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 AMY CATHERINE PRESTIDGE

29 September 2023

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WYNN WILLIAMS

Introduction

1 My name is Amy Catherine Prestidge.

2 I am a Technical Principal Engineer (Water Conveyance) at WSP. I have been in this position since July 2023, and have been with WSP since 2010. I am responsible for three waters project design, design management and providing guidance and review to project teams around the country.

3 I have been asked to provide evidence by Queenstown Lakes District Council (**QLDC** or **Council**).

4 My evidence focuses on the ability for the development proposed within Te Pūtahi Ladies Mile Plan Variation area (**TPLM Variation Area**) to be serviced by three waters infrastructure. I have appended to my evidence as **Appendix A,** a report that I prepared addressing the water supply, wastewater and stormwater servicing concepts for the TPLM Variation Area. This report, titled Te Pūtahi Ladies Mile Plan Variation – 3 waters Servicing Concept (**WSP Report**), forms the basis of my evidence.

Qualifications and experience

5 I have a Bachelor of Engineering (Hons) in Civil Engineering from Canterbury University. I am also a Chartered Professional Engineer with Engineering NZ, practicing in the Water and Civil areas. I am a Chartered Engineering NZ member and a member of Water NZ.

6 I have worked as a water engineer on roading and three waters projects for 18 years in New Zealand and briefly in the UK. I have experience in three waters design, specifically conveyance and engineering solutions, for new roading projects, new commercial/government developments, roading upgrades and reticulation upgrades. I have worked on projects across the country, but specifically in the Queenstown Lakes district since 2016. My specific recent three waters experience includes, Queenstown Alliance Arterials (water supply and wastewater) and New Zealand Upgrade Programme (**NZUP**) (water supply, wastewater and stormwater) projects, Mt Iron Roundabout, Bath Street Trunk Main Renewal, Queenstown Housing Infrastructure Fund projects, Peacockes Wastewater Housing Infrastructure Funding projects and Corrections Ancillary Upgrades. I have also provided technical guidance on many

small local projects for water supply, wastewater and stormwater conveyance and soakage.

Code of conduct

7 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

8 My evidence addresses the following:

(a) Water supply servicing concept for the TPLM Variation Area;

(b) Wastewater servicing concept for the TPLM Variation Area;

(c) Stormwater servicing concept for the TPLM Variation Area; and

(d) Response to submissions regarding water supply and wastewater

Executive Summary

9 I have considered the constraints and necessary three waters infrastructure required to facilitate development and my evidence confirms that in my opinion there are feasible options available to service this area.

Background

10 WSP has previously been engaged by QLDC in the development of three waters infrastructure concept plans to support a business case for the Ladies Mile Housing Infrastructure Funding (**HIF**).

11 Subsequent to this work, QLDC embarked on the master planning exercise for the wider Te Pūtahi Ladies Mile area (**TPLM**). The background to Te Pūtahi Ladies Mile Masterplan (**TPLM Masterplan**) is explained in the evidence of Mr Harland. The master planning work involved modelling and engineering studies on critical infrastructure services for the TPLM Masterplan area. Candor3 completed this work on behalf of QLDC and produced two infrastructure reports that ultimately informed the final TPLM Masterplan and the TPLM Variation. These

reports are appended to the section 32 analysis for the variation and are further explained in the evidence of Mr Gardiner. These reports are titled:

(a) Three Waters Infrastructure Report (**Candor3 Report**); and

(b) Stormwater Management Options Memo – Rev A.

12 In preparing my evidence, I have reviewed the following documents:

(a) The TPLM Variation (and associated document) as relevant to my area of expertise;

(b) Submissions on the TPLM Variation reference in my evidence;

(c) Ladies Mile Te Pūtahi Masterplan: Three Waters Infrastructure Report (Final) (Candor3 2022);

(d) Queenstown water supply model: model update and system performance assessment (Mott MacDonald 2022);

(e) Shotover Country, Borefield & WTP: Network Functional Description, Facility Commissioning and Network Integration (QLDC 2022);

(f) Queenstown Water Supply: Shotover Country Water Treatment Plant Integration Review Report (Watershed 2023);

(g) Wakatipu Water Supply Master Plan – April 2020 Rev B;

(h) Shotover Country Water Treatment Plant & Bore Pump: Operations & Maintenance Manual (Fulton Hogan Ltd, n.d.);

(i) Shotover Country Borefield, Water Treatment Plant and Rising Mains Concept Design Report (Fluent 2018);

(j) Shotover Country Borefield, Water Treatment Plant and Rising Mains Detailed Design Report (Fluent 2019);

(k) Arrowtown-Lake Hayes Rising Main Capacity Assessment Transient Assessment And Hydraulic Analysis (GHD 2023);

(l) Project Shotover Stage 3 – Detailed Design Report (Beca 2022);

(m) Shotover Country Water Supply, Bridge Crossing: Detailed Design Report (Fluent 2020);

(n) SH6 Shotover Bridge Proposed Water Mains: Effect on Live and Seismic Bridge Capacities (WSP-Opus 2019);

(o) Queenstown Country Club Retirement Village Trunk Stormwater Pipeline Design Report for Engineering Approval (Fluent 2017);

(p) Evidence of Mr Gardiner.

13 I have appended to the WSP Report, as **Appendix A**, a Three waters Servicing Plan that depicts the concepts outlined in my evidence and the WSP Report.

Water Supply servicing concept

14 Section 4 of the WSP Report outlines the existing water supply service for TPLM.

15 In order to determine a servicing concept for the TPLM Variation Area I have calculated the water demand for development within the TPLM Variation Area. I have reviewed the water supply demands in section 7.3 of the Candor3 Report and comment below on where I have used different assumptions.

16 In order to manage demand in accordance with my assumptions, I have suggested some additional rules to be included in the TPLM Variation. These are addressed further below.

Parameter	**Candor3 Assumption**	**WSP Assumption**	**Comment**
Residential water demand			
New residential units	2400 DUEs	2400 DUEs	No difference
Average Day Demand	700L/person/day (or 250L/person/day taking into account the higher density which is expected to	1000 L/DUE/day	Fluctuating opinions on design demands over the past few years have resulted in a number of differing

	generate less demand for water i.e less garden water)		instructions from QLDC. Due to a desire to reduce excess water usage, water restricting fixtures and less need for substantive irrigation, QLDC agreed to an ADD of 1000L per dwelling per day.
Peak Day Demand	2,800 L/DUE/day	2000 L/DUE/day	This follows the current QLDC design guidance of a peaking factor of 2 for PDD.
Average Day Demand	No figure given.	2400m^3/day (27.8 L/s)	Based directly on 2400 dwelling equivalents at 1000 L/day
Peak Day Demand	82.4L/s	4800m^3/day (55.6 L/s)	Using a peaking factor of 2 on ADD.
Commercial water demand			
New commercial area	2.1ha	2.4ha	Commercial area was provided in the TPLM
Commercial demand rate	0.7L/s/Ha	0.7L/s/Ha	No difference
Commercial demand	No figure given	147m^3/day (1.7L/s)	The difference is minor due to the slightly smaller

			area but the same demand. Also the commercial demand is far outweighed by residential demand and doesn't affect sizing of the infrastructure.

17 Using the WSP assumptions, Section 4.2.3 of the WSP Report describes a servicing concept for the TPLM Variation Area. New infrastructure will be required to service the new development within the TPLM Variation Area. It is possible that the development is serviced from the Shotover Country Water Treatment Plan (**Shotover WTP**). That will require:

(a) New trunk main to deliver water from Shotover WTP to the Ladies Mile Reservoir;

(b) A new Ladies Mile Reservoir;

(c) A new bore and pump station at the Shotover Country Borefield and WTP;

(d) New trunk reticulation from the reservoir to the development areas.

18 I have considered the water supply demand for the development and it is my opinion that the water concept design detailed in the WSP Report provides a feasible water supply servicing solution for the development anticipated within the TPLM Variation Area.

19 I note that these concepts are intended to guide future engineering projects that will include both new infrastructure and the optimization of existing infrastructure to service the area. While I have set out some proposed servicing routes in the WSP Report, design of local reticulation within the area will be the responsibility of developer's engineers.

Te Mana o Te Wai

20 In preparing the WSP Report and my evidence I have considered the principles of Te Mana o te Wai and the National Policy Statement for Freshwater Management (**NPSFM**).

21 At section 4.4 of the WSP report I have concluded that the Water Supply Concept will give effect to Te Mana o te Wai in a number of ways.

Suggested changes to provisions

22 At paragraph 4.3 of the WSP Report I have set out the following recommended provisions:

(a) All water supply infrastructure is to be designed and constructed in accordance with the current QLDC Draft Code of Practice 2022 requirements and additional provisions below.

(b) Development and management of the water supply network is to be developed in conjunction with QLDC so as to achieve the outcomes required for reliable network operations. No private water supply systems are permitted.

(c) Land be made available for bulk reticulation (trunk rising mains, falling mains and reservoirs) within road corridors or sufficiently sized easements provided.

(d) Rules outlined in Table 4-1 be adopted to promote efficient water usage.

23 I understand that these matters will be addressed in the Section 42A report to the extent it is possible to include them in the TPLM Variation.

Wastewater servicing concept

24 Section 5.1 of the WSP Report outlines the existing wastewater servicing for the TPLM Variation Area.

25 In order to determine a servicing concept for the TPLM Variation Area I have calculated the wastewater servicing required to accommodate the development within the TPLM Variation. I have reviewed the wastewater demands in section 6.1 of the Candor3 Report and comment below on where I have used different assumptions.

Parameter	Candor3 Assumption	WSP Assumption	Comment
Residential Wastewater Discharge			
New residential units	2400 DUEs	2400 DUEs	No difference
People Per Dwelling	2.78	3 capita/ DUE	The QLDC CoP has been updated for 3 people per dwelling.
Average Dry Weather Wastewater Discharge Per Capita	Dry weather flow of 250/L/person/ day	250 L/capita/day	No difference
Average Dry Weather Wastewater Flow per DUE		750 L/DUE/day	Based on 3 people per dwelling
Average Wastewater Discharge	Not stated	1,800 m^3/day (20.8 L/s)	
Dry Weather Peaking Factor	2.5	2.5	
Wet Weather Peaking Factor	2	2	
Peak Wastewater Discharge	Dry weather peak: 51.8 L/s	104L/s	May be a rounding difference, but they are

	Wet weather peak: 103.5 L/s		essentially the same for PDWF and PWWF.
Commercial Wastewater Discharge			
New commercial Area	2.1 Ha	2.4 Ha	As for water, the TPLM stated the commercial area.
Commercial Water Usage (Medium)	0.7 L/s/Ha	0.7L/s/Ha	
Average Commercial demand	Not stated	69m^3/day (0.8 L/s)	
Total Wastewater Discharge			
Average Wastewater Discharge	Not stated	21.6 L/s	
Peak Wastewater Discharge	Not stated	104.8 L/s	Note that this is the raw expected inflow to the pump station. The pump design has a performance factor applied.

26 Using the WSP assumptions, Section 5.2.3 of the WSP Report describes a wastewater servicing concept for the TPLM Variation Area. New reticulation will be required to service the new development within the Variation, including:

(a) A new pumping station (**Ladies Mile PS**) at the eastern extent of the zone;

(b) A new pressure main;

(c) A new bridge crossing; and

(d) A new inlet nozzle to the Shotover Waste Water Treatment Plant (**SWWTP**).

27 In the WSP Report I have identified that the preferred location for the new Ladies Mile PS is on the north side of State Highway 6 (**SH6**) near McDowell Drive. This is because of the natural fall of the land to the east and will allow the entire TPLM wastewater catchment to flow by gravity to the new Ladies Mile PS.

28 I am aware that Threepwood Farm Residents Association and Threepwood Custodians Limited (submitter 33) have submitted on the TPLM Variation noting that the Three Waters Infrastructure Report states that the proposed pump station will be located on land owned by the Council. However, the site identified is owned by Threepwood. As with Candor3, I have identified the same preferred location for the Ladies Mile PS. While this location is preferred, it is not a requirement of the TPLM Variation. Therefore, if agreement cannot be reached with the landowner regarding location of the Ladies Mile PS, an alternative location will need to be identified.

29 I have considered the wastewater servicing for the development and it is my opinion that the wastewater concept design detailed in the WSP Report provides a feasible wastewater servicing solution for the development anticipated within the TPLM Variation Area.

30 I note that these concepts are intended to guide future engineering projects which will include both new infrastructure and the optimization of existing infrastructure to service the area. Design of local reticulation within the area will be the responsibility of developer's engineers.

Timing of Infrastructure Delivery

31 As there is no existing wastewater reticulation for TPLM, there is limited scope for development to proceed in advance of the new infrastructure being delivered.

32 There is some capacity to stage development of new infrastructure from TPLM as there is some capacity in the existing Arrowtown-Lake Hayes Rising Main (RM). This would require:

(a) The initial construction of the Ladies Mile PS and construction of the Rising Main that outlets to the gravity section of the Arrowtown-Lake Hayes RM.

(b) When TPLM develops such that capacity of the gravity section of Arrowtown-Lake Hayes RM is exceeded, construct a parallel pipeline connecting the Ladies Mile RM directly to the Shotover Waste Water Treatment Plant (**SWWTP**) (including Shotover River crossing).

(c) Pumps at the Ladies Mile PS can be staged for both rising main configurations.

Capacity of the Shotover Bridge

33 The proposed Wastwater Servicing concept requires a new pipe to be installed below the Shotover Bridge to take wastewater from TPLM to the SWWTP.

34 As set out in section 5.3 of the WSP Report, I have considered whether there is capacity to install a new pipe under the Shotover Bridge. In my opinion, subject to confirming with Waka Kotahi who are the owners of the structure, it is feasible to install the required wastewater pipe in the upstream armpit of the Shotover Bridge and this could be accommodated based on the 2019 live load and seismic resistance assessment of the Shotover Bridge.

Te Mana o Te Wai

35 As with Water Supply, in preparing the WSP Report and my evidence I have considered the principles of Te Mana o te Wai and the NPSFM.

36 At section 5.5 of the WSP report I have concluded that the Wastewater Supply Concept will give effect to Te Mana o te Wai in a number of ways.

Suggested changes to provisions

37 At paragraph 5.4 of the WSP Report I have set out the following recommended provisions

(a) All wastewater infrastructure is to be designed and constructed in accordance with the current QLDC Draft Code of Practice 2022 requirements and additional provisions below.

(b) Development of the wastewater network is to be in conjunction with QLDC to produce an integrated solution to provide efficient wastewater servicing to the Zone and greater area.

(c) Development and management of the wastewater network is to be in conjunction with QLDC so as to achieve the outcomes required for reliable network operations. No private wastewater systems are permitted.

(d) Land be made available for wastewater infrastructure within road corridors or sufficiently sized easements provided.

38 I understand that these matters will be addressed in the Section 42A report to the extent it is possible to include them in the TPLM Variation.

Stormwater Servicing Concept

39 Section 6.2 of the WSP Report outlines the existing stormwater servicing for the TPLM Variation area.

40 I note that there are existing overland flows from Slope Hill, north of the TPLM Variation area, generally southeast towards Lake Hayes, spilling widely across the flat plains of Ladies Mile. Overland flow then passes through wide channels, through the low point along the TPLM Variation area with a gradual slope of less than 1% to the south-west towards Lake Hayes. The existing overland flows to Lake Hayes are addressed in section 6.3 of the WSP Report.

