Candor³

ENGINEERING FOR LIFE

LADIES MILE TE PŪTAHI MASTERPLAN

THREE WATERS INFRASTRUCTURE REPORT (FINAL)

1 DOCUMENT CONTROL

PROJECT

Project Name	Ladies Mile Te Pūtahi Masterplan

DOCUMENT

Document Name	Three Waters Infrastructure Report

REVISION

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AUTHOR

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3 EXECUTIVE SUMMARY

This three waters infrastructure report covers the assessment of the existing and future proposed stormwater, wastewater and water supply infrastructure that will enable the development of the Ladies Mile Te Pūtahi masterplan. The proposed masterplan is expected to deliver a maximum of approximately 2,400 new dwellings, a primary school, a secondary school, sport and recreation facilities, and a town centre.

The proposed stormwater management objectives and principles were developed in conjunction with the existing site appraisal and proposed development masterplan. The proposed stormwater management approach was prepared to achieve the set objectives and principles. As per Figure 3.1 the masterplan area was split into five different stormwater management catchments based on existing features and future proposed land use.

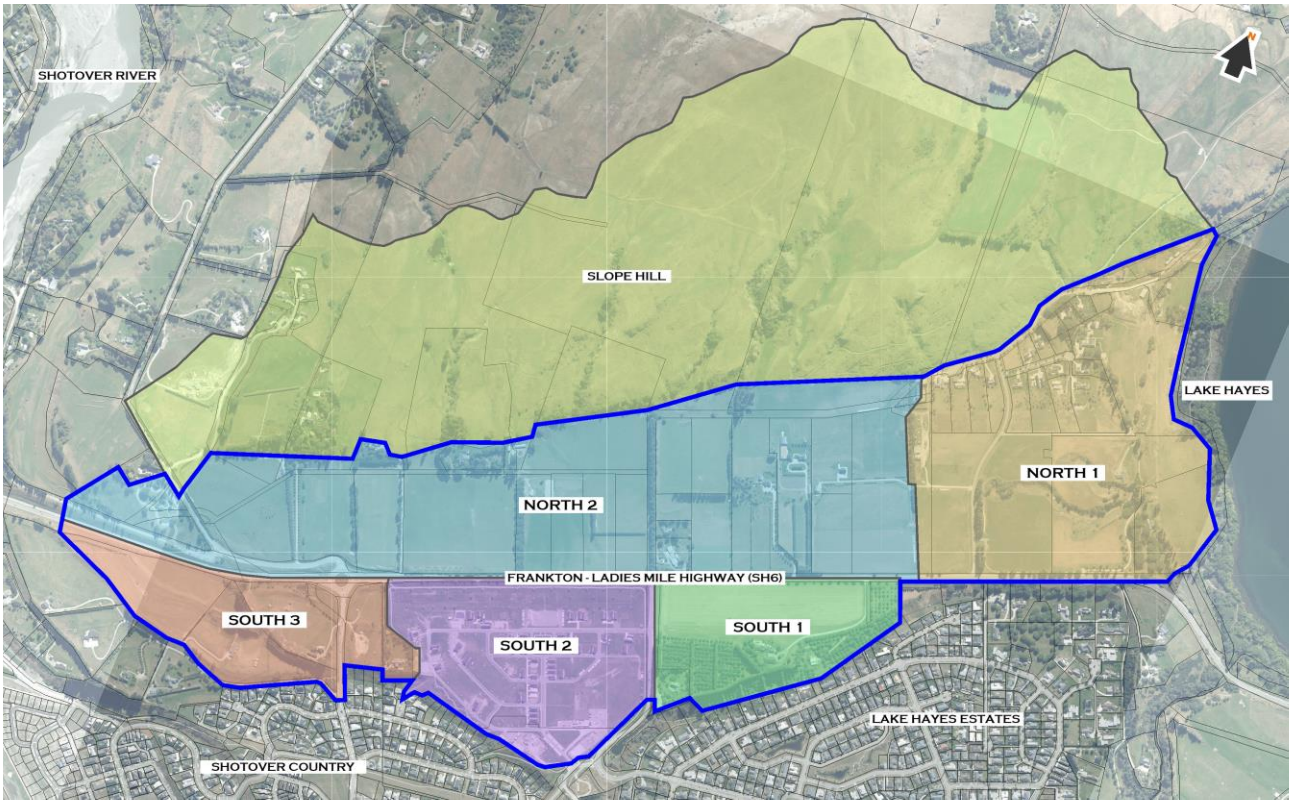


Figure 3.1 – Proposed masterplan stormwater management catchment delineation.

North 1 comprises of existing lifestyle properties where no land use changes are anticipated under the proposed masterplan. Site specific stormwater management is proposed for this catchment, which will meet the objectives and principles in this report.

North 2 generally comprises of higher density developments, a town centre, a primary school, and a secondary school, as proposed under this masterplan. Two centralised stormwater management areas are proposed for this catchment to maximise the developable land whilst maintaining and potentially improving social and environmental outcomes. A central conveyance swale is also proposed within this catchment to manage the high peak flows and volumes of rainfall runoff expected to enter the masterplan area from Slope Hill, which is a relatively steep and large undeveloped catchment the north.

South 1 comprises sport and recreation facilities, as proposed under this masterplan. As the majority of this catchment will remain as open space, it is proposed to integrate the stormwater management approach with the sports fields and other passive recreation areas. There will be ample opportunity to design solutions that ensure sports fields do not flood in less than 20 year events. Management could be carried out via underground infiltration and swales. The stormwater management approach meets the objectives and principles in this report.

South 2 comprises the existing Queenstown Country Club retirement village. This catchment is serviced by existing infrastructure this is expected to be utilised in case of future redevelopment. The stormwater management approach supporting future redevelopment will meet the objectives and principles in this report.

South 3 comprises lower density developments, as proposed under this masterplan. Due to the lower density and limited number of landowners, site specific stormwater management is proposed for this catchment that will meet the objectives and principles in this report.

The proposed wastewater management approach was developed by considering the optimisation of the wider wastewater infrastructure planned by QLDC and the proposed masterplan development plan. Three approaches were considered including a single pump station scheme, a multiple pump station scheme, and a vacuum and low-pressure sewer scheme. A decision on the implementation of the final wastewater management scheme will be closely related to the future wider wastewater network optimisation assessment and recommended upgrades that is currently being undertaken.

The total peak dry and wet weather flows for the proposed masterplan area are estimated at 50.6 l/s and 101.2 l/s, respectively.

The proposed water supply management approach was developed by considering the wider water supply infrastructure works proposed by QLDC and the proposed masterplan development plan. The implementation of the final water supply solution will be closely related to the future wider water supply network capacity upgrades planned.

The total peak domestic water supply demand for the proposed masterplan area is estimated at 216.1 l/s. The total peak demand could be reduced to 82.4 l/s, subject to confirmation on the average daily water demand for the area.

The three waters assessment carried out for the masterplan area demonstrated that the stormwater, wastewater, and water supply infrastructure required to service the proposed development can be provided. However, due to limitations identified in this report further work is recommended to finalise the proposed three waters management approach and solutions.

To support the staging of the proposed masterