replenishment of the Windemeer Aquifer.

(b) Managing the high peak flows and stormwater runoff volumes expected to flow into the Masterplan area from Slope Hill. The total runoff for the 24-hour 100-year ARI rainfall event was estimated at approximately 97,000m^3. The estimated peak flows from some of the individual Slope Hill gully features could be up to approximately 3.5m^3/s.

(c) Providing discharge points for the primary stormwater systems. The existing primary stormwater system in the area, including the 1050mm diameter stormwater pipe located within Howards Drive, does not have the capacity to service the proposed Masterplan area (nor the smaller TPLM Variation area).

(d) Providing discharge points for the secondary stormwater systems. The management of surface water flows from area North 2 to the nearest water body is precluded by area North 1. The management of surface water flows from South 1, South 2, and South 3 are limited by the steep terrace slopes and the existing developments.

(e) Secondary stormwater flows which currently flow towards Lake Hayes cannot be redirected across SH6. To redirect flows to the south of the highway they would need to be routed underneath the highway.

(f) Lake Hayes margins have been identified as a regionally significant wetland by the Otago Regional Council. In addition to this, Lake Hayes has been targeted for water quality rehabilitation as a part of the ORC long term plan, and subsequently as a part of Jobs for Nature programme with funding from the Department of Conservation. The sensitive nature of these receiving waters make it important that discharge to Lake Hayes is managed.

(g) There are a large number of different landowners within the TPLM Variation Area. Coordination and alignment of development timelines will be required for large diversion options.

52 The stormwater management assessment in the Three Waters Report then considered both water quantity management (stormwater conveyance; stormwater disposal; flood risk management) and water quality management. In April 2021 at the time the Three Waters Report was completed, a range of work was identified as needing to be completed to finalise the proposed stormwater management approach and develop the final stormwater solutions for the, then, Masterplan area.

53 In developing the Three Waters Report and as a part of developing the TPLM Masterplan, a range of options were considered in relation to how stormwater could be managed.

54 These options are addressed in the following section of my evidence.

Options considered for managing stormwater runoff during development of TPLM Masterplan

55 In the following options I refer to both “primary” and “secondary” flows and networks. Primary flows are those generated by storms up to and including the 1 in 20 year ARI event (or 5% AEP event). Primary flows are typically collected and piped to the ultimate discharge point. Secondary flows are flows generated by storm events greater than the 1 in 20 year ARI. These flows are typically controlled within road corridors or via engineered overland flow paths as pipe sizes become prohibitive from a conveyance perspective. The calculation of runoff from storm events utilised in the assessment of options takes into account the effects of climate change.

Option 1: Piping primary and secondary flows:

56 This option would involve installing new piped stormwater networks capable of conveying the 1 in 100 year ARI event from the TPLM Variation Area to the Kawarau River, the Shotover River or Lake Hayes Creek or a combination of the three rivers. Piping stormwater runoff from events greater than a 1 in 20 year ARI storm is not normal engineering practice however in this case would be required to implement this option due to Waka Kotahi not allowing runoff to flow across SH6. It is also not normal practice to divert stormwater from it's normal catchment and common law principles of Natural Servitude and The Drainage Act provisions would have to be addressed were this to occur, most notably gaining the approval of any affected landowners. However, given the principle that no flows discharge to Lake Hayes this would be necessary. Having piped the runoff under SH6, it would then also be necessary to pipe the runoff all the way to the rivers as existing flowpaths south of SH6 were not designed to handle large volumes of runoff from out of catchment.

57 This option was discounted because of the size of the pipework required, the excessive cost of the piped networks due to new pipes having to be laid in and around existing underground infrastructure through existing neighbourhoods, the disruption to residents and potential environmental damage to the Hayes Creek if that option were utilised. This option also limits opportunities to recharge the Windemeer aquifer.

Option 2: Piped network with detention devices:

58 The second option considered was constructing stormwater management devices within the TPLM Variation Area to hold back water in large storm events (e.g. events greater than the 1 in 20 year ARI event) allowing a reduction in the size of new pipelines required to be constructed downstream as per the solution discussed at paragraph 56 above. This option was also discounted as costs were still significant and the complexity and risks in the works were not mitigated in any meaningful way by reducing pipe sizing. This option also limits opportunities to recharge the Windemeer aquifer.

Option 3: Soakage/infiltration for primary and secondary flows:

59 The third set of options considered soakage as the primary means of disposal given the good soakage rates identified across the flat areas of the TPLM Variation Area (as identified above in paragraphs 37 and 38). Four options involving soakage were considered. Each of these is discussed as follows.

60 An integrated solution is one that considers the wider catchment and benefits of a limited number of larger centralised communal systems (potentially inter connected) as opposed to a fragmented regime of solutions on individual properties that do not consider wider effects across the catchment.

Option 3A – Piped network with stormwater devices adjacent to SH6:

61 This option involves locating stormwater management devices within the 20m amenity access area adjacent to SH6 with some potential widening of the amenity access area to provide for larger basins at strategic locations as per **Figure 5A** below. Trial soakage basins and a piped network were sized and modelled in 3D to understand if this option would provide the necessary capacity. While the modelling indicated that a solution of this nature was possible, the modelling exercise identified a number of factors that strongly influenced subsequent thinking. If runoff from Slope Hill is piped through the TPLM Variation Area for treatment, attenuation and soakage adjacent to SH6 it is necessary to use large pipes given the volumes of runoff to be conveyed, particularly those flows from Slope Hill.