41 I understand that Lake Hayes is currently degraded, and improvement of the Lake Hayes water quality is of high concern to QLDC, mana whenua and the Friends of Lake Hayes in particular. This has informed the stormwater servicing concept for TPLM.

42 I have also considered the TPLM guiding principles for stormwater management that were developed in response to the Council initially being concerned about requiring an integrated solution. These Principles are set out in the evidence of Mr Gardiner and I do not repeat them here. I have incorporated these principles into the concept design for stormwater management at TPLM.

43 Section 6.5 of the WSP Report describes a stormwater servicing concept for the TPLM Variation Area. New stormwater infrastructure will be required to service the new development within the TPLM Variation Area, including:

(a) A fully integrated stormwater management solution for Ladies Mile and Slope Hill is to be coordinated across development blocks to provide between 1 and 4 facilities (detention basins and/or soakage devices). This will include coordinated overland flow paths through the developments to ensure no adverse effects on downstream properties.

(b) A vegetated swale/basins with incorporated water quality pre-treatment and soakage to ground along the northern boundary of the site to capture runoff from Slope Hill. This system should be designed to capture up to the 1% Annual Exceedance Probability (**AEP**) rainfall event with no discharges to Lake Hayes.

(c) If soakage to ground for the 1% AEP event is not feasible, stormwater from events up to and including the 5% AEP are to be soaked to ground with overflow permitted to Lake Hayes or Hayes Creek.

(d) Local first flush treatment of carparks and roads is to be provided within the development area.

44 I have considered the stormwater servicing for the development based on the work completed by Candor3 and adjacent work undertaken by the NZUP project and it is my opinion that the stormwater concept design detailed in the WSP Report provides a feasible stormwater servicing solution for the development anticipated within the TPLM Variation Area.

45 The success of this stormwater concept will depend in large part on the multiple landowners working together to deliver an integrated system. I

agree with Mr Gardiner that individual stormwater systems will be complex and require considerably more land than an integrated system.

46 In my opinion, if this integrated stormwater concept is implemented, it will improve the water quality in Lake Hayes in that either no runoff that is sediment laden will make it to the lake, or only the larger events would result in discharges to the lake but these events would be less frequent, because of the attenuation capacity in the system, than in the current undeveloped situation and therefore there would be less frequent discharges to the lake. When discharges do occur in the larger events, the overland flows created may have less sediment because the pastural land is changed and less able to give up sediment. Therefore, overall implementation of an integrated stormwater system should result in improved quality of the water entering Lake Hayes from the TPLM Variation Area.

47 I note that these concepts are intended to guide future engineering projects which will include both new infrastructure and the optimization of existing infrastructure to service the area. Design of local reticulation within the area will be the responsibility of developer's engineers.

Response to submissions

48 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 in the TPLM Variation. One of the key concerns in these submissions is the effect of discharges to Lake Hayes.

49 Importantly, as is detailed in the WSP Report, stormwater runoff from events up to and including the 1% AEP event is to be soaked to ground with no discharges to Lake Hayes. Only if this is proven infeasible, stormwater from events up to and including the 5% AEP is to be soaked to ground with overflow of stormwater to Lake Hayes or Hayes Creek. I note that any discharge of stormwater is a matter regulated by Otago Regional Council, not QLDC.

50 A water quality expert would be required to comment on the effect of these stormwater overflow events to Lake Hayes. However, I have considered a number of options or features that could be incorporated

into the TPLM Variation Stormwater system to prevent erosion at the source and provide water quality treatment. These measures are set out in section 6.2 of the WSP Report and include:

(a) Sediment control measures that could be encouraged on Slope Hill include:

(i) Gully planting to establish indigenous vegetation which will improve channel stability and reduce erosion. Planting of steep channels is particularly of concern on Slope Hill as soils are predominately loess and easily mobilised by rainfall.

(ii) Sedimentation basins in the upper gullies on Slope Hill (where feasible) to temporarily store and release runoff and allow suspended debris and sediment to settle. These features will require periodic maintenance to remove sediments.

(b) Water quality improvement features that could incorporated into the swale include:

(i) Contoured rock bunding/ baffles perpendicular to the channel to temporary store and release flows over multiple days to provide sedimentation treatment. Sections of the swale should include low-flow naturalised meandering channel with sections longitudinal riffles (turbulent areas), runs (smooth water surface), and pools (deeper and slow - moving areas).

(ii) A wider swale around the low flow channel allowing for treatment of regular events with a higher level discharge to ground via scruffy dome manholes sitting above the channel invert.

(iii) Planting of indigenous vegetation in and across the stream channel to provide filtering of runoff while also providing habitat.

(iv) Regular sediment depth measurements in the swale should be undertaken to record track accumulation and identify where removal maintenance is necessary to avoid reanimation during large events that may spill to Lake Hayes.

51 If these measures are incorporated into the final design of the stormwater system, I consider that it will be consistent with best practice for stormwater management.

Te Mana o Te Wai

52 As with Water Supply and Wastewater, in preparing the WSP Report and my evidence I have considered the principles of Te Mana o te Wai and the NPSFM.

53 At section 6.7 of the WSP Report I have concluded that the Stormwater Supply Concept will give effect to Te Mana o te Wai in a number of ways.

Suggested changes to provisions

54 At paragraph 6.6 of the WSP Report I have set out the following recommended provisions:

(a) All stormwater management infrastructure is to be designed and constructed in accordance with the current QLDC Draft Code of Practice 2022 requirements and additional provisions below;

(b) A fully integrated stormwater management solution for Slope Hill (including treatment) is to be coordinated across development blocks to provide between 1 and 4 facilities (detention basins and/or soakage devices). This will include coordinated overland flow paths through the developments to ensure no adverse effects on downstream properties;

(c) Land along the toe of Slope Hill be made available for made available for stormwater management;

(d) Pre-treatment of Slope Hill Runoff and treatment of first flush from roads, carparks etc must be provided to ensure longevity of soakage devices;

(e) Stormwater runoff from events up to and including the 1% AEP event is to be soaked to ground. If this is proven infeasible, stormwater from events up to and including the 5% AEP is to be soaked to ground with overflow of stormwater to Lake Hayes or Hayes Creek;

(f) Easements are to be provided as required for new stormwater trunks and swales cross private property. Where possible

infrastructure will be coordinated within QLDC owned road corridors and the SH6 corridor.

(g) Sediment and erosion control plans be prepared by a suitably qualified temporary works engineer and be implemented for the duration of the construction.

(h) All stormwater management systems will be designed considering climate change adjusted rainfall (RCP6.0 for the period 2081-2100).

55 I understand that these matters will be addressed in the Section 42A report to the extent it is possible to include them in the TPLM Variation.

Response to Submissions

56 I have reviewed the submissions that comment on matters relevant to delivery of wastewater and water supply infrastructure required as part of the TPLM Variation area being developed. The key matters raised in submissions are:

(a) The ability to provide infrastructure to service development enabled by the TPLM Variation; and

(b) Wastewater disposal.

57 I respond to these matters below.

Ability to provide infrastructure to service the TPLM Variation

58 Sherry Thornburg (submitter 63) and Park Ridge Limited (submitter 75) submit that there is insufficient infrastructure to services the additional growth and development enabled by the TPLM Variation.

59 In particular, Celine Austin (submitter 57) raises concerns that with the capacity of the SWWTP to accommodate development of the TPLM Variation Area.

60 Waka Kotahi (submitter 104) seeks to understand Council's capacity to deliver core wastewater and water supply to the TPLM Variation Area and submits there is benefit in aligning delivery of this infrastructure with corridor improvements proposed by Waka Kotahi and the subsequent development of the TPLM Structure Plan Area.

61 I agree that the existing infrastructure for water and wastewater conveyance is insufficient to handle the full extent of development. I do

believe that new infrastructure to facilitate development can be constructed. It would be beneficial to work with Waka Kotahi to position and coordinate installation of infrastructure that would be utilising the state highway corridor, for efficiencies of cost and to avoid trenching through new pavements, although this is not a barrier to the work if coordination is not possible. The upgrades to the existing SWWTP are underway to increase service flows, and I have been informed by the engineer (John Crawford, Beca) that there will be capacity to accept the TPLM wastewater flows into the plant with only upgrades to the inlet headworks necessary.

Wastewater disposal

62 Nadie Lisitsina (submitter 23) submits that the TPLM Variation needs to account for future wastewater infrastructure.

63 John Alexander (submitter 70) has concerns with treated disposal being discharged to the Kawarau River.

64 I have referred to the infrastructure and SWWTP in paragraph 59 above. I agree that future infrastructure upgrades to the SWWTP is necessary, but I believe new conveyance reticulation is the only aspect necessary. I do not know enough about the risk profile for overflows/discharges from the SWWTP to comment on the submission of John Alexander (submitter 61) but note that the SWWTP (and discharges from it) is separately regulated.

Amy Catherine Prestidge

29 September 2023

Queenstown Lakes District Council

TE PŪTAHI LADIES MILE PLAN VARIATION

3 WATERS SERVICING CONCEPT

29 SEPTEMBER 2023

PUBLIC

TE PŪTAHI LADIES MILE PLAN VARIATION
3 WATERS SERVICING CONCEPT

Queenstown Lakes District Council

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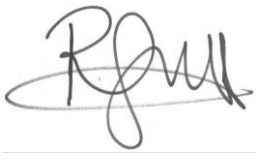
REV	DATE	DETAILS
1	08/09/2023	Draft for client review
2	27/09/2023	Revised draft from client comments, stormwater sections added
3	29/09/2023	Report issued as final

	NAME	DATE	SIGNATURE
Prepared by:	Mark de Lange	26/09/2023	
Reviewed by:	Amy Prestidge	29/09/2023	
Approved by:	Richard Gill	29/09/2023	

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EXECUTIVE SUMMARY

Queenstown Lakes District Council (QLDC) has proposed the Te Pūtahi Ladies Mile Variation to the Proposed District Plan (PDP). This variation will enable approximately 2,400 new, mostly higher density, residential units as well as provide a range of open spaces, community facilities and a new town centre. This report presents high-level 3 waters concepts to prove the feasibility of servicing the Te Pūtahi Ladies Mile area. These concepts are intended to guide future planning and subsequent coordinated engineering projects which will include both new infrastructure and the optimization of existing infrastructure to service the area. Local subdivisional reticulation within the areas is out of scope and will be the responsibility of developer's engineers.

WATER SUPPLY

The water supply servicing concept includes the following key infrastructure:

- Installation of a new bore and pump at Shotover Country Water Treatment Plant
- 2,000 m of new DN 400 PE100 PN16 trunk rising main to deliver water from SOC WTP to the new Ladies Mile Reservoir
- A new 2.5 ML Ladies Mile Reservoir on Slope Hill
- 3,500 m of new DN 450 PN16 PE 100 falling main and ring mains through development area

The estimated cost of water supply infrastructure to service the Te Pūtahi Ladies Mile Zone is **$20,060,000**, excluding GST and including a 50% contingency.

WASTEWATER

The wastewater servicing concept includes the following key infrastructure:

- A new pumping station at the eastern extent of the zone with a pump capacity of 120 L/s and 750 m^3 of emergency storage
- 3,500 m of new DN 400 PE100 PN16 pressure pipe in the State Highway 6 road corridor from the new pumping station to the Shotover Wastewater Treatment Plant (WWTP) headworks (excluding the Shotover River crossing)
- 350 m DN 300 stainless steel pressure pipeline across the Shotover River (fixed to the Shotover River bridge in the upstream underarm of the bridge deck)
- A new inlet nozzle at the Shotover WWTP headworks

A live load and seismic resistance assessment of the Shotover River Bridge was undertaken in 2019 by WSP which found it could support four 457 mm OD steel epoxy lined pipelines without compromising performance. Since this assessment, pipes previously installed in the internal bridge deck have been removed with two of the four possible pipelines installed on the downstream armpit of the bridge. There remains space on the upstream armpit of the bridge deck for the proposed stainless steel wastewater main. However, the upstream side is congested with a large gas main utility, and any proposed mountings would need to consider and satisfy both the maintenance and operations of the gas service utility as well as Waka Kotahi, and QLDC services. Included in the report are mounting details and further items to initiate consultations with involved stakeholders, and guide design solutions.

The estimated cost of wastewater infrastructure to service in the Te Pūtahi Ladies Mile Zone is **$28,551,000**, excluding GST and including a 50% contingency.

STORMWATER

The stormwater management concept described in this report is based on work described in John Gardiner's Candor3 Ladies Mile reports, Warren Ladbrook's Flints Park report, hydraulic modelling data from the Kā Huanui a Tāhuna Howards Drive Roundabout project, and various supporting documents.

The improvement of the water quality discharges to Lake Hayes is of high concern to QLDC, Kāi Tahu and Friends of Lake Hayes. Hydraulic modelling indicates there are likely existing overland flow discharges to Lake Hayes during large rainfall events, however in the interest of preserving water quality in the lake, the concept described has been developed such that there are no overland discharges for events up to the 1% Average Recurrence Interval (ARI) event.

The stormwater concept includes the following key infrastructure:

- A fully integrated stormwater management solution for Te Pūtahi Ladies Mile and Slope Hill that coordinated across development blocks to provide between 1 and 4 facilities (detention basins and/or soakage devices). This will include coordinated overland flow paths through the development areas to ensure no adverse effects on downstream properties.
- A vegetated swale/basin with incorporated water quality pre-treatment and soakage to ground along the northern boundary of the site to capture runoff from Slope Hill. This system is to be designed to capture up to the 1% AEP rainfall event with no discharges to Lake Hayes.
- If soakage to ground for the 1% AEP event is infeasible, stormwater from events up to and including the 5% AEP are to be soaked to ground with overflow permitted to Lake Hayes or Hayes Creek.
- Local first flush treatment of carparks and roads is to be provided within the development area in accordance with the QLDC Code of Practice.

Further details to support each of the 3 waters concepts, including giving effect to Te Mana o te Wai, recommended conditions, land take requirements, timing and staging are provided in each respective 3 waters section.

1 INTRODUCTION

Queenstown Lake District Council (QLDC) has proposed the Te Pūtahi Ladies Mile Variation to the Proposed District Plan (PDP). This Variation includes the redesignation of roughly 160 Ha of land (currently Rural, Rural Lifestyle, and Large Lot Residential) along the Te Pūtahi/Ladies Mile Corridor between Kimi-ākau/Shotover River and Te Whaka-ata a Haki-te-kura/Lake Hayes to allow for higher housing density and provide for future demand.