62 Using large pipes means that the invert of the pipework and stormwater management devices must be constructed well below existing ground levels. In this case, the depth of stormwater management devices required is increased because the ground levels adjacent to SH6 are higher than the ground levels midway between Slope Hill and SH6. Under this option the stormwater management devices must also increase in size to allow stable side slopes within the basins that can be easily maintained.

Option 3B – Swales and stormwater devices adjacent to SH6

63 As a variation on Option 3A, it is also possible to change the conveyance mechanism for runoff from Slope Hill to the stormwater management devices from pipes to swales. Because swales are open drains which are constructed at surface level with no requirement to be buried like piped networks the stormwater management devices can be considerably shallower and thus smaller in area. This is shown in **Figure 5** below. There is however, a direct transfer of land area from the stormwater management devices (beside SH6) to swales to provide the conveyance. There are also other complexities potentially introduced with road crossings, and service clashes and culverts being required. Effectively under this Option, or Option 3A all of the SH6 amenity area would need to be utilised for stormwater management devices with supplementary land also being required as the amenity area is inefficient in terms of shape. **Figure 5A** shows this concept.

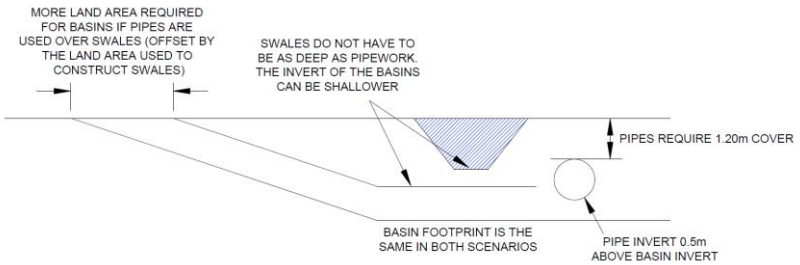

Figure 5 – Swales versus piped networks and impact on basin sizing

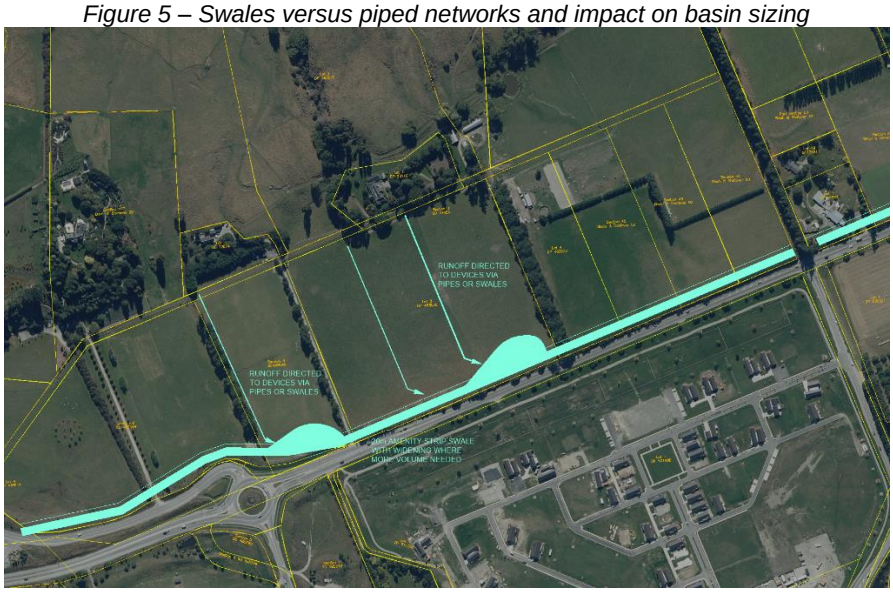

Figure 5A–SW Management areas using 20m amenity strip alongside the Highway.

Option 3C – Piped network and stormwater devices midway between Slope Hill and SH6

64 This option involved locating stormwater management devices midway between Slope Hill and SH6 as per **Figure 6** below. This option works with the existing landform and sites the stormwater devices generally at the lowest level of most of the properties within the TPLM Variation Area. This minimises the depth and thus size of the devices required. As stormwater runoff from Slope Hill still has to be collected and delivered to the devices, the pipework needs to be large and therefore forces depth into the network which translates to bigger devices (although the pipes would not be as large as in Option 3A above). With large stormwater devices sited mid block it is also harder to develop coherent roading patterns across the TPLM Variation Area as most sites are long and narrow and the devices themselves potentially cut most blocks in half.

Figure 6 –SW Management areas at low point of natural catchment.

Option 3D – Multiple communal stormwater management devices:

65 We also looked at Option 3C scenario using a smaller number of larger communal facilities rather than stormwater management devices for individual sites as is shown in **Figure 6**. Communal facilities are more efficient than individual devices but the piped networks delivering runoff from Slope Hill become more complex due to aggregation of Slope Hill catchments and how this is dealt with by individual owners in terms of piped networks which could drive high costs into some developments.

Option 3E – Two communal stormwater management devices:

66 The final option considered as part of the TPLM Masterplan involved an integrated solution containing two communal stormwater management devices sited at the base of Slope Hill connected by a swale, the purpose of which was to intercept Slope Hill runoff so that it will not need to be managed within the subdivisional developments across the flatter land (this is shown in **Figure 7** below).