The Te Pūtahi Ladies Mile Variation will enable approximately 2,400 Dwelling Unit Equivalents (DUEs) consisting primarily of medium and high-density apartments and duplexes, as well as some standalone housing. The rezoned areas will also provide a range of open spaces and community facilities and a new town centre. Figure 1-1 presents the concept layout of the Te Pūtahi Ladies Mile Zone. (QLDC , 2023)

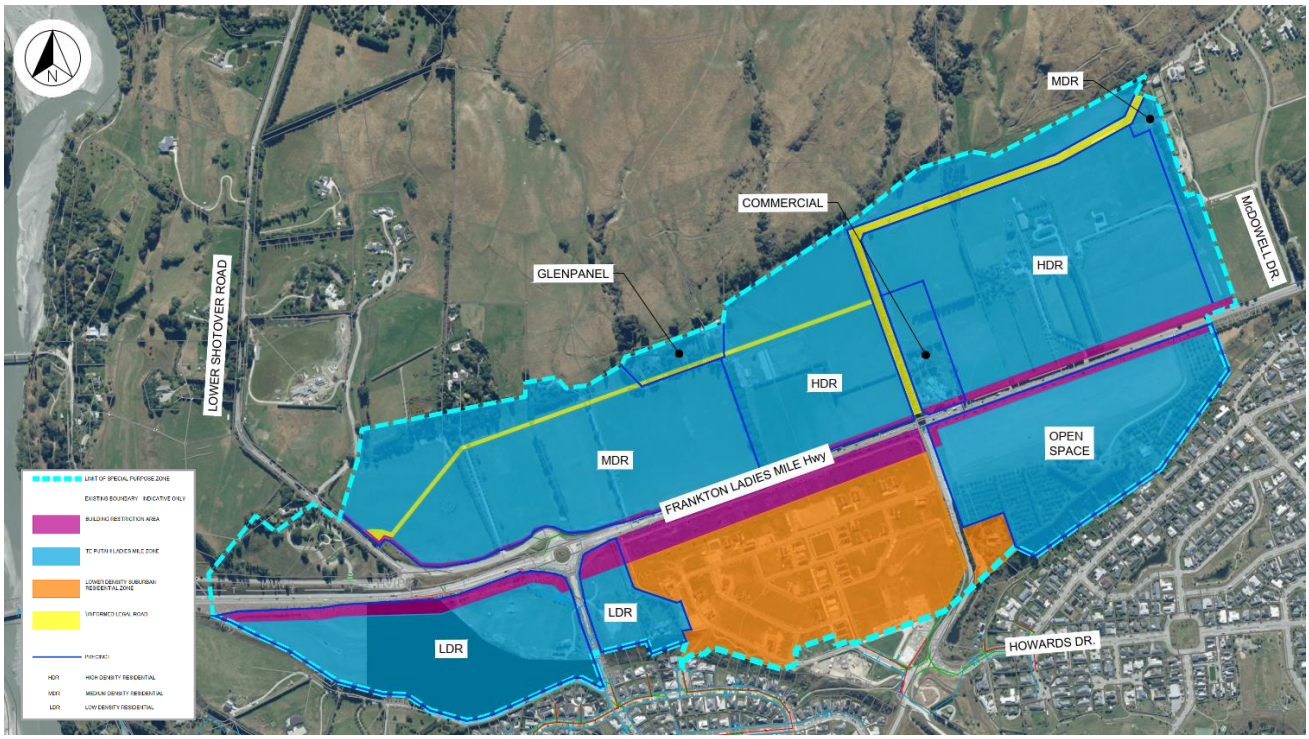

Figure 1-1: Te Pūtahi Ladies Mile Concept Layout (QLDC, 2023)

This report details the 3 waters servicing concept developed to support the Te Pūtahi Ladies Mile Plan Variation. The methodology and key assumptions used to develop water supply, wastewater and stormwater servicing concepts are described in each respective section.

This report presents high-level servicing solutions to inform the Te Pūtahi Ladies Mile Variation to prove feasibility of service to the area. The solutions in this report are intended to guide future planning and subsequent engineering projects that will introduce the new infrastructure and optimize existing infrastructure to coordinate servicing the Te Pūtahi Ladies Mile area. Details of local reticulation will be the responsibility of developer's engineers.

2 BACKGROUND

WSP has previously advised QLDC in the development of 3 waters infrastructure concept plans to support the Ladies Mile Housing Infrastructure Funding (HIF) detailed business case (WSP Opus, 2018). Further to this work, QLDC have undertaken a range of Master Planning, modeling and engineering studies on critical infrastructure to service Te Pūtahi Ladies Mile. Reports from these investigations and QLDC planning documents have formed the basis of this assessment.

Reports reviewed to inform this assessment include the following:

- Ladies Mile Te Pūtahi Masterplan: Three Waters Infrastructure Report (Final) (Candor3 2022)
- Queenstown water supply model: model update and system performance assessment (Mott MacDonald 2022)
- Shotover Country, Borefield & WTP: Network Functional Description, Facility Commissioning and Network Integration (QLDC 2022)
- Queenstown Water Supply: Shotover Country Water Treatment Plant Integration Review Report (Watershed 2023)
- Wakatipu Water Supply Master Plan – April 2020 Rev B
- Shotover Country Water Treatment Plant & Bore Pump: Operations & Maintenance Manual (Fulton Hogan Ltd, n.d.)
- Shotover Country Borefield, Water Treatment Plant and Rising Mains Concept Design Report (Fluent 2018)
- Shotover Country Borefield, Water Treatment Plant and Rising Mains Detailed Design Report (Fluent 2019)
- Arrowtown-Lake Hayes Rising Main Capacity Assessment Transient Assessment And Hydraulic Analysis (GHD 2023)
- Project Shotover Stage 3 - Detailed Design Report (Beca 2022)
- Shotover Country Water Supply, Bridge Crossing: Detailed Design Report (Fluent 2020)
- SH6 Shotover Bridge Proposed Water Mains: Effect on Live and Seismic Bridge Capacities (WSP-Opus 2019)
- Queenstown Country Club Retirement Village Trunk Stormwater Pipeline Design Report for Engineering Approval (Fluent 2017)

3 TE MANA O TE WAI

Te Mana o te Wai, or mana of the water, is centered on recognising the importance of clean, healthy water for maintaining the health of waterbodies, freshwater ecosystems and the communities that rely on them. This approach sets out to support the health and wellbeing of a waterway, rather than the customary approach of limiting adverse effects to within acceptable limits.

Te Mana o te Wai sets outs to achieve the following:

- Recognise that protecting the health of freshwater (te hauora o te wai) protects the health and well-being of the wider environment (te hauora o te taiao) and of people (te hauora o te tangata)
- Protect the mauri of the wai.

Policy 1 of the National Policy Statement for Freshwater Management requires water be managed in a way that gives effect to Te Mana o te Wai, such that:

- The health and well-being of water bodies and freshwater ecosystems is prioritised
- Tangata whenua are actively involved in freshwater management and decision-making
- An integrated approach is adopted to recognize the interconnectedness of the whole environment, ki uta ki tai (from the mountains to the sea).

Principles that can be adopted in Te Pūtahi Ladies Mile Plan Variation to promote Mana o te Wai include the following:

- Consultation with iwi to ensure that the mauri of the wai is protected.
- Limiting private water supplies and wastewater disposal systems within the zone and instead relying on centralised QLDC led and managed systems, following best practice to protect waterways and promote ecosystem health.
- Introducing conditions/ policies to reduce residential and commercial water usage in new development areas to minimise demand on water sources and wastewater generation.
- Water supply intake volumes be proportional to the natural flow and intakes be designed to not disrupt this flow.
- Ecosystem needs be considered holistically, both through maintaining natural flow of watercourses and preventing contamination.
- Maintaining natural connections between surface water and groundwater.
- Attenuation of stormwater at source and the use of the cleansing/ purifying processes of the whenua to remove contaminants.
- Establishment and maintenance of riparian buffers consisting of indigenous vegetation between watercourses and built infrastructure.
- Considering resilience and factors of safety to protect against wastewater overflows and leakage.
- Design for changing environment, with particular focus on the effects of climate change.

Further details of how each of the 3 waters concepts to service Te Pūtahi Ladies Mile gives effect to Te Mana o te Wai is provided in each section.

4 WATER SUPPLY

4.1 EXISTING WATER SUPPLY SERVICING

There is currently limited water supply servicing for Te Pūtahi Ladies Mile, with the southwestern portion and the Queenstown Country Club serviced by the Shotover Country (SOC) Water Supply. Figure 4-1 presents the layout of the existing water network and identifies key features.

Figure 4-1: Existing Water Supply Network Servicing

The SOC Borefield and Water Treatment Plant (WTP) have recently been upgraded to comply with the Drinking-water Standards for New Zealand (DWSNZ) and provide for growth. This upgrade consisted of the initial development of 4 production bores (3 duty/assist pumps and 1 standby) with the ultimate build out of the site including 6 bores (5 duty/assist pumps and 1 standby).

The flow rate from the Borefield and WTP is determined by the number of pumps running as follows:

- 1 pump, 80-85 L/s, equivalent to 7 MLD over 24 hrs, or 5.5 MLD over 18 hrs.
- 2 pumps, 160-170 L/s, equivalent to 14 MLD over 24hrs, or 11 MLD over 18 hrs.
- 3 pumps, 240-255 L/s, equivalent to 21 MLD over 24hrs, or 16.5 MLD over 18 hrs.
- 4 pumps, 320-340 L/s, equivalent to 28.5 MLD over 24hrs, or 22 MLD over 18 hrs.
- 5 pumps, 400-425 L/s, equivalent to 34.5 MLD over 24hrs, or 27.5 MLD over 18 hrs.

Upon successfully commissioning the new bores, the initial SOC Borefield and WTP setup (3 duty/assist pumps and 1 standby) is anticipated to be the sole source for the Wakatipu Water Supply until approximately 2028, by which time additional bore pump/s will be commissioned and/or the Kelvin Heights intake is brought back into service. (QLDC, 2023)

The detailed design report for the SOC WTP allowed for an ultimate built-out flow of 564.4 L/s for the year 2068 with 82.5 L/s dedicated to Lake Hayes/ Ladies Mile (Fluent, 2019). This indicates that further upgrades of the planned 5 duty/assist pumps will be required in the future if no alternative supply is created for the current service areas.

The recently upgraded SOC WTP is the nearest plant in Queenstown that fully complies with the Drinking Water Standards for New Zealand (DWSNZ) and has planned upgrades for growth, therefore has been chosen to service growth in Te Pūtahi Ladies Mile. The WTP's detailed design report states that a new treatment plant on Spence Road may be required in future if increased demand on the SOC bores results in decreased source water quality.

The SOC WTP and borefield has planned capacity to service development in Te Pūtahi Ladies Mile, however there is no existing trunk reticulation to, or storage capacity within, land north of State Highway 6. New infrastructure including rising mains, reservoir(s), falling mains, will be required to service this area. There is a low capacity watermain (DN 150) crossing the highway at the Stalker Road roundabout to service a private water supply. This connection will provide minimal water supply servicing to the area and therefore has not been developed as an option to service new development. Areas of Te Pūtahi Ladies Mile south of the highway and east of Stalker Road are currently under development with water supply servicing provided from the existing Lower Shotover network. These areas have been identified as low density residential in the Plan Variation and will not be serviced by new water supply infrastructure described in the following sections.

4.2 SERVICING CONCEPT

4.2.1 OVERVIEW

New trunk reticulation from the SOC WTP is required to service new development areas in Te Pūtahi Ladies Mile. This reticulation will consist of the following:

- New trunk rising main to deliver water from SOC Borefield WTP to the new Ladies Mile Reservoir,
- A new bore and pump in the SOC Borefield and WTP (contingent on wider water provisioning for the service area);
- A new Ladies Mile Reservoir, and
- New trunk reticulation from the Ladies Mile Reservoir to new development areas.

4.2.2 WATER DEMAND

Per capita water consumption in Queenstown is amongst the highest in New Zealand, with QLDC's Land Development and Subdivision Code of Practice (LD&S CoP) requiring reticulation be designed for a demand of 700 L/person/day. To manage demand Te Pūtahi Ladies Mile, rules outlined in Table 4-1 are recommended to promote efficient water usage. These are elements that could be introduced at a local level to dwellings within the development.

Table 4-1: Water Demand Management Interventions

DESCRIPTION	CONSENT CONDITION	CONSENT NOTICE	CONSENT ON TITLE
Shower heads and at least 70% of other taps shall be 4 Star or better water-saving fixtures			Yes
Shower head/tap restrictors			Yes

DESCRIPTION	CONSENT CONDITION	CONSENT NOTICE	CONSENT ON TITLE
Flow meters required (both each property and for small DMA zones)	Yes		
Irrigation flow meters (encouraged)			
All fixed water-using appliances (dishwasher) shall be 4 Star or better water-saving fixtures			Yes
All houses to have 6/3 litre, or less, dual flush toilets			Yes
No water features/ ponds or other high-volume uses to be connected to the potable public water supply system		Yes	
Only 1 outdoor tap			Yes
Rainwater collection and re-use for garden irrigation		Yes	
Aerated taps			Yes
SW re-use for irrigation			Yes
Zone/District Plan restrictions/limitations on water demand sensitive planting rules for irrigation and property planting.	Yes	Yes	Yes

Considering the demand management strategies outlined above, Table 4-2 presents a breakdown of the water demand calculation for Pūtahi Ladies Mile.

Table 4-2: Water Demand Calculation

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Residential Water Demand		
New Residential Units	2,400 DUEs	Te Pūtahi Ladies Mile Factsheet (QLDC , 2023)
Average Day Demand per Unit (Represented as daily average, not a peak instantaneous flow)	1000 L/DUE/day	Email from QLDC (08/08/20230)
Peak Day Demand per Unit (Represented as daily average, not a peak instantaneous flow)	2000 L/DUE/day	Email from QLDC (08/08/20230)

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Average Day Demand (Represented as daily average, not a peak instantaneous flow)	2,400 m^3/day (27.8 L/s)	-
Peak Day Demand (Represented as daily average, not a peak instantaneous flow)	4,800 m^3/day (55.6 L/s)	-
Commercial Water Demand		
New Commercial Area	2.4 Ha	Estimated from Te Pūtahi Ladies Mile Factsheet (QLDC , 2023)
Commercial Demand Rate (Medium)	0.7 L/s/Ha	QLDC LD&S CoP Section 5.3.5
Commercial Demand	147 m^3/day (1.7 L/s)	-
Total Water Demand		
Total Average Day Demand (Represented as daily average, not a peak instantaneous flow)	2,547 m^3/day (29.5 L/s)	-
Total Peak Day Demand (Represented as daily average, not a peak instantaneous flow)	4,947 m^3/day (57.3 L/s)	-

4.2.3 BASIS OF DESIGN

As noted in Section 4.1, the design of the SOC WTP has allowed for a peak daily flow of 82.5 L/s for Lake Hayes and Ladies Mile in 2068 (Fluent, 2019). This is sufficient to meet the calculated demand for Ladies Mile (assuming an 80% to 20% distribution of new connections between Ladies Mile and Lake Hayes as per QLDC's Demand Projections 2021 – 2051). However, demand from Lake Hayes and Ladies Mile contributes to the full demand on the SOC Borefield WTP in 2068 of 564.4 L/s, which exceeds the built-out borefield capacity (5 pumps, 400-425 L/s). Additional bore/s and pump/s will be required at SOC Borefield WTP if other areas are not supplied from alternate sources. The SOC Borefield WTP, including mains and feeds from the borefield, has been sized for 2068 design flows.

The required volume of the new Ladies Mile Reservoir was determined in accordance with the Draft QLDC Water Supply Reservoirs design guideline, which requires reservoirs minimum gross storage be the greater of:

- 24 hours of average day demand
- 12 hours of peak day demand

— 6 hours of average day demand plus the greatest firefighting storage requirement for the network as defined by SNZ PSA 4509:2008

Table 4-3 presents the reservoir storage calculation, concluding a storage volume of 2,500 m^3 is required.

Table 4-3: Ladies Mile Reservoir Storage Calculation

PARAMETER	VOLUME (M^3)
24 Hours of Average Day Demand	2,547 (Critical Volume)
12 Hours Peak Day Demand	2,474
6 Hours Peak Day Demand	*1,237*
Greatest Firefighting Demand (FW2)	*540*
6 Hours Peak Day Demand + Greatest Firefighting Demand (m^3)	1,777

The previous recommended location for the new reservoir is on Slope Hill, north of the Te Pūtahi Ladies Mile zone. The desired level is RL 407 m to match the height of the existing reservoirs at Quail Rise. The target static pressure for water supply networks at the property boundary is 300 to 750 kPa (Draft QLDC Three Waters System Performance Indicators, item WS-SPI– 07). Figure 4-2 shows the available static pressure through the Pūtahi Ladies Mile Zone considering a reservoir at RL 407 m. The target level of service is achieved for the extent of Te Pūtahi Ladies Mile zone, with no discrete pressure zones required. Red low pressure spots within the green/blue zone are the tops of tree and should be disregarded. This is due to unprocessed LiDAR data.

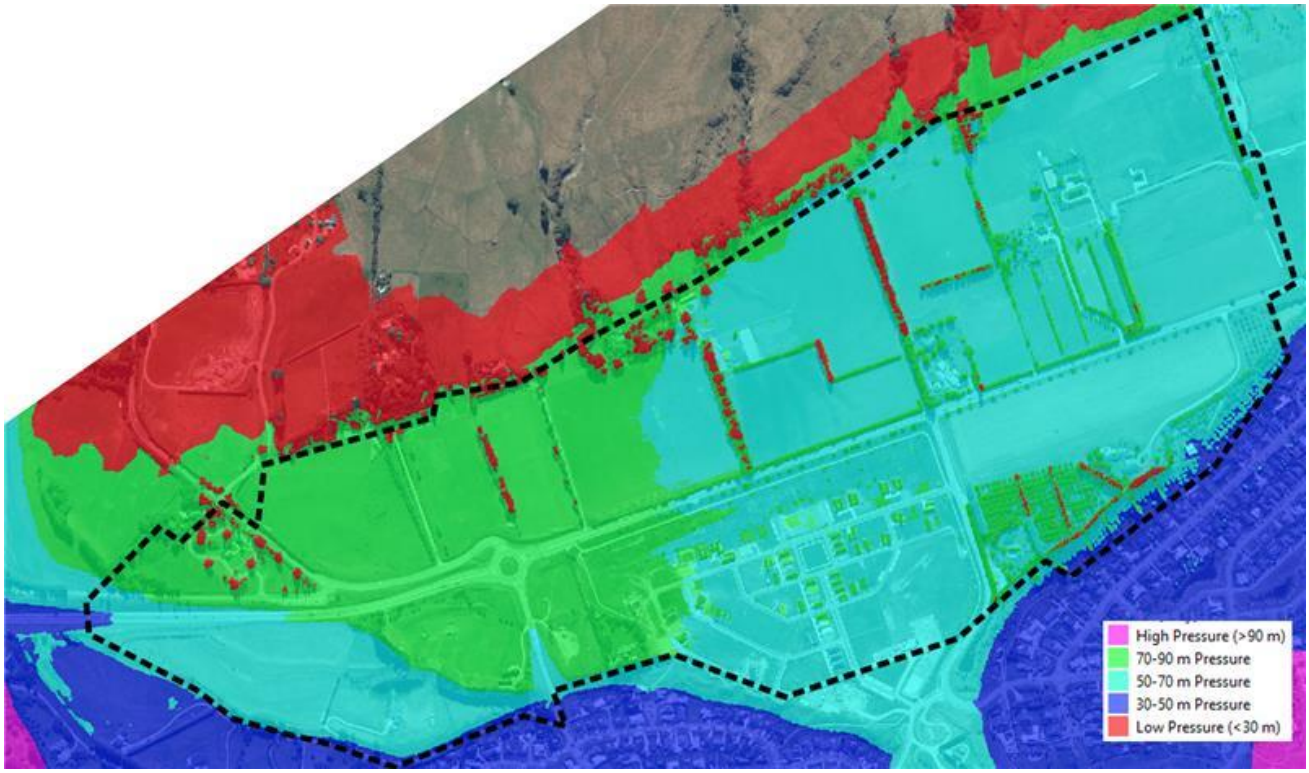

Figure 4-2: Static Pressure for Extent of Te Pūtahi Ladies Mile (Approximate Extent Shown in Black)

The rising main from the SOC WTP to the new Ladies Mile reservoir and falling main to service developed areas was calculated in accordance with the Draft QLDC Water Supply Trunkmains design guideline. The calculated sizing for each is presented in Table 4-4.

Table 4-4: Water Supply Pump and Trunk Mains Sizing Calculations

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Total Peak Day Demand (Represented as daily average, not a peak instantaneous flow)	57.3 L/s	Table 4-2
Pumps/ Rising Main		
Design Statement	Pipe size selected such that pressure loss does not exceed 5 m/km under average day demand (i.e. pump running)	Draft QLDC Three Waters System Performance Indicators, item WS-SPI– 09
Peaking Factor	1.33	Draft QLDC Three Waters System Performance Indicators, item WS-SPI– 14 (24 Peak Day Demand pumped over 18 hours pump operation)

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Peak Flow	76.2 L/s	-
Change in Elevation	108 m	423 m – 315 m
Friction Headloss	4.1 m	Darcy–Weisbach equation, f = 0.06
Total Head	112 m	Change in Elevation + Friction Headloss (rounded)
Pump Operation	Duty/Standby	
Pump Size	75 L/s @ 112 m head	
Resilience	Stand-by Generator on site	
Pipe Size	DN 400 PN16 PE 100	-
Fiction Headloss per km	2.1 m/km	Friction Headloss/ Pipe Length
Peak Velocity	0.9 m/s	Q = VA
Falling Main		
Design Statement	Pipe size selected such that pressure loss does not exceed 5 m/km under average day demand (peak diurnal) or 10 m/km under firefighting scenarios	Draft QLDC Three Waters System Performance Indicators, items WS-SPI– 09 and WS-SPI– 10
Peaking Factor	2.0	Peak day Peak Hour factor (4)
FW2 Demand	50 L/s	Draft QLDC Three Waters System Performance Indicators, item WS-SPI– 13
Peak Flow	114.6 L/s	
Peak Flow + FW2 Demand	164.2 L/s	-
Pipe Size	DN 450 PN16 PE 100	-
Fiction Headloss per km @ Peak Flow	2.6 m/km	Friction Headloss/ Pipe Length
Peak Velocity @ Peak Flow	1.1 m/s	Q = VA

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Fiction Headloss per km @ Peak Flow + FW2 Demand	5.1 m/km	Friction Headloss/ Pipe Length
Peak Velocity @ Peak Flow+ FW2 Demand	1.6 m/s	Q = VA

Appendix A contains the 3 waters servicing plan for Te Pūtahi Ladies Mile.

The proposed servicing route for the trunk rising main from SOC borefield WTP follows Tony's Terrace to Stalker Road. From Stalker Road the main heads north, crossing State Highway 6 at the roundabout, before running cross country to the location of the new reservoir. Congestion with existing services along Old School Road (DN 560 and DN 150 watermains, DN 63 wastewater rising main) makes servicing the reservoir via a rising main on Old School Road/ State Highway 6 less favourable.

The proposed falling main will supply the development areas. At a suitable location within the area, a ring main will be necessary to ensure pressure and flow remain sufficient across the site. This will likely follow the proposed collector roadways according to the Te Pūtahi Ladies Mile concept plan. The location of this main will be revised as layout of the zone is refined and shall be collocated with road corridors or reserve areas.

The network should employ telemetered bulk flow metering at reservoir outlets and within local reticulation (designed by developers) to track and manage network leakage.

It has been assumed upgrades to the SOC borefield WTP processes or a new treatment plant on Spence Road will not be required to service Te Pūtahi Ladies Mile.

4.2.4 TIMING AND STAGING

As there is no existing reticulation north of State Highway 6 suitable for servicing the scale of the Te Pūtahi Ladies Mile there is limited scope for staging new infrastructure. Duplication of reticulation may be appropriate however this will increase overall costs. There is potential for reservoir storage to be staged to service growth as it comes online.

If the housing density of the areas in the zone currently under development (south of the highway and east of Stalker Road) is increased such that the existing connection to the Lower Shotover network is no longer sufficient, increased demand can be met through a new connection to the RM from Shotover WTP on Stalker Road.

4.2.5 LAND-TAKE REQUIREMENTS

All new water supply trunk mains within Te Pūtahi Ladies Mile are to be located within QLDC owned road corridors or easements provided where roadways are not available. The new Ladies Mile reservoir will be located outside of the zone, requiring easements for the reservoir and trunk connections. The exact location of the reservoir will be confirmed as details of the zone layout are refined.

4.2.6 COST ESTIMATE

The estimated cost to provide water supply servicing to the Te Pūtahi Ladies Mile Zone is $20,060,000, excluding GST and including a 50% contingency. A detailed breakdown of this estimate is contained in Appendix B.

The water supply cost estimate includes the following elements and assumptions:

- 2.5 ML Reservoir on Slope Hill;
- New bore and pump at SOC Borefield WTP;
- 2,000 m DN 400 PE100 PN16 rising main; and
- 3,500 m DN 450 PN16 PE 100 PE100 PN16 falling main and ring main through development area

The following assumptions have been adopted in developing cost estimates:

- Ground improvements will be necessary at the Ladies Mile reservoir site
- Installation of the rising main will be predominantly in the road, so traffic management costs are included in the rate
- Installation of the pipes will be to QLDC CoP standards for embedment and backfill
- No upgrade of the treatment processes (i.e. new WTP on Spence Road) will be necessary

4.3 RECOMMENDED PROVISIONS

The following provisions are recommended for development within the Te Pūtahi Ladies Mile zone:

- All water supply infrastructure is to be designed and constructed in accordance with the current QLDC Draft Code of Practice 2022 requirements (specifically section 6.3.3 for future development) and additional provisions below.
- Development and management of the water supply network is to be developed in conjunction with QLDC so as to achieve the outcomes required for reliable network operations. No private water supply systems are permitted.
- Land be made available for bulk reticulation (trunk rising mains, falling mains and reservoirs) within road corridors or sufficiently sized easements provided.
- Rules outlined in Table 4-1 be adopted to promote efficient water usage.

4.4 TE MANA O TE WAI

The water supply servicing concept for the Te Pūtahi Ladies Mile Zone gives effect to Te Mana o te Wai in the following ways:

- QLDC guiding the development and managing the water supply system will mean infrastructure is designed to a high standard, minimising leakage and water wastage.
- A centralised water supply network (no private supplies) will allow for efficient water abstraction, treatment and distribution, reducing demand on sources.
- The introduction of demand management interventions to reduce demand on water sources.

— Water from high quality sources is used, which results in higher quality drinking water, less waste and lower treatment costs.

— Resource consent applications for water takes have considered the wider effects on the water bodies that they draw from.

— There is no impact on fish passage as a result of the SOC borefield operation or any of the proposed new infrastructure.

5 WASTEWATER

5.1 EXISTING WASTEWATER SERVICING

There is limited wastewater servicing for Te Pūtahi Ladies Mile. Existing urban development areas adjacent to the zone are serviced by local gravity systems and a series of integrated pumping stations (PSs) and pressure mains (PMs) discharging to the Shotover Wastewater Treatment Plant (WWTP) west of the Shotover River.

Key wastewater infrastructure relevant to the servicing in the Te Pūtahi Ladies Mile zone is summarised below and shown on Figure 5-1.

- Arrowtown-Lake Hayes PS services Arrowtown and Lakes Hayes Estate. Wastewater is pumped to a force main along State Highway 6 that consists of the following sections:
  - 3 km DN 355 PN12.5 PE100 pipeline (installed 2009) from Arrowtown-Lake PS to McDowell Drive.
  - 1.9 km DN 300 PN6 (Class B) PVC pipeline (installed 1996) from McDowell Drive to the Stalker Road roundabout.
  - 250 m of DN 350 PE80 pipeline (installed 2015) traversing the Stalker Road roundabout.
  - 800 m of DN300 PN6 PVC pipeline (installed 1996) from the Stalker Road roundabout to just east of the Shotover River bridge. This section of pipeline crosses a highpoint from where the pipeline transitions from a pressure to a gravity main.
  - 100 m of DN 335 PE100 pipeline (installed 2020) from just east of the Shotover River bridge to the bridge crossing
  - 345 m of DN 300 stainless steel pipeline (installed 2020) for the Shotover River crossing (operating as an inverted siphon).
  - 500 m of DN300 PN6 PVC pipeline (installed 1996) from the Shotover Bridge to the inlet to the Shotover WWTP.
- Lake Hayes, Kawarau Heights and Lower Shotover are each serviced by local pumping stations discharging to the Arrowtown-Lake Hayes PM through a DN 375 PVC gravity just south of the Lower Shotover Road/ Spence Road intersection (DN 300 PN6 PVC section of pipeline west of high point)
- Threepwood is serviced by local pumping stations with a DN 150 PVC PM crossing State Highway 6 at McDowell Drive and discharging to the Lake Hayes Network.

Stage 3 of improvement works at the Shotover WWTP is currently underway which will increase the treatment capacity to approximately 22 ML/d Peak Dry Weather Flow and have a scheduled completion date in 2025. The upgrade is designed to have capacity until the 2048 planning horizon based on pre-existing loading extrapolated for QLDC growth projections (Beca, 2022).

The upgrade also includes installation of a third screen at the headworks, however, these specific works are for current known demand and will not have space for any additional discharge for a new pipe from Te Pūtahi Ladies Mile without further upgrades.

Figure 5-1: Overview of Existing Wastewater Network Servicing Te Pūtahi Ladies Mile

New trunk reticulation is needed to service development in Te Pūtahi Ladies Mile north of State Highway 6. The recent capacity assessment of the Arrowtown-Lake Hayes RM recommended that the current flow setting in this pipeline not be increased as it would increase the rate of deterioration of the aging sections of DN 300 pipe (GHD, 2023). As is described later in this report (Section 5.2.4) there is opportunity to increase flows in the gravity sections of the pipeline, thus allowing for the construction of a new main suspended by the Shotover Bridge to be delayed. As described, further analysis of this option is needed.

The SOC WWTP has planned capacity to service development in Te Pūtahi Ladies Mile, however additional capacity will be needed at the inlet if a new pipeline is installed.

As was noted for water supply, areas of Te Pūtahi Ladies Mile south of the highway and east of Stalker Road are currently under development and being serviced by the existing Lower Shotover network. These areas have been identified as low density residential in the Plan Variation and will not be connected to new wastewater infrastructure needed to service land north of the highway.