67 This solution would mean that subdivisional pipework would generally be smaller in diameter and significantly cheaper for developers. In large storm events (i.e. in excess of the 1 in 20 year ARI event) any roads or stormwater pipework within the TPLM Variation Area will not be required to convey any of the large volumes of runoff from Slope Hill which is a significant advantage over other options given the volumes of flow calculated as being generated off Slope Hill.

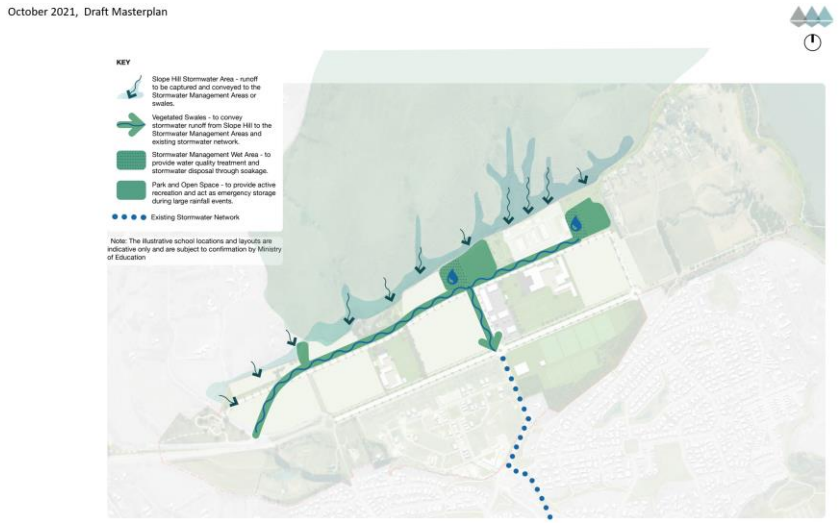

Figure 7 – Two SW Management areas at base of Slope Hill.

68 Soakage testing was carried out in the locations shown in **Figure 8** below to allow stormwater management devices to be sized indicatively and to prove the concept solution. Sizing was calculated using the HEC-HMS computer software to determine storage required given the calculated runoff inflows and the actual soil infiltration outflow rates as measured by Geosolve. A 3d model of the proposed SMA basins was also constructed in order to confirm the capacity, depth and area relationships of the proposed basins. The information derived from the 3d model was integrated with the HEC-HMS model to ensure consistency of information between the two software packages. Soakage rates varied across the test locations but soakage rates provided by Geosolve were more than adequate to confirm that soakage is a viable solution for stormwater disposal for storm events up to and including the 1 in 100 year ARI event.

Figure 8 – Soakage test locations

69 Based on advice from Geosolve, it was established that satisfactory soakage will occur across the entire TPLM Variation Area to ensure this option would deliver on the principles for stormwater design outlined above.

The stormwater solution proposed through the TPLM Masterplan

70 Ultimately, the options above were considered by the interdisciplinary team as part of the draft Masterplan and Option 3E was chosen as the preferred option.

71 Consultation on the draft Masterplan and draft TPLM Variation provisions occurred on this basis in April 2021 (although it was acknowledged at the time that the management and funding for stormwater across the site was still be to resolved).

72 Subsequent to the Council receiving feedback from landowners on the draft TPLM Masterplan and draft TPLM Variation provisions a letter was sent by the Council to the landowners within the TPLM Variation Area (on 30 March 2022) stating that the Council would not pursue the centralised system (i.e. Option 3E above) defined in the Draft Masterplan. The letter also set out QLDC's expectation that landowners would still be responsible for implementing an integrated stormwater solution across the TPLM Variation Area without providing much guidance as to what acceptable solutions might look like. As a consequence, the specific locations for a centralised stormwater approach (as shown above on **Figure 7**) were removed from both the Masterplan and the TPLM Variation.

73 In conjunction with the move away from a centralised stormwater solution as proposed in the draft version of the TPLM Masterplan, the final TPLM Masterplan document set out guiding principles for Stormwater Management but with landowners being responsible for detailed solutions subject to Council endorsement and rather than **Figure 7**, a new plan for Stormwater was included being **Figure 9** below.

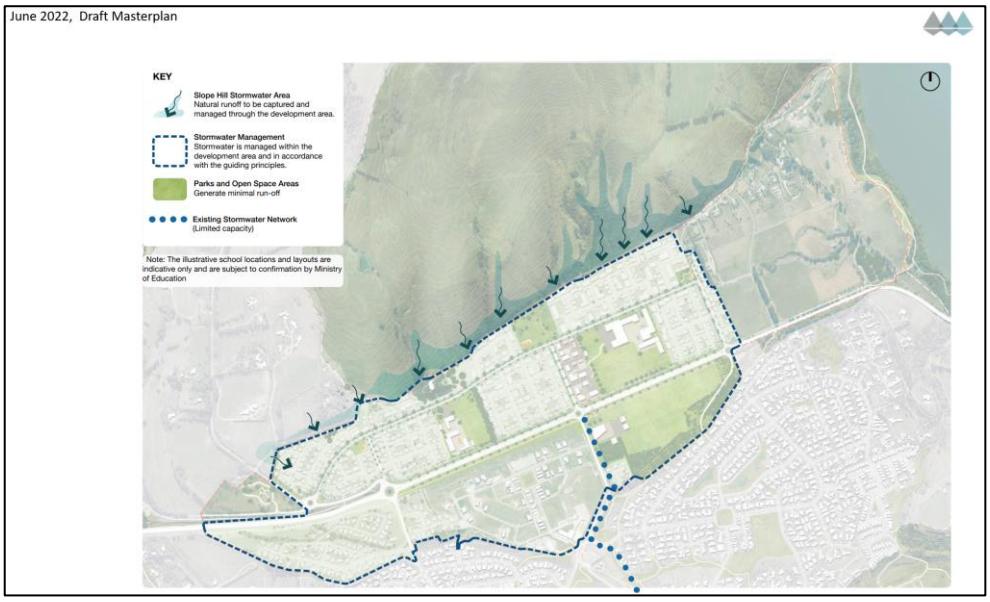

Figure 9 – Final SW Plan

74 As outlined above, the change in approach from specifying the detailed design solution to a landowner led 'principles approach' came about due to Council concerns about taking financial responsibility for the works, particularly the large land purchases for the detention areas. Landowners were also concerned that the Council would not be in a position to pursue the centralised approach and that those most impacted would not be fairly compensated for their loss of developable land.

75 The final TPLM Masterplan guiding principles developed for stormwater management from the TPLM Variation Area take into account all of the factors and constraints identified in our various assessments. These can be summarised as follows:

(a) Utilise stormwater management solutions that mimic the natural water cycle and enhance water quality.

(b) Employ an integrated stormwater management approach that supports connectivity to the natural environment and gives effect to Te Mana o te Wai and community wellbeing.

(c) Manage flooding and surface water flow to safeguard the community and infrastructure in a sustainable manner.

(d) The hydrological regime in the area is replicated such that the maximum rate of discharge and peak flood levels post development are no greater than pre development

(e) That there are no overland flows from attenuation systems or soakage pits for 1% AEP events or less unless there is a defined and acceptable overland flow path

(f) Ensure that there is a maximum 24-hour drain-down period for any attenuation systems basins/soak pits for 1% AEP events.

(g) That there are no overland flows across SH6 for rainfall events up to and including the 1% AEP event.

(h) That there are no direct discharges from the development area into Lake Hayes

(i) That runoff from all roads is managed through appropriate stormwater treatment device(s).

(j) Avoid a proliferation of multiple stormwater management systems and devices. Depending on location and land ownership structures this may necessitate co-operation of multiple landowners to ensure an acceptable approach.

(k) Implement stormwater management solutions that deliver lifecycle operational and economic resilience.

(l) Align ‘blue’ stormwater solutions and the wider ‘green’ landscape and open space strategies wherever possible.

The stormwater solution proposed through the notified TPLM Variation

76 Given where matters had got to with respect to the Masterplan, when the TPLM Variation was notified, it also did not include a centralised stormwater solution.

77 Instead, some of the salient aspects of the guiding stormwater principles were translated into the TPLM Variation in the form of new objectives policies, matters for discretion and assessment criteria.

78 In particular, the Variation introduced:

(a) Provisions into Chapter 49:

Objective 49.2.8 Development that supports resilience to the current and future effects of climate change. and

Policies

49.2.8.1 Encourage site layout and building design that promote sustainability, including design that conserves energy, reduces waste and reduces emissions.

49.2.8.2 Require a minimum level of permeable surface on a site for stormwater management and landscape amenity.

(b) New Wakatipu Basin specific Policies under **Chapter 4 Urban Development** 4.2.2.21 for Te Pūtahi Ladies Mile including:

4.2.2.21 Ensure that development within the Te Putahi Ladies Mile Zone provides for:

…

(f) Ngāi Tahu values, including:

i. Incorporating climate change mitigation and adaptation within design;

ii. Protecting the mauri of water with water sensitive design, incorporating on-site management of stormwater and requirement for permeable surfaces, utilising reticulated systems for potable supply and wastewater, incorporating onsite water retention and reducing operational water use;

iii. Preferring the use of indigenous vegetation that naturally occurs and/or previously occurred in the area as part of landscape design, including species preferred by indigenous birds; and

iv. Incorporating reference to Ngāi Tahu values in design where appropriate.

(iii) Changes to Chapter 27 (Subdivision) with a new policy:

Policy 27.3.24.7 Require the design of stormwater management systems to avoid stormwater discharges to Lake Hayes and avoid the adverse effects of discharges to the Shotover and Kawarau Rivers, the State Highway network, and groundwater resources.

(iv) Changes to Chapter 27 (Subdivision) with a new Rule 27.7.28 which provides that the subdivision of land is a restricted discretionary activity with discretion restricted to (among other matters):

(b) the spatial layout of the subdivision, and its relationships to and integration with other sites and development, taking into account the location of:

iii Three waters infrastructure, including the retention and treatment of stormwater, and integration with the stormwater network within the Zone.

(v) Amendments to the Assessment Matters in relation to Rule 27.7.28.1 including Assessment Matter 27.9.8.1:

b. The extent to which a development provides logical integration of infrastructure, including roading (including walking and cycling networks), parks and open spaces within the Sub Area and where relevant, adjoining Sub-Areas taking into account the relevant matters in (c) below,

c. The extent to which:

ii. the subdivision design provides for:

(c) the appropriate management of stormwater through water sensitive design and through the retention and treatment of stormwater, and integration with the stormwater network within the Zone;

(vi) For 2 or more dwellings, discretion is limited to

49.4.4 (g)(iii) Three waters infrastructure, including the retention and treatment of stormwater, and integration with the stormwater network within the Zone

(vii) Building for non residential activities discretion is limited to:

49.4.18(j)(iii) Three waters infrastructure, including the retention and treatment of stormwater, and integration with the stormwater network within the Zone.