5.2 SERVICING CONCEPT

5.2.1 OVERVIEW

New reticulation is required to service development in Te Pūtahi Ladies Mile, including:

- A new wastewater pumping station (Ladies Mile PS) at the eastern extent of the zone;
- A new pressure main;
- A new bridge crossing; and
- A new inlet nozzle to the Shotover WWTP.

Local pumping stations may be required to convey wastewater to the new Ladies Mile PS if the topography is manipulated to require it. However details of local reticulation have not been developed as part of this study and it appears possible to gravity the full extent of the land to a terminal pump station in the east. There are also opportunities to coordinate upgrade/renewal of the Arrowtown-Lake Hayes PS and PM with new Ladies Mile PS (i.e. a single combined line and PS).

With the topographical profile of the pressure main route, there is significant fall down to the Shotover River, thus turning the lower section of the pressure main into a force main. An air intake valve would likely be necessary at the transition point.

5.2.2 DESIGN FLOWS

Table 5-1 presents a breakdown of the wastewater design flow calculation for Te Pūtahi Ladies Mile.

Table 5-1: Wastewater Design Flow Calculation

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Residential Wastewater Discharge / Demand		
New Residential Units	2,400 DUEs	Te Pūtahi Ladies Mile Factsheet (QLDC , 2023)
People Per Dwelling	3 capita/DUE	QLDC CoP Section 5.3.5.1
Average Dry-Weather Wastewater Discharge Per Capita (Represented as daily average, not a peak instantaneous flow)	250 L/capita/day	QLDC CoP Section 5.3.5.1
Average Dry Weather Flow Wastewater Discharge Per Capita (Represented as daily average, not a peak instantaneous flow)	750 L/DUE/day	QLDC CoP Section 5.3.5.1
Average Dry Weather Flow (ADWF) Wastewater Discharge (Represented as daily average, not a peak instantaneous flow)	20.8 L/s (1,800 m^3/day)	-
Dry Weather Peaking Factor	2.5	QLDC CoP Section 5.3.5.1
Wet Weather Peaking Factor	2	QLDC CoP Section 5.3.5.1
Peak Wet Weather Flow (PWWF) Wastewater Discharge (Represented as Peak Instantaneous Flow (PIF))	104.0 L/s	-
Commercial Wastewater Discharge		
New Commercial Area	2.4 Ha	

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Commercial Water Usage (Medium)	0.7 L/s/Ha	QLDC CoP Section 5.3.5.1
Average Commercial Water Demand	1.7 L/s (147 m^3/day)	-
Total Wastewater Discharge		
Average Dry Weather Flow (ADWF) Wastewater Discharge (Represented as daily average, not a peak instantaneous flow)	22.5 L/s (1,947 m^3/day)	-
Peak Wet Weather Flow (PWWF) Wastewater Discharge (Represented as Peak Instantaneous Flow (PIF))	105.7 L/s	-

5.2.3 BASIS OF DESIGN

The QLDC CoP Appendix G document was used to determine indicative pumping design. The calculation for sizing each is presented in Table 4-4.

Table 5-2: Wastewater Infrastructure Sizing Calculation

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Average Dry Weather Flow (ADWF) Wastewater Discharge (Represented as daily average, not a peak instantaneous flow)	22.5 L/s (1,947 m^3/day)	Table 5-1
Peak Wet Weather Flow (PWWF) Wastewater Discharge (Represented as Peak Instantaneous Flow (PIF))	105.7 L/s	Table 5-1
Pumping Station		
Design Statement	Sized to convey peak wet weather flow as defined in QLDC CoP Section 5.3.5.1	
Pump Operation	Duty/ standby	QLDC CoP Appendix G

PARAMETER	VALUE	REFERENCE/ ASSUMPTION
Change in Elevation	15 m	368 m – 353 m
Friction Headloss	18 m	Darcy–Weisbach equation, f = 0.06
Total Head	33 m	Change in Elevation + Friction Headloss
Pump Size	33 m Head, 120 L/s	Design flow + 15%
Emergency Storage	729 m^3	9 hours AWDF as per QLDC CoP Appendix G
Resilience	Stand-by Generator on site	QLDC CoP Appendix G
Pressure Main		
Design Statement	Sized to convey Peak Wet weather for 1 in 5 ARI storm event.	QLDC CoP section 5.3.5.1
State Highway 6 Pipe Size	DN 400 PN16 PE 100	-
State Highway 6 Peak Velocity	1.8 m/s	Q = VA Acceptable as per QLDC CoP Appendix G
Bridge Crossing Pipe Size	DN 300 Stainless Steel Sch 10S	-
Bridge Crossing Velocity	1.3 m/s	Acceptable as per QLDC CoP Appendix G

Note that emergency storage would normally be provided at the smaller pump stations upstream of this terminal pump station, and therefore volume required could be reduced if there are intermediate pump stations, and if there are emergency/resilience provisions for power (e.g. dual power sources, standby generator, or plug for mobile generator).

Appendix A contains the 3 waters servicing plan for Te Pūtahi Ladies Mile.

The preferred location of the new Ladies Mile PS is on the north side of State Highway 6 near McDowell Drive, as the natural fall of the land is to the east. The fall of the land allows for the entire Te Pūtahi Ladies Mile wastewater catchment to flow by gravity to the new pumping station location without needing interim pumping (maximum wet well depth less than 8m). The pressure main from this pumping station will run west on the northern boundary of State Highway 6 to the Shotover WWTP, crossing the Shorover River fixed to the upstream end of the Bridge. Details of the Shotover Bridge's capacity to accommodate an additional pipeline are described in Section 5.3.

At the Shotover WWTP, servicing a new line from Te Pūtahi Ladies Mile will require the installation of an additional inlet nozzle. This upgrade may require the extension of the trough behind the screens, however further modelling will be needed to confirm this.

It is recommended that smart control of all the contributing pump stations is implemented to not overwhelm the treatment plant. This can also be accomplished via buffer storage at strategic locations in the local reticulation in combination with the storage requirements at the Ladies Mile PS).

5.2.4 TIMING AND STAGING

As there is no existing wastewater reticulation north of State Highway 6 suitable for servicing development the scale of Te Pūtahi Ladies Mile therefore there is limited scope for staging new infrastructure.

The capacity assessment of the Arrowtown-Lake Hayes RM recommended the current flowrate not be increased in the aging DN 300 sections of pipeline to the Stalker Road roundabout. Flows in the gravity section of the pipeline could be increased up to 160 L/s (assuming theoretical spare capacity of 40 l/s, which equates to 920 DUE's), however this should only be done with consideration to the substantial increased pipe material deterioration risk on this aged asset and understanding the need for construction of air valves at high points along the pipeline. (GHD, 2023)

Based on the above there is some capacity to stage development of new infrastructure from Te Pūtahi Ladies Mile. This would include:

- The initial construction of the Ladies Mile PS and construction of the RM that outlets to the gravity section of the Arrowtown-Lake Hayes RM.
- When Te Pūtahi Ladies Mile develops such that capacity of the gravity section of Arrowtown-Lake Hayes RM is exceeded, construct a parallel pipeline connecting the Ladies Mile RM directly to the Shotover WWTP (including Shotover River crossing).
- Pumps at the Ladies Mile PS can be staged for both RM configurations.

If the housing density of the areas in the zone currently under development (south of the highway and east of Stalker Road) were to increase in future such that capacity of the network south if the highway is exceeded, wastewater servicing can be provided through a new PS that connects directly to the proposed PM in the highway corridor.

5.2.5 LAND-TAKE REQUIREMENTS

All new trunk sewers and rising mains within Te Pūtahi Ladies Mile are to be located within QLDC owned road corridors, the State Highway 6 corridor or easements provided.

A centralised WWPS will be required, generally collocated with community spaces (parks, reserves, etc.).

5.2.6 COST ESTIMATE

The estimated cost to provide wastewater servicing to the Te Pūtahi Ladies Mile Zone is **$28,551,000**, excluding GST and including a 50% contingency. A detailed breakdown of this estimate is contained in Appendix B.

The wastewater cost estimate includes the following elements and assumptions:

- 3,500 m DN 400 PE100 PN16 pressure pipe;
- 350 m DN 300 stainless steel pressure pipe across the bridge;
- Bridge seismic joints and bracket support along superstructure;
- 120 L/s capacity pump station with a 750 m^3 emergency storage tank; and
- New inlet nozzle at the Shotover WWTP headworks.
- All reticulation within the development area will be constructed by the developer, with only the works from the terminal pump station included in the QLDC costings;
- Pipe installation is in the side of state highway with associated traffic management costs;
- Bridge pipe installation will require scaffold and potential permanent structures to bring the connections around the existing gas seismic joints;
- Installation of the pipes will be to QLDC CoP standards for embedment and backfill;
- Sizing of pumps is based on 10-15% greater than PWWF for long term performance;
- Depth of pump station assumed no greater than 8 m deep;
- Power to the pump station will be available through upgrades for the development, so no specific power connections and transformers are included; and
- Pipe costs include necessary fittings and valves.

5.3 SHOTOVER BRIDGE CAPACITY

The State Highway 6 Shotover River Bridge was constructed in the early 1970s and is a Waka Kotahi asset. The bridge is a large precast concrete post-tensioned box girder bridge, consisting of eleven spans with a total length of 322 m.

5.3.1 EXISTING SERVICES

There are a number of existing services are supported by the bridge, including:

- A QLDC owned and operated DN 450 stainless steel water supply pipeline under the downstream deck cantilever (“armpit”) installed 2020 (as per Section 5.1).
- A QLDC owned and operated DN 300 stainless steel wastewater pipeline under the downstream armpit installed in 2020.
- Two 150 mm PVC ducts under the downstream armpit for telecommunications owned and operated by Chorus.
- A small diameter fibre-optic cable in the upstream chamber of the box girder for telecommunications owned and operated by Chorus.
- A 200 mm gas pipe under the upstream armpit owned and operated by Rockgas.
- A 150 mm telecom duct under the upstream armpit for telecommunications owned and operated by Rockgas.

Redundant services in the chamber of the two-box girder were removed during 2020 upgrades, these included QLDC owned and operated 330 mm OD watermain and a 457 mm OD wastewater pipe.

5.3.2 LIVE LOAD AND SEISMIC RESISTANCE ASSESSMENT

In 2019 a live load assessment and seismic resistance assessment of the bridge was undertaken to determine its capacity to support additional services (WSP Opus, 2019). This assessment evaluated the bridge's capacity to support four, 457 mm OD spiral wound epoxy lined steel pipes, concluding the following:

The installation of the four 457mm OD mains will increase the mass of the bridge by about 10% and the seismic demand by about up to 12%, depending on the direction of shaking and the amount of damping in the watermain / bracket system. We believe that the above increase is acceptable as our assessment has determined that:

- *Under the Damage Control Limit State (DCLS) event (Annual Exceedance Probability of 1/7,000), the Demand / Capacity ratio for critical element would still be less than 1.0, and*
- *Under the Collapse Avoidance Limit State (CALS) event (AEP of 1/3,500), collapse of the bridge would still be unlikely.*

5.3.3 BRIDGE CAPACITY

As above, a DN 450 stainless steel water supply pipeline and a DN 300 stainless steel wastewater pipeline were installed in the downstream armpit of the bridge in 2020. However, the two other pipelines considered in the live load and seismic resilience assessment have not been installed.

The proposed DN 300 stainless steel pipeline to service Te Pūtahi Ladies Mile is within the bounds of the 2019 assessment if installed in the upstream armpit. Therefore, subject to approval by Waka Kotahi, no further assessment of the bridge capacity is needed.

Further constraints that make the upstream armpit the preferred location for the new pipeline are as follows:

- There is no further capacity under the downstream armpit for mounting services of this size, both considering loading to the bridge and available space.
- Local roads pass under the bridge at the land spans on both ends. These roads have existing vehicle height restrictions due to the clearance under the bridge and mounting services below the bridge soffit would worsen these.
- Services on the downstream side of a bridge have a lower risk of collision with floodwater debris. Due to the height of the bridge consideration debris strike to any upstream mounted services is very unlikely.
- Waka Kotahi requested the removal of any similar services from inside the bridge to allow access for inspection and to mitigate the risk of overloading the bridge were a burst to occur. Therefore, it is unlikely a request for a wastewater service within the bridge voids will be approved in future.

5.3.4 PIPELINE MOUNTING AND SPATIAL ARRANGEMENT

The bridge deck cantilever has previously been found to be at capacity and therefore it is unlikely Waka Kotahi would approve the suspending additional infrastructure at this location. Pipelines installed in 2020 were fixed to the bridge by a bracket system bolted through the web of the box girder. The supports were designed to allow for the pipes to be installed and maintained without removing other services.

It is feasible to replicate this support bracket system for the DN 300 stainless steel pipeline on the upstream end of the bridge. A driver in the 2020 upgrades was to minimise the seismic restraints between the bridge and the pipes resulting in three anchor points. There are potentially more efficient designs if more anchoring points are allowed for.

There is an existing 200 mm gas main supported from the upstream deck cantilever. This gas main was installed in 2017 and may conflict with further services on the upstream side.

Figure 5-2 shows a proposed sketch of an indicative DN 450 pipe on the same support system developed in the 2019 design and mounted in the same location as the 2019 DN 450 pipe. The gas main location has been approximated and will require on-site confirmation to inform detail design. It can be seen from

Figure 5-2 that it is feasible to construct and maintain a new pipeline up to DN 450 pipe without changes to the existing gas main on the bridge. However, as shown on Figure 5-3, consideration will need to be given to where the pipeline leaves the bridge as there may be conflicts with the existing Rockgas main.