(viii) 49.7 Assessment matters for site and building design:

f. Sustainability and resilience

Whether the development incorporates innovative design responses that are likely to create a benefit for the environment, in the areas of carbon emission reductions, stormwater management and water quality, biodiversity, renewable energy, and energy efficiency, significantly beyond the minimum levels required by the Plan, through consideration of the extent to which the development:

(iv) includes the appropriate management of stormwater through water sensitive design and through the retention and treatment of stormwater, and integration with the stormwater network within the Zone.

The submissions relating to stormwater management and the need for an integrated approach

79 A range of submissions have been received on the TPLM Variation in relation to the stormwater solution.

80 Several submitters (Friends of Lake Hayes (submitter 39), the Director-General of Conservation (submitter 44), Ms Louise McQuillan (submitter 98), Aukaha and Te Ao Marama Inc on behalf of the Papatipu Rūnanga and Te Rūnanga o Ngāi Tahu (collectively referred to as Kāi Tahu) (submitter 100)) have all opposed the stormwater solution and sought that new objectives and policies be included in the TPLM Variation in order that an integrated stormwater management network in the Structure Plan is provided for.

81 In contrast, Glenpanel Development Limited (submitter 73) has sought the removal of references to “integrated stormwater approach” from matters for discretion in 27.7.28.1 b.(iii).

82 Given the strong opposition to the developer led stormwater solution proposed by the TPLM Variation, I have given further consideration to the options for managing stormwater from the TPLM Variation Area while addressing QLDC’s objectives for stormwater management and the wishes of the submitters including those submissions from landowners.

83 Having discounted piped networks as a solution for stormwater discharge from the TPLM Variation Area during Masterplan development, I have reconsidered the soakage discharge options that have the ability to satisfy the developed

stormwater principles (outlined in paragraph 75 above) as follows before making a recommendation in relation to a proposed stormwater solution.

(a) *An integrated solution*: This option includes any solution that manages runoff from both Slope Hill and from developments that is coordinated across development blocks to provide a limited number (between 1 and 4) of communal / centralised facilities (detention basins and/or soakage devices) across the entire TPLM Variation Area. Under this option, Option 3E above with two communal stormwater management devices at the base of Slope Hill could be implemented, or another integrated system with up to 4 devices could be implemented provided the stormwater principles were achieved.

(b) *SH6 amenity corridor for storm water*: This could be achieved as per Option 3A above.

(c) *Stormwater Management Devices midway between SH6 and Slope Hill*: This could be achieved as per Option 3B above.

84 The SH6 amenity corridor and mid-block options (3A and 3B) are already described above, so are not repeated here.

85 Option 3E with two stormwater management devices was the preferred solution when the initial Masterplan was developed. This did not find favour with the landowners, contributing to the removal of the initial stormwater concept from the notified TPLM Variation.

86 In considering how an integrated option could be achieved while providing more flexibility for landowners, I considered an option that takes the total catchment and divides it into four sub catchments as per **Figure 10** below with one device being allowed for each identified sub catchment. Other sub-catchment definitions are possible.

87 By allowing up to four devices within the TPLM Variation Area QLDC will have to take ownership of four devices, which, for a catchment of this size does not seem unreasonable and thus it meets the QLDC's objectives to avoid the proliferation of small stormwater devices and the challenges posed by them.

88 From a landowners perspective, the number of parties having to negotiate a stormwater solution that allows development of their land is reduced, increasing the likelihood of an agreement being reached. In addition, by allowing flexibility as to where the devices are located within the sub catchment (or the TPLM Variation Area) developers have the ability to structure their developments to get the best outcome possible. This might include locating a device where the highest soakage rates have been identified within the catchment, utilising land that cannot otherwise

be developed (the amenity strip for example) or at the low point of the land thus minimising device footprints. Sub-catchments could also potentially be amended to accommodate those parties that choose to cooperate leaving parties who do not wish to work together to resolve their issues at a later date.

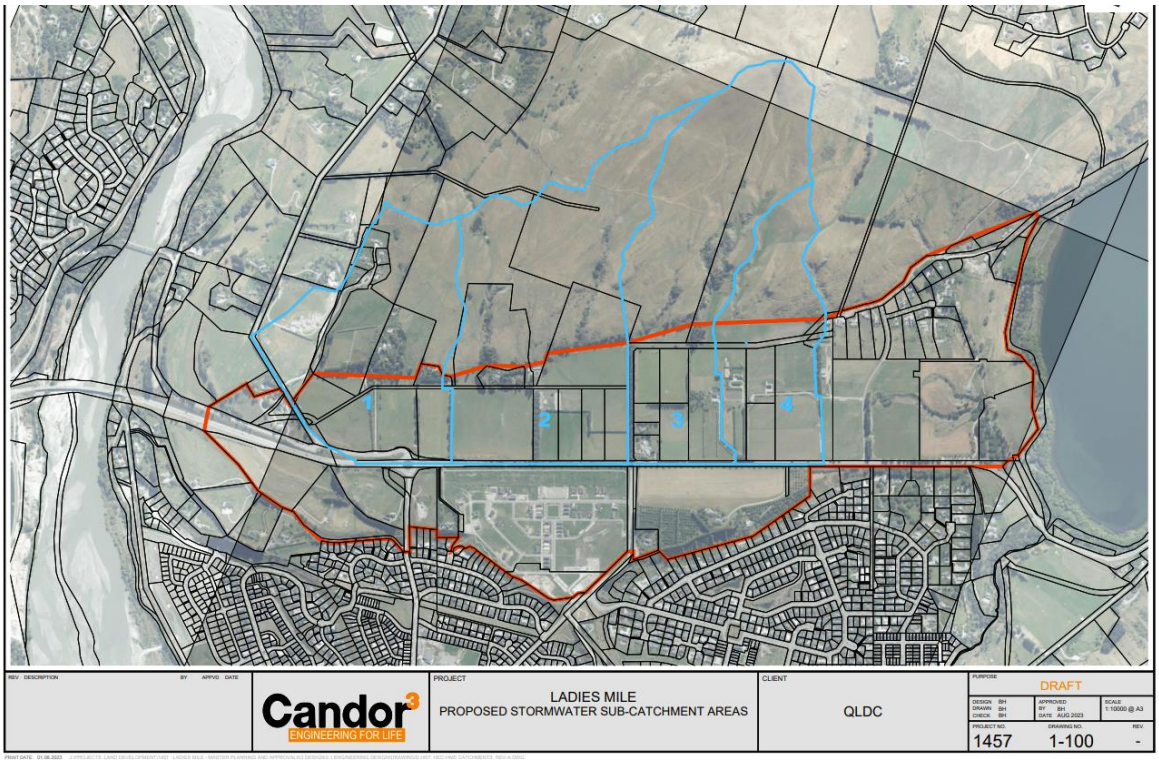

Figure 10 – Potential sub catchments for stormwater management devices

89 Effectively this approach requires integration across the sub-catchments and construction of centralised stormwater management devices but limits the number of devices to mitigate future issues for the community and Council in terms of maintenance over the long term. At the same time the approach attempts to provide developers with more flexibility than the original option in the draft Masterplan which indicated where the stormwater devices would be located.

90 In terms of the land area required to achieve an integrated solution, this will depend on the exact solution implemented. However, based on Candor[3]'s calculations for Option 3E, being the two basin option, approximately 5.5ha of land will be required excluding swales that will be needed to catch runoff from Slope Hill. Based on work that Candor[3] have completed, increasing the number of devices will likely increase the area of land required for devices considerably although I acknowledge that there are quite a number of factors that influence this and it is possible that with more detailed work four basins may be delivered using minimal additional land. In my opinion, individual stormwater systems will be complex and require considerably more land than an integrated system.

91 I reiterate that in my opinion an integrated solution (which may include up to 4 stormwater basins/detention basins) could be designed in a way so that it can accommodate stormwater for a 1 in 100 ARI event via soakage. This would avoid any discharge or overflow to Lake Hayes in such rainfall events.

92 I note that standard engineering practice is to design primary stormwater solutions in which runoff from events smaller than 1 in 20 ARI events are managed (in this case via discharge to ground), with higher flow events being managed by designing overland flowpaths for secondary flows. If the integrated stormwater system were designed for the 1 in 20 ARI event only, then in this case secondary flows would overflow to Lake Hayes (as is understood to currently occur in some rain events). This solution, should it be acceptable, would reduce the land area required for stormwater detention. It is difficult to assess what the reduction in land requirement would be as there are many factors to consider but it is unlikely to reduce by more than 20%. As I outline in paragraph 55 above, it is normal engineering practice for secondary stormwater flows to be managed by overland flow paths.

The recommended stormwater solution

93 In my opinion an integrated stormwater system with between 1 and 4 stormwater devices would achieve the objectives for stormwater management in the TPLM Variation Area and the principles for stormwater outlined above. This is because it would:

(a) Rely on soakage as the means of disposal allowing for recharge of the Windemeer aquifer and mimicking of the natural water cycle.

(b) If implemented in conjunction with appropriate bunds / swales, landform and road grading could be designed to prevent stormwater discharges between sub-catchments or direct to Lake Hayes. When compared with the current pre-development situation, an integrated system (as described above), which will also have to address run-off from Slope Hill, will reduce inflows to lake Hayes and may contribute to improving water quality.

(c) Provide connectivity to the natural environment.

(d) Ensure that the hydrological regime in the area is replicated such that the maximum rate of discharge and peak flood levels post development are no greater than pre development.

(e) Ensure that there are no overland flows from attenuation systems or soakage basins for 1% AEP events or less unless there is a defined and acceptable overland flow path; that there is a maximum 24-hour drain-down period for

any attenuation systems for 1%AEP events and that there are no overland flows across SH6 for events up to and including the 1% AEP event.

(f) Manage flooding and surface water flow to safeguard the community and infrastructure in a sustainable manner.

(g) Implement stormwater management solutions that deliver lifecycle operational and economic resilience.

(h) Avoid a proliferation of multiple stormwater management systems and devices.

94 In my opinion an integrated stormwater disposal regime allowing up to four stormwater management devices across the TPLM Variation Area provides more flexibility for landowners than the original draft Masterplan. Allowing choice in the siting of devices provides further flexibility although it is important in any design to capture and direct runoff from Slope Hill to the chosen stormwater management area in a controlled manner. It is also critical that any overland flow paths (particularly roads) are sized to accommodate the design overland flow and that flow depths and velocities are assessed to ensure that they are acceptable and do not pose a hazard to the public.