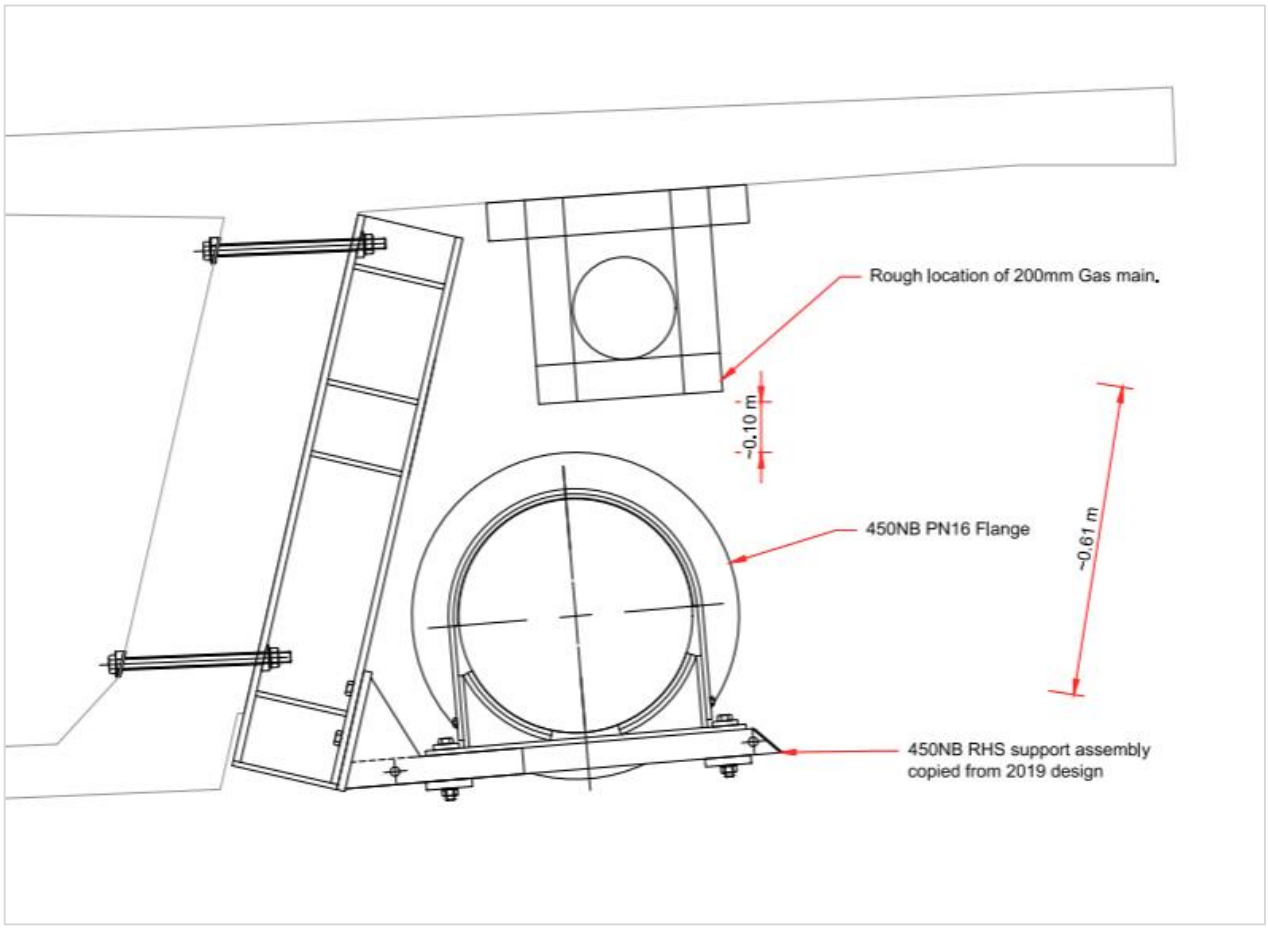

Figure 5-2: Sketch of Potential Services Arrangement on Upstream End of Shotover River Bridge (Dimensions Indicative Only)

Figure 5-3: Existing Rockgas Gas Pipeline Configuration at Cromwell Abutment of Shotover River Bridge

5.3.5 APPROVALS

Waka Kotahi's State Highway Structures Management Consultant (SMC) has been contacted for comment on the feasibility of the proposal. As the effect on bridge performance has previously been assessed it is feasible Waka Kotahi accept the new stainless steel main. However, acceptance is likely to be conditional on the following:

- The pipeline is not to be installed inside the bridge box girders and rather is attached by brackets to be within the armpit of the bridge,
- Brackets are attached to the web of the box girder, not the deck cantilever,
- Bracket anchors are percussion drilled and fixed mechanically (i.e., no chemical anchors),
- Waka Kotahi's SMC is involved in reviewing any design,
- The bracket is designed to carry all current and potential future services.
- The installation Contractor has relevant previous experience,
- A process of progressive approvals is arranged with Waka Kotahi.

The owners of additional services suspended on the upstream end of the bridge (Rockgas gas main and telecom duct) must be liaised with during design and construction. Any changes to the gas main will need Rockgas input and approval, and scheduled to minimise service disruption.

5.4 RECOMMENDED PROVISIONS

The following provisions are recommended for development within the Te Pūtahi Ladies Mile zone:

- All wastewater infrastructure is to be designed and constructed in accordance with the current QLDC Draft Code of Practice 2022 requirements (specifically section 5.3.3 for future development) and additional provisions below.
- Development of the wastewater network is to be in conjunction with QLDC to produce an integrated solution to provide efficient wastewater servicing to the Zone and greater area. This includes minimising the number of pumped facilities to optimise overall asset management by QLDC.
- Development and management of the wastewater network is to be in conjunction with QLDC so as to achieve the outcomes required for reliable network operations. No private wastewater systems are permitted.
- Land be made available for wastewater infrastructure within road corridors or sufficiently sized easements provided.

5.5 TE MANA O TE WAI

The wastewater servicing concept for the Te Pūtahi Ladies Mile Zone gives effect to Te Mana o te Wai in the following ways:

- Limiting private wastewater disposal systems but rather promoting best practice environment and waterways through QLDC managed system.
- The introduction of water demand management interventions which will reduce the total volume of wastewater generated.
- Consultation with iwi partners for further crossing of the Shotover River with wastewater, and for intensified disposal of wastewater.
- Resource consent applications for water takes have considered the wider effects of discharge of treated wastewater effluent.

6 STORMWATER

6.1 INTRODUCTION

The stormwater commentary undertaken for this report is based on the work undertaken by John Gardiner's Candor3 Ladies Mile reports, Warren Ladbrook's Flints Park report and various appended supporting documentation from Geosolve et al. WSP modelling data from the Ka Huanui a Tahuna Howards Drive Roundabout project has been referred to in understanding the exiting overland flow paths.

Interpretation of this analysis has allowed for feasible stormwater management solutions to be proposed. No further independent in-depth analysis has been carried out to confirm the proposal.

6.2 EXISTING STORMWATER INFRASTRUCTURE

There is no existing stormwater management infrastructure in Te Pūtahi Ladies Mile north of State Highway 6. Overland flow from Slope Hill, north of the Zone, generally flows southeast towards Lake Hayes, spilling widely across the flat plains of Ladies Mile. The Zone area sits on a flat terrace, with a gradual slope of less than 1% to the south-west towards Lake Hayes. The terrace sits above flat developed areas of Lake Hayes Estate and Shotover Country to the south. The flat plains demonstrate an unquantified capacity to soak to ground, however this may be substantial based on unvalidated commentary from local property owners.

There is an existing DN 1050 stormwater trunk on Howards Drive that was constructed with capacity set aside for parts of Te Pūtahi Ladies Mile development (specifically the Glenpanel development). This pipe was designed for conveyance of runoff from the post-development Queenstown Country Club site for up to a 1% Annual Exceedance Probability (AEP) event including allowance for climate change (2°C increase by 2090) and provided additional capacity in the pipeline to accommodate a maximum discharge of 1.5 m^3/s from Te Pūtahi Ladies Mile (Fluent, 2017). Current available capacity in the Queenstown Country Club trunk stormwater sewer has not been independently verified in this assessment.

The new intersection upgrade at Howards Drive includes a DN 600 siphon culvert to allow for the continuation of overland flow along the state highway. Some overland flow from the western end of Ladies Mile may enter the highway swales and be carried through this overland path. No crossing culvert to join into the Howards Drive DN 1050 has been included in the roundabout works scope at this time.

Areas of Te Pūtahi Ladies Mile south of the highway and east of Stalker Road are currently under development with stormwater managed by a local conveyance and attenuation system discharging to the Lower Shotover network.

6.3 LAKE HAYES

As indicated in John Gardiner's report, Lake Hayes is currently degraded, and improvement of the water quality is of high concern to QLDC and local Mana Whenua. It is not desirable from a healthy water position for untreated water to continue to enter the lake. The issue of sedimentation is one that has the most potential for benefit to the quality of the water in Lake Hayes.

Recent rain on grid hydraulic modelling results (undertaken as part of the Ka Huanui a Tahuna Howards Drive Roundabout project) have been reviewed to understand existing overland flow paths in Te Pūtahi Ladies Mile. Figure 6-4 presents model results for the 1% AEP event, showing during large rainfall events overland flow discharges from gullies in Slope Hill to the flats of Ladies Mile. Overland flow passes through wide channels through the low point along the terrace sloping towards Lake Hayes. There is limited flow predicted to cross State Highway 6 for the 1% AEP event.

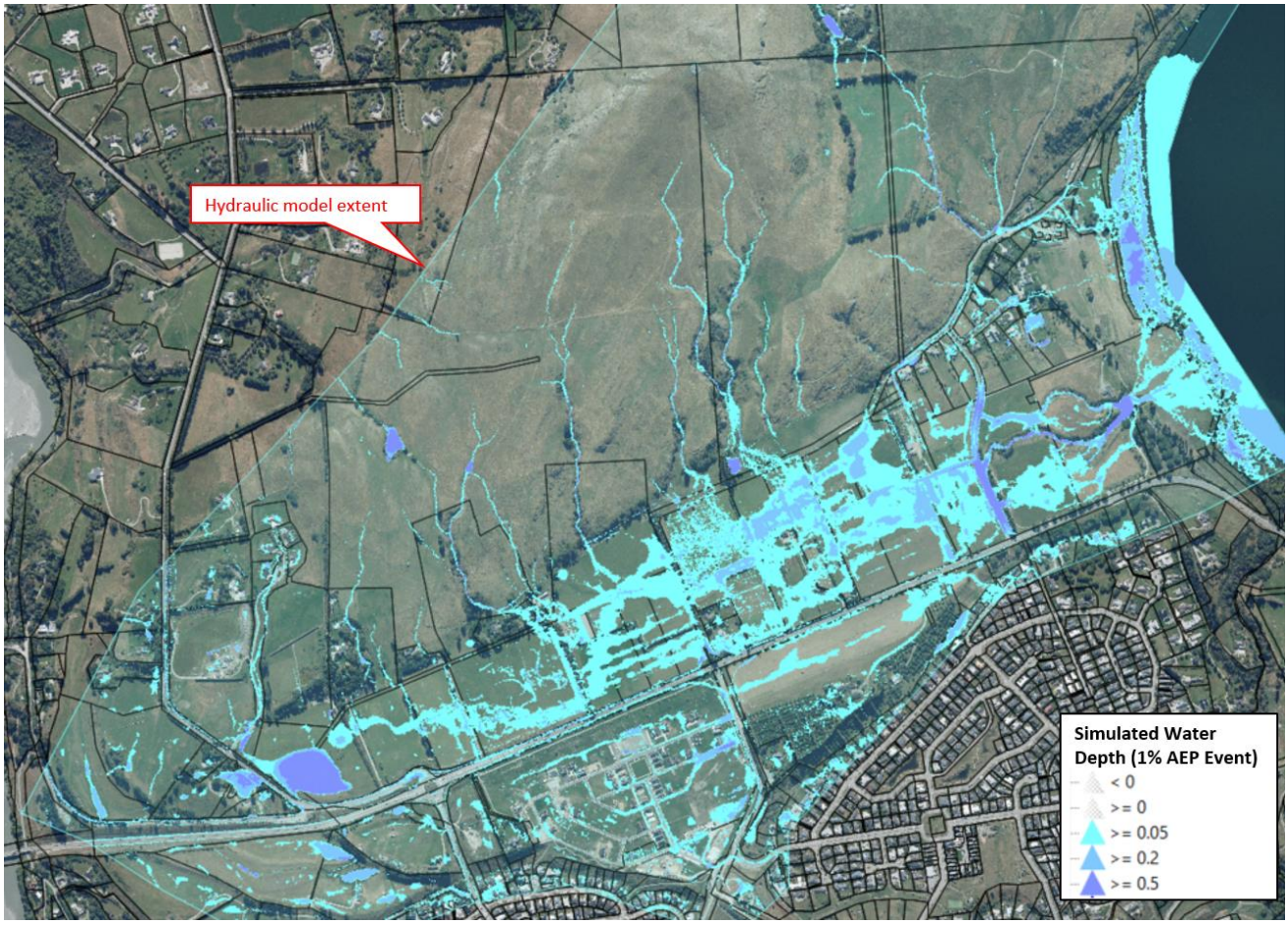

Figure 6-1: Predicted Overland Flow Depth for 1% AEP Event

The current overland discharge from Ladies Mile is a wide overland flow channel across the eastern boundary. Model results for 1% AEP event at the eastern end of the site are shown on Figure 6-2, showing overland flow crossing McDowell Drive and flowing to the land gully at the eastern end of the terrace then dropping into the lake (see Figure 6-3). The state highway swale flows also appear to turn north into McDowell Drive and discharge to Lake Hayes via this gully.

It is noted that in rain on grid modelling a CN value of 64 has been applied across the entirety of the Ladies Mile catchment, both Slope Hill and the flat plains. This uniform assumption may underpredict runoff from Slope Hill (schist) and overpredict runoff from the flat plains (underlain by alluvial gravels).

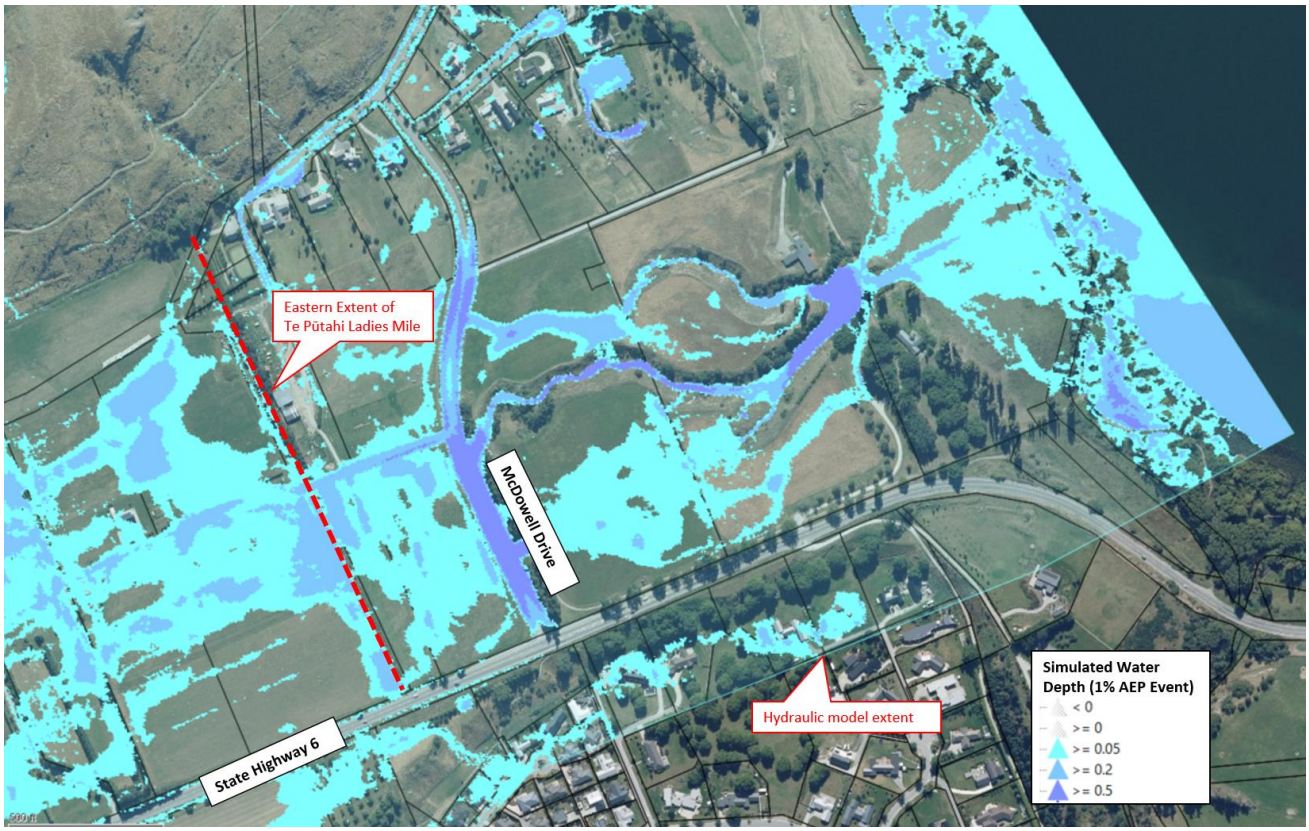

Figure 6-2: Predicted Overland flow from Ladies Mile to Lake Hayes

Figure 6-3: Google Earth view of the incised gullies through the eastern end of Ladies Mile

There is no formal attenuation of flood flows upstream of Lake Hayes, rather the flat plains provide areas of local ponding and soakage due to the low gradients. As a result the time of concentration will not be short.