95 Accordingly, in response to the submissions listed above seeking an integrated stormwater solution be accepted, I recommend that an integrated stormwater management approach should be taken within the TPLM Variation Area. The evidence of Ms Prestidge outlines her recommendation in relation to the specific parameters for the provisions to give effect to an integrated solution.

96 Irrespective of the number or location of stormwater management devices ultimately designed, soakage is recommended in this catchment as a means of disposal for the following reasons:

(a) Ongoing replenishment of the Windemeer Aquifer over the long term.

(b) Managing the high peak flows and stormwater runoff volumes expected to flow into the masterplan area from Slope Hill. The total runoff for the 24-hour 100-year ARI rainfall event has been calculated at approximately 97,000m^3. The estimated peak flows from some of the individual Slope Hill gully features will be as high as 3.5m^3/s.

(c) Avoiding expensive and disruptive construction works through existing neighbourhoods or environments to install new piped reticulation to convey stormwater to the Shotover or Kawarau Rivers.

(d) Preventing any stormwater runoff passing across SH6 in large storm events.

(e) Preventing stormwater runoff from any developments running into Lake Hayes. Lake Hayes margins have been identified as a regionally significant wetland by the Otago Regional Council. In addition to this, Lake Hayes has been targeted for water quality rehabilitation as a part of the ORC long term plan, and subsequently as a part of the "Jobs for Nature" programme with funding from the Department of Conservation. The sensitive nature of these receiving waters will make it difficult to discharge to this location (although as I outline above in paragraph 92, there may be able to be a distinction drawn between 1 in 20 ARI events, and higher rainfall events).

Response to other stormwater submissions

97 In the following section of my evidence, I respond to other submissions that relate to stormwater. I have grouped the submissions under headings in order to address the issues thematically.

Effects on Lake Hayes

98 Various submissions[2] raise the following issues in relation to Lake Hayes:

(a) The stormwater assessment that informed the TPLM Variation under estimates flow to Lake Hayes and overestimates soakage capacity of soils in the TPLM Variation area (especially in winter when the ground is frozen);

(b) When Ladies Mile is built up, water will have nowhere to go except Lake Hayes (and through Threepwood);

(c) The TPLM Variation area is within the Lake Hayes catchment according to submitter's Hydrology Report (refer Friends of Lake Hayes submission 39);

(d) Seek excess run-off out of catchment through a new culvert;

(e) Lake Hayes is particularly sensitive, and it is important that land use within the TPLM Variation area is robust in terms of three waters infrastructure and does not risk further degradation of Lake Hayes;

(f) Consider construction effects on Lake Hayes (including silt washing into lake).

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[2] Threepwood Farm Residents Association & Threepwood Custodians (submitter 33); Friends of Lake Hayes Society Incorporated (submitter 39); Amanda Styris (submitter 40); Miranda Spary (submitter 43); Llyod and Debbie Anderson (submitter 48); Kim Netzier (submitter 50); Romain Kuhm (submitter 64); Sarah and Blaire O'Donnell (submitter 67); Otago Regional Council (submitter 83); Louise McQuillan (submitter 98); Te Rūnanga o Ngāi Tahu (submitter 100); David Finlin (submitter 101); Janie Reese and Rob Lee (submitter 112); Gordon Griffin (submitter 114); Kirsty Mactaggart and Justin Crane (submitter 115); Louise and Philip Keoghan (submitter 120).

99 In relation to (a) as outlined above, it is accepted that there is minimal soakage to ground on Slope Hill due to the underlying schist. While the impact of frozen or sodden ground on the volume of water from Slope Hill has not been specifically analysed it is potentially not significantly different from what has been assumed in calculations recognising the impervious nature of the underlying schist.

100 In large storm events land use also plays a less significant part in minimising runoff as the volume of rainfall being deposited far exceeds the ability of most soils to absorb any meaningful volume and consequently pasture can act in a similar way to a paved surface with most rainfall running off the surface by way of overland flow. The volumes of runoff calculated are, in my professional opinion, conservative given that the initial calculations carried out assumed minimal soakage across Slope Hill.

101 Further, the method of calculating runoff and the runoff factors ultimately used in calculations are a matter that would be considered by Council at detailed design stage at the time of resource consent. I also note that Stormwater Management Devices are typically sized allowing safety factors by way of specified freeboard and in my opinion these concerns will be addressed through the resource consent process. It is also possible to design overflow outlets that discharge into the deeper gravels underlying the farm flats such that in large events there is less reliance on surficial soils for soakage and the frozen nature of surface layers then becomes less relevant.

102 In relation to the prospect of discharge occurring to Lake Hayes:

(a) As set out above, the notified plan provisions require that any discharge to Lake Hayes is avoided.

(b) In my opinion, the proposed integrated stormwater solution, which relies on soakage to ground actually works to the benefit of Lake Hayes. This is because, as described above, the flow in the underlying aquifer runs away from Lake Hayes. Stormwater soaking to ground will therefore run towards the Shotover or Kawarau Rivers.

(c) In order to help ensure that there is no discharge, or runoff to Lake Hayes it is also recommended that a bund / swale be constructed along the eastern boundary of the TPLM Variation within Lot 1 DP 475308 to trap any overland flow and divert it to stormwater management devices thus preventing any stormwater from the urban area developed pursuant to the TPLM Variation and Slope Hill areas entering Lake Hayes.

(d) In relation to the submissions suggesting that excess run-off be diverted out of catchment through a new culvert, I do not recommend this approach for the following reasons.