Modelling described above predicts discharges of 3.67 m^3/s and 7.25 m^3/s for the 5% and 1% AEP events respectively. Whilst this is indicative only, it does demonstrate the current overland contributions to Lake Hayes from Te Pūtahi Ladies Mile to Lake Hayes during large rainfall events.

The water quality policy point 24.2.4.2 for the Wakatipu Basin states: Restrict the subdivision, development and use of land in the Lake Hayes catchment, unless it can contribute to water quality improvement in the catchment commensurate with the nature, scale and location of the proposal.

The implications of continuing to allow overland discharges to Lake Hayes should be assessed by a water quality specialist. Removing regular flows that are untreated may be beneficial however it would be useful to understand the consequence of allowing infrequent flows from large rainfall events. If it is inappropriate to allow any discharges into Lake Hayes, and soakage to ground is not a complete answer, a reticulated system with capacity up to the 1% AEP event would be necessary to collect and discharge downstream of Lake Hayes (Hayes Creek) and/ or to the Howards Drive DN 1050 if capacity allows.

6.4 SOAKAGE INVESTIGATIONS

The Candor3, Geosolve and Flints Park reports for the soakage testing and analysis completed for the Ladies Miles development area has been reviewed, with locations and results summarised on Figure 6-4 and Table 6-1.

Figure 6-4: Te Pūtahi Ladies Mile Soakage Testing Locations

Table 6-1: Te Pūtahi Ladies Mile Soakage Testing Results

SITE REFERENCE	TEST DEPTH (M BGL)	SOIL DESCRIPTION AT BASE OF SOAK TEST	UNFACTORED INFILTRATION RATE (MM/H)*
2021- 3	1.4	SAND, underlain by sandy GRAVEL at 1.5 m bgl	82.8
2021- 6	1.2	Sandy GRAVEL, underlain by SAND with some silt at 1.6 m bgl	112.4
2021- 9	2.0	Sandy GRAVEL with a trace of silt, underlain by silty SAND at 2.5 m bgl	129.6
2021-12	1.5	Sandy GRAVEL with a trace of silt, underlain by SAND with some silt at 2.6 m bgl	972
2021-14	1.5	Silty SAND underlain by SAND with some silt at 1.7 m bgl	1.98
2022-1	1.6	Sandy GRAVEL (Deltaic Gravel)	300
2022-2	1.8	Sandy GRAVEL (Deltaic Gravel) with sand lens extending from2.2 to 2.35 m bgl	850
2022-3	2.2	Sandy GRAVEL (Deltaic Gravel)	1400
2022-4	1.9	Sandy GRAVEL (Deltaic Gravel)	1000

SITE REFERENCE	TEST DEPTH (M BGL)	SOIL DESCRIPTION AT BASE OF SOAK TEST	UNFACTORED INFILTRATION RATE (MM/H)*
2022-5	1.95	Sandy GRAVEL (Deltaic Gravel)	850
2022-6	2.65	Sandy GRAVEL (Deltaic Gravel)	120

The conclusions regarding the infiltration rates measured are similar to the tests that were carried out along the State Highway in 2022 and 2023 by Kā Huanui a Tāhuna for NZUP, and they show definite increases in infiltration rates approaching State Highway 6.

Soakage testing undertaken for the NZUP project along Ladies Mile/State Highway 6 between Howards Drive and Stalker Road indicated infiltration rates of between 500 mm/hr and 1500 mm/hr. The test method followed BRE365, which has been adopted by QLDC as an acceptable test method.

Generally, the depth of test was between 2 and 2.5 m below ground level. Due to the very fast draining properties of the soils it was not possible in most cases to perform the test for the full depth of the excavated hole. Whilst this makes it difficult to get an accurate result, it also bodes well for the permeability of the underlying soils/gravels. To assist with achieving a test result, the test holes are continuously filled with water as fast as possible until the infiltration starts to slow down. This also provides significant pre-soaking of the ground.

With these relatively high infiltration rates, disposal to ground is, for most rainfall, feasible. In order to make the most of this disposal method, pre-treatment of stormwater and easily maintained soakage devices will be necessary as part of the design. With these aspects included, the factor of safety used in design may be reduced to allow less of a footprint. It is expected that the Auckland Council GD07 document will be followed to select the most appropriate factor of safety, and that site specific testing will be undertaken as part of the concept design to select the most beneficial.

6.5 SERVICING CONCEPT

6.5.1 OVERVIEW

New stormwater infrastructure is required to service new development areas in Te Pūtahi Ladies Mile. This will consist of the following:

— A fully integrated stormwater management solution for Ladies Mile and Slope Hill is to be coordinated across development blocks to provide between 1 and 4 facilities (detention basins and/or soakage devices). This will include coordinated overland flow paths through the developments to ensure no adverse effects on downstream properties. Adopting a naming convention to identify each major contributing catchment such as 1 – 4 (from west to east as the land falls towards Lake Hayes).

— A vegetated swale/basins with incorporated water quality pre-treatment and soakage to ground along the northern boundary of the site to capture runoff from Slope Hill. This system should be designed to capture up to the 1% AEP rainfall event with no discharges to Lake Hayes.

- If soakage to ground for the 1% AEP event is infeasible, stormwater from events up to and including the 5% AEP are to be soaked to ground with overflow permitted to Lake Hayes or Hayes Creek.
- Local first flush treatment of carparks and roads is to be provided within the development area.

A detailed hydraulic modelling assessment will be required to understand runoff from the Slope Hill catchment for the various design conditions and hydraulic properties of the ground surface so that the treatment swale/basins can be holistically designed across development blocks.

A stormwater hydraulic model must be developed in accordance with QLDC standards, and accessible across zone developer applicants. It will be vested as a QLDC owned asset upon each version update.

6.5.2 PRE-TREATMENT AND SEDIMENT CONTROL

The improvement of the water quality discharges to Lake Hayes is of high concern to QLDC, Kāi Tahu and Friends of Lake Hayes. Several features can be incorporated into the swale/basins in the north of Te Pūtahi Ladies Mile and its catchment area to prevent erosion at the source and provide water quality treatment.

Sediment control measures that could be encouraged on Slope Hill include:

- Gully planting to establish indigenous vegetation which will improve channel stability and reduce erosion. Planting of steep channels is particularly of concern on Slope Hill as soils are predominately loess and easily mobilised by rainfall.
- Sedimentation basins in the upper gullies on Slope Hill (where feasible) to temporarily store and release runoff and allow suspended debris and sediment to settle. These features will require periodic maintenance to remove sediments.

Water quality improvement features that could incorporated into the swale include:

- Contoured rock bunding/ baffles perpendicular to the channel to temporary store and release flows over multiple days to provide sedimentation treatment. Sections of the swale should include low-flow naturalised meandering channel with sections longitudinal riffles (turbulent areas), runs (smooth water surface), and pools (deeper and slow -moving areas).
- A wider swale around the low flow channel allowing for treatment of regular events with a higher level discharge to ground via scruffy dome manholes sitting above the channel invert.
- Planting of indigenous vegetation in and across the stream channel to provide filtering of runoff while also providing habitat.
- Regular sediment depth measurements in the swale should be undertaken to record track accumulation and identify where removal maintenance is necessary to avoid reanimation during large events that may spill to Lake Hayes.

Pre-treatment of stormwater from new developments should be completed in accordance with the QLDC Draft Code of Practice 2022 requirements.

6.5.3 TIMING AND STAGING

Progressive development of the wider Te Pūtahi Ladies Mile area will raise challenges with managing erosion and sediment control as well as management of any upstream overland flows

from neighbouring undeveloped areas. Part of the integrated stormwater system will need to include how to provide temporary stormwater facilities, and the ability to pass flows through sites without concentrating flows in a detrimental manner.

Appropriate sediment and erosion control plans are to be implemented for the period up to completion of the full development within each block, with consideration to the impact on neighbouring development blocks.

6.5.4 LAND-TAKE REQUIREMENTS

Land will be required for the following:

- A pre-treatment and soakage basin along the northern boundary of the site to capture runoff from Slope Hill.
- Centralised stormwater management and attenuation systems within each development block.
- Easements will be required where new stormwater trunks and swales cross private property. Where possible infrastructure will be coordinated within QLDC owned road corridors and the State Highway 6 corridor.

6.5.5 COST ESTIMATE

With the uncertainty of the final feasible solution, no formal cost estimate was able to be prepared. However early cost estimates from Candor3 and indicative rates for treatment and soakage along Ladies Mile state highway upgrades allow for very high level cost ranges to be provided to give an order of magnitude forecast. Note that costing for any necessary large diameter discharge pipes are not included.

It is anticipated that:

- Slope Hill pre-treatment, conveyance and soakage is in the order of $20 - $40 million.
- Development areas pre-treatment, conveyance and soakage is in the order of $2 million per hectare of developed land.

6.6 RECOMMENDED PROVISIONS

The following provisions are recommended for development within the Te Pūtahi Ladies Mile zone:

- All stormwater management infrastructure is to be designed and constructed in accordance with the current QLDC Draft Code of Practice 2022 requirements (specifically section 4.3.3 for future development) and additional provisions below.
- A stormwater hydraulic model must be developed in accordance with QLDC standards, and accessible across zone developer applicants. It will be vested as a QLDC owned asset upon each version update.
- A fully integrated stormwater management solution for Slope Hill (including treatment) is to be coordinated across development blocks to provide between 1 and 4 facilities (detention basins and/or soakage devices). This will include coordinated overland flow paths through the developments to ensure no adverse effects on downstream properties.

- Land along the toe of Slope Hill be made available for made available for stormwater management.
- Pre-treatment of Slope Hill runoff and treatment of first flush from roads, carparks etc must be provided to ensure longevity of soakage devices.
- Stormwater runoff from events up to and including the 1% AEP event is to be soaked to ground. If this is proven infeasible, stormwater from events up to and including the 5% AEP is to be soaked to ground with overflow of stormwater permitted to Lake Hayes or Hayes Creek.
- Easements are to be provided as required for new stormwater trunks and swales cross private property. Where possible infrastructure will be coordinated within QLDC owned road corridors and the State Highway 6 corridor.
- Sediment and erosion control plans be prepared by a suitably qualified temporary works engineer and be implemented for the duration of the construction.
- All stormwater management systems will be designed considering climate change adjusted rainfall (RCP6.0 for the period 2081-2100).

6.7 TE MANA O TE WAI

The stormwater management concept for the Te Pūtahi Ladies Mile Zone gives effect to Te Mana o te Wai in the following ways:

- Reducing untreated overland runoff to Lake Hayes by treating and soaking runoff to ground for events up to the 1% AEP where feasible.
- Constructing a new swale to along the northern boundary of the site to intercept and treat overland flow from Slope Hill, improving water quality and providing habitat.
- Maintaining the natural flow of the water by requiring soakage systems throughout the developed areas.
- Developing in a way that maintaining natural connections between surface water and groundwater through distributed stormwater treatment and soakage systems.
- Attenuation of stormwater at source and the use of the cleansing/ purifying processes of the whenua to remove contaminants.
- Improving ecosystem health by providing habitat for within stormwater management areas.
- Promoting water conservation through use of residential rainwater collection and re-use for irrigation (see water supply section of this report).
- Designing for changing environment by considering the effects of climate change in design of treatment, soakage, detention and conveyance infrastructure.

7 LIMITATIONS

This report ('Report') has been prepared by WSP exclusively for Queenstown Lakes District Council ('Client') in relation to the 3 waters servicing concept for the new the new special Purposes Zone, Te Pūtahi Ladies Mile Zone ('Purpose') and in accordance with the Offer of Service date 21 July 2023. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('Client Data') provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

The stormwater commentary undertaken for this report is based on the work undertaken by John Gardiner's Candor3 Ladies Mile reports, Warren Ladbrook's Flints Park report and various appended supporting documentation from Geosolve et al. WSP modelling data from the Ka Huanui a Tahuna Howards Drive Roundabout project has been referred to in understanding the exiting overland flow paths. Interpretation of this analysis has allowed for feasible stormwater management solutions to be proposed. No further independent in-depth analysis has been carried out to confirm the proposal.

Qualifications and Assumptions

The services undertaken by WSP in preparing this Report were limited to those specifically detailed in the Agreement and the Report and are subject to the scope, qualifications, assumptions and limitations set out in the Report and/or otherwise communicated to the Client. Except as otherwise stated in the Report and to the extent that statements, opinions, facts, conclusion and/or recommendations in the Report ('Conclusions') are based in whole or in part on information provided by the Client and other parties ('Information'). The Information has not been and have not been verified by WSP and WSP accepts no liability for the reliability, adequacy, accuracy and completeness of the Information.

The data reported and conclusions drawn by WSP in this Report are based solely on information made available to WSP at the time of preparing the Report. The passage of time; unexpected variations in ground conditions; manifestations of latent conditions; or the impact of future events (including (without limitation) changes in policy, legislation, guidelines, scientific knowledge; and changes in interpretation of policy by statutory authorities); may require further investigation or subsequent re-evaluation of the Conclusions.

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8 REFERENCES

Beca. (2022). *Project Shotover Stage 3 - Detailed Design Report.* Beca.

Fluent. (2017). *Queenstown Country Club Retirement Village: Trunk Stormwater Pipeline Design Report for Engineering Approval.* Queenstown: Fluent Infrastructure Solutions Ltd.

Fluent. (2019). *Shotover Country Borefield, Water Treatment Plant and Rising Mains Detailed Design Report.* Fluent.

GHD. (2023). *Arrowtown-Lake Hayes Rising Main Capacity Assessment: Transient Assessment and Hydraulic Analysis.* GHD.

Kā Huanui a Tāhuna. (2022). *Re-assessment of Water Quality Depth and Intensity for Stormwater Treatment Design* . Kā Huanui a Tāhuna.

QLDC . (2023). *Te Pūtahi Ladies Mile Plan Variation*. Retrieved from Queenstown Lakes District Council: https://www.qldc.govt.nz/your-council/district-plan/te-putahi-ladies-mile-variation

QLDC. (2022). *Land Development and Subdivision Code of Practive.* Queenstown: QLDC.

QLDC. (2022). *Water Supply Reservoirs: Development and Subdivision Code of Practice Addendum.* Queenstown: QLDC.

QLDC. (2022). *Water Supply Trunkmains: Development and Subdivision Code of Practice Addendum.* Queenstown: QLDC.

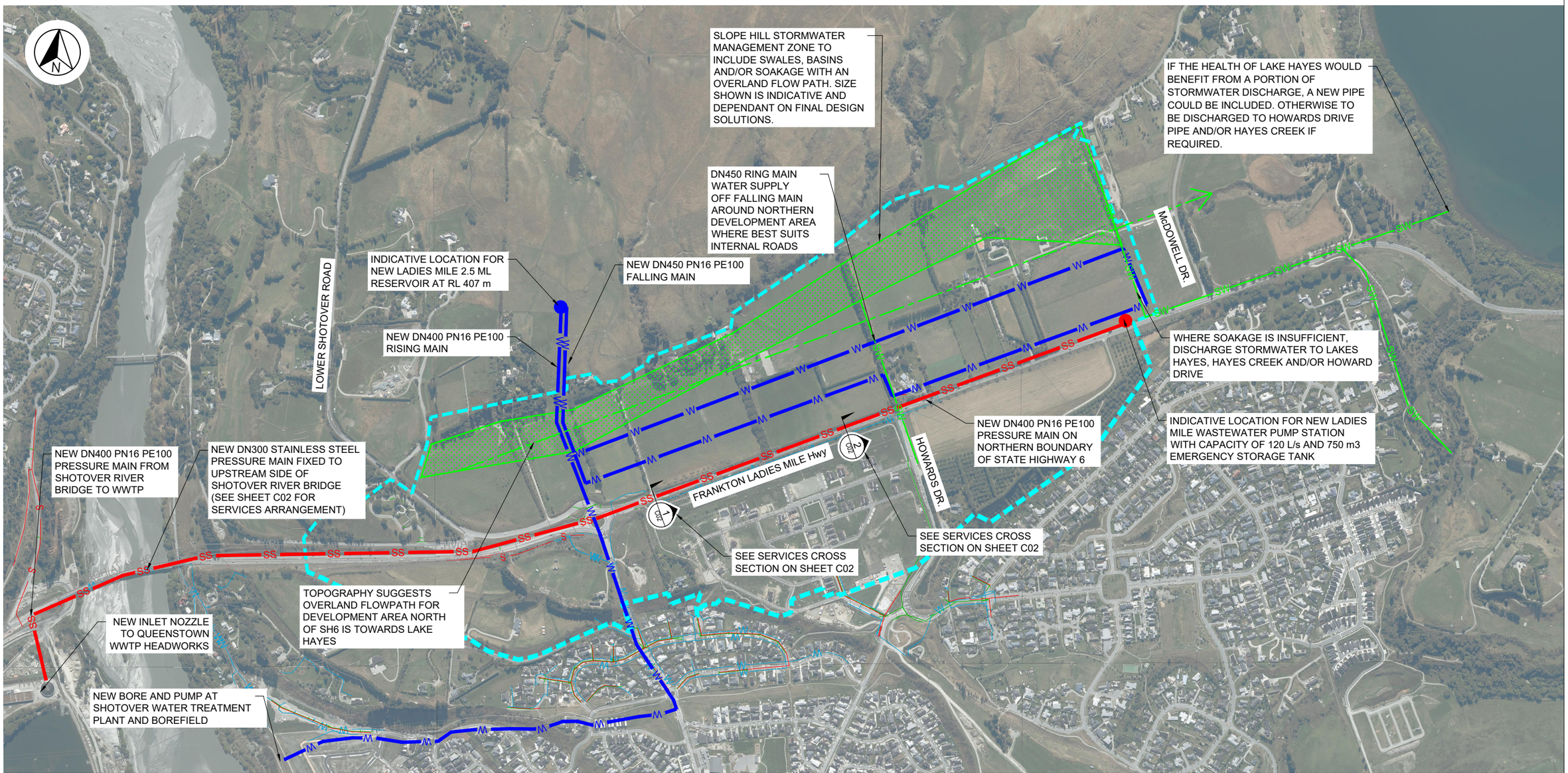
QLDC. (2023). *Shotover Country Bores Integration – Hydraulic Modelling.* Queenstown: QLDC.

Watershed Engineering Limited. (2023). *Shotover Country WTP Integration Review.* Watershed Engineering Limited.

WSP Opus. (2018). *Ladies Mile HIF Housing Infrastructure Fund Scoping and Concept Design.* Queenstown: WSP Opus.

WSP Opus. (2019). *SH6 Shotover Bridge Proposed Watermains: Effect of Live and Seismic Bridge Capacities.* WSP Opus.

APPENDIX A - TE PŪTAHI LADIES MILE 3 WATERS SERVICING PLAN



NOTES:

1. ZONE NORTH OF SH6 CAN LIKELY FLOW BY GRAVITY TO NEW WASTEWATER PUMP STATION
2. WATER SUPPLY FALLING MAIN TO BE A RING MAIN TO PROVIDE BEST LEVEL OF SERVICE. THIS CAN FOLLOW ROADS WITHIN THE ZONE
3. ZONE SOUTH OF SH6 HAS SOME EXISTING SERVICES BUT CAN BE CONNECTED TO THE NEW RETICULATED SUPPLY. THIS WOULD REQUIRE PUMPED WASTEWATER

KEY:

EXISTING WATER SUPPLY	W
EXISTING WASTEWATER	SS
EXISTING STORMWATER	SW
PROPOSED WATER SUPPLY	W
PROPOSED WASTEWATER	SS
PROPOSED STORMWATER	SW

NOT FOR CONSTRUCTION

1:5000 @ A1
1:10000 @ A3
0 50 100 150 200 250 300 350 400 450 500 m

REVISION	AMENDMENT	APPROVED	DATE
A	DRAFT FOR CLIENT REVIEW	A.P	07/09/23
B	CONCEPT ISSUED AS FINAL	A.P	28/09/23
C	STORMWATER DETAIL ADDED	A.P	29/09/23

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CIVIL

SCALES: 1:5000 (A1) ; 1:10000 (A3)
ORIGINAL SIZE: A1

DRAWN	DESIGNED	APPROVED
W. HEFFERNAN	M. DE LANGE	R. GILL

DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
A. PRESTIDGE	A. PRESTIDGE	29/09/23

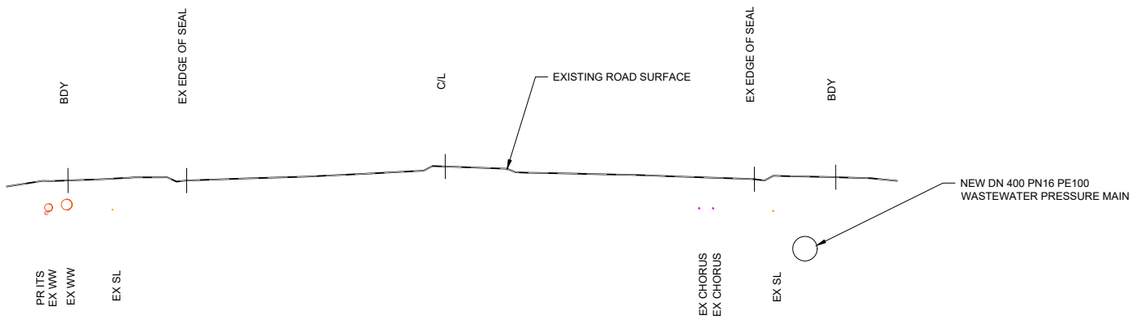
CONCEPT

PROJECT: QUEENSTOWN LAKES DISTRICT COUNCIL
TE PUTAHI LADIES MILE
QLDC LADIES MILE

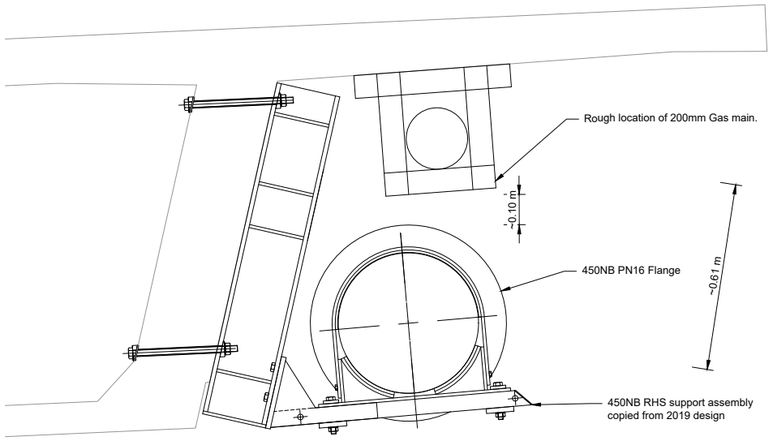
TITLE: THREE WATERS CONCEPT

WSP PROJECT NO. (SUB-PROJECT): 6-XQ118.10
SHEET NO.: C01
REVISION: C

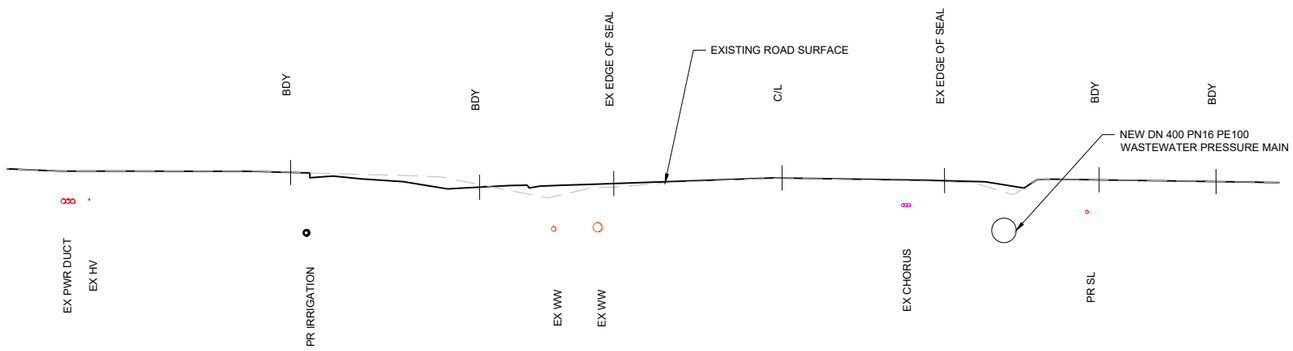
Original sheet size A1 (841x594) Plot Date 2023-09-29 at 4:13:05 PM \\corp.pbwan.net\ANZ\ProjectsNZ\6x\6-XQ118.10 Ladies Mile 3-Waters Masterplan Update\Home\03_Tech_Docs\02_Tech_Out\01_WIP\01_Drawings\6XQ118.10_concept.dwg C02



1 C01 SH6 SERVICES CROSS SECTION 1
NTS



CONCEPT SERVICES ARRANGEMENT ON
UPSTREAM END OF SHOTOVER RIVER BRIDGE
(DIMENSIONS INDICATIVE ONLY)



2 C01 SH6 SERVICES CROSS SECTION 2
NTS

NOT FOR CONSTRUCTION

1:5000 @ A1
1:10000 @ A3
0 50 100 150 200 250 300 350 400 450 500 m

REVISION	AMENDMENT	APPROVED	DATE
A	DRAFT FOR CLIENT REVIEW	A.P	07/09/23
B	CONCEPT ISSUED AS FINAL	A.P	28/09/23

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ORIGINAL SIZE: A1

DRAWN	DESIGNED	APPROVED
W. HEFFERNAN	M. DE LANGE	R. GILL
DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
A. PRESTIDGE	A. PRESTIDGE	28/09/23

CONCEPT

PROJECT
QUEENSTOWN LAKES DISTRICT COUNCIL
TE PUTAHI LADIES MILE
QLDC LADIES MILE

TITLE
SH6 SERVICES CROSS SECTIONS

WSP PROJECT NO. (SUB-PROJECT): 6-XQ118.10
SHEET NO.: C02
REVISION: B

APPENDIX B – COST ESTIMATES

Table B-1: Water Supply Cost Estimate

ITEM	UNIT	QTY	RATE	TOTAL	NOTES
Design					
Development / Concept			3%	$ 341,000	Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Consenting			3%	$ 341,000	
Design			6.5%	$ 739,532	Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Procurement			0.05%	$ 5,689	Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Construction					
Consultancy Fees			5%	$ 568,871	5% of Physical Works Subtotal Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Physical Works					
Preliminary & General		15%		$ 1,484,010	
Ladies Mile Reservoir (2.5 ML)	Ea.	1	$5,000,000	$ 5,000,000	Assume $1 million per ML, factor of 2 for ground improvements
Rising Main - DN 400 PN16 PE 100	m	2,000	$950	$ 1,900,000	75% within non-SH roadway, 25% soft cut, includes fittings and valves
Falling Main - DN 450 PN16 PE 100	m	3,250	$900	$ 2,925,000	100% soft cut, includes fittings and valves
New Pump at Shotover WTP	Ea.	1	$68,400	$ 68,400	80-85 L/s capacity Detailed design report Table 8.1: Proposed Bore Pumps, plus 20%. Detailed costing (Appendix S) not available.
Physical Works Subtotal				$ 11,377,410	
Totals					
Base Estimate				**$ 13,373,501**	
Contingency			50%	$ 6,686,750	
Total (if 50% Contingency)				**$20,060,251**	
Rounded Total (if 50% Contingency)				**$20,060,000**	

Table B-1: Wastewater Cost Estimate

ITEM	UNIT	QTY	RATE	TOTAL	NOTES
Design					
Development / Concept			3%	$486,000	Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Consenting			3%	$486,000	
Design			6.5%	$1,052,480	Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Procurement			0.05%	$8,096	Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Construction					
Consultancy Fees			5%	$809,600	5% of Physical Works Subtotal Assumed from WWL cost estimation manual and ACENZ Fee Estimation Guidelines (2004)
Physical Works					
Preliminary & General		15%		$2,112,000	
Pressure Main - DN 400 PN16 PE 100 (Ladies Mile PS to bridge crossing)	m	3,000	$1,050	$3,150,000	Assumes open cut installation 1.5 m deep (to invert) inside of state highway (includes traffic management costs), includes fittings and valves
Pressure Main - DN 300 Sch10S Stainless Steel (bridge crossing)	m	350	$5,000	$1,750,000	Assumes scaffold and attachments to bridge and traffic management costs
Pressure Main - DN 400 PN16 PE 100 (bridge crossing to WWTP)	m	500	$900	$450,000	
Bridge Crossing terminations	Ea.	2	$600,000	$1,200,000	Assumes the engineering required to bring the pipe off the bridge ends and around the gas is significant due to spatial constraints and EQ movement
Ladies Mile WWPS	Ea.	1	$4,000,000	$4,000,000	Includes duty/ standby pumps (120 L/s capacity). Assume power will be provided under Ladies Mile.
WWPS Emergency Storage	Ea.	1	$3,500,000	$3,500,000	For emergency storage (3.4 ML), installed in ground via benching
New nozzle at Shotover WWTP	Ea.	1	$30,000	$30,000	Sum of items 2.11 - 2.13 in Appendix W of Stage 3 Detailed Design Report, plus 20%
Physical Works Subtotal				$16,192,000	
Totals					
Base Estimate				$19,034,176	
Contingency			50%	$9,517,088	

ITEM	UNIT	QTY	RATE	TOTAL	NOTES
Total (if 50% Contingency)				$28,551,264	
Rounded Total (if 50% Contingency)				$28,551,000	