(i) Given the size of the Slope Hill catchment it is not practical to collect and divert the amount of runoff that will be generated in large storm events out of catchment and away from Lake Hayes in a piped system. Waka Kotahi will not allow overland flows across the State Highway making it necessary to pipe the 1% AEP runoff. To pipe the 1%AEP storm event is a technically challenging and financially prohibitive exercise.

(ii) Any pipe would also have to be constructed down to the Kawarau River in my opinion if issues with existing neighbourhoods and infrastructure are to be avoided. This is discussed in my evidence at paragraph 51 and was discounted as an option for financial, health and safety and environmental reasons.

(iii) The Drainage Act and common law principles of natural servitude will also apply to any such proposal and any affected party will need to give their agreement to such a diversion of water from it's natural catchment. Based on previous experience I suspect that approval would be difficult to obtain.

103 Friends of Lake Hayes Society Incorporated (submitter 39), Gordon Griffin (submitter 144), and Kirsty Mactaggart and Justin Crane (submitter 115) also raises the issue of construction effects on Lake Hayes (silt washing into lake).

104 Sediment control ponds or other devices will be required to be installed to trap sediment laden runoff during construction as per section *2.3.7 Erosion, sediment, and dust control* of the QLDC Engineering standards. These sediment control devices will be dependent on soakage for their outlets and thus runoff will soak through the overburden soils leaving sediment behind, with treated water entering the aquifer and running towards the Shotover or Kawarau Rivers. Consents will also be required from the Otago Regional Council for residential earthworks which includes gaining consent for proposed erosion and sediment control measures.

Effect on Shotover and Kawarau Rivers

105 In addition to seeking an integrated stormwater approach (as addressed above) Kāi Tahu (submitter 100) also seeks that the 49.1 Zone Purpose is updated to include avoiding direct discharges to important water bodies such as Waiwhakaata Lake Hayes, Kimiākau/Shotover River or the Kawarau River.

106 To clarify, under the stormwater solution proposed it is not intended that any piped networks be installed that will discharge to any water body directly. As is explained above soakage is the preferred means of stormwater disposal with in the TPLM Variation Area. As is further explained in paragraph 102(c) it is recommended that a bund or swale be constructed along the eastern boundary of the TPLM Variation within Lot 1 DP 475308 to trap any overland flow and divert it to stormwater management devices preventing surficial flows into Lake Hayes.

Community Park is subject to substantial flooding

107 The Sanderson Group and Queenstown Commercial Limited (submitter 93) and Maryhill Limited (submitter 105) seek the following:

(a) greater flexibility for location of parks and possibly use of stormwater management function.

(b) Allow for greater flexibility in the design, size, and location of the public park within sub Area C and otherwise allow flexibility to create smaller and more dispersed parks to assist in managing stormwater if a significant single park is to be pursued.

108 As is outlined in Ms Galavazi's evidence, the Council's position is that recreation reserves and stormwater management areas have separate functions and should not be combined. Therefore, the Community Park (or any other park) is not intended to be used for stormwater management.

109 Managing runoff from Slope Hill through or around the Community Park will need to be considered further in detailed design and through the resource consenting process.

110 In any event, paragraphs 72 through 92 of my evidence above sets out an option for stormwater management areas that provides more flexibility in terms of number and location of devices without allowing a mass proliferation of devices.

Earthworks

111 The urban zonings proposed by the TPLM Variation are divided by the existing SH6, with medium and high density precincts and a commercial precinct identified on the north side of SH6 and lower density and open space precincts proposed on the south side of SH6.

112 From a land development perspective the earthworks required to shape the land will be minimal and will be driven primarily around the stormwater solutions and the need to direct all flows through the stormwater management devices. As part of the investigations inputting into the Masterplan, Candor3 undertook

3D modelling to ensure that physical implementation of the solutions investigated is possible. As a result of this work, initial estimates of the quantum of earthworks likely for the north side of SH6 were derived.

113 Based on this, approximately 175,000m^3 of cut to fill across an area of circa 65ha is estimated to be required. Based on my experience in land development, this level of earthworks is at the low end of the spectrum.

114 The land to south of SH6 consists of the Council owned 516 Frankton Ladies Mile Highway, the Queenstown Country Club (**QCC**) and the Koko Ridge subdivision (which is well advanced), plus two smaller parcels of land immediately east of Stalker Road.

115 There is a steep escarpment terrace (circa 15m high) that forms the southern boundary for Council's 516 site and the Country Club land which also continues to the west of Stalker Road. Earthworks have been completed as part of the Koko Ridge development and the QCC site. Minimal earthworks are anticipated for the Council's 516 site which is intended to be developed into a sports park and community hub. Apart from the possible new road connection from Sylvan Street to SH6 as shown on the Structure Plan it is not anticipated that earthworks would be required to the terrace and overall earthworks for any remaining development land would again be at the low end of the spectrum given the generally flat nature of the land.

Conclusion

116 In conclusion, in my professional opinion, there is no technical reason associated with either stormwater or earthworks that mean the TPLM Variation Area cannot be rezoned for urban purposes. Solutions are available to dispose of stormwater and the proposed rules, objectives and principles provide guidance as to how this can be adequately managed to achieve sound engineering solutions.

117 The land proposed to be subject to development is relatively flat and the quantum of earthworks required to effect any development will therefore be minimal. I can see no technical reason that the land form cannot be reshaped to allow for development and to manage stormwater overland flows.

John Fraser Gardiner

29 September 2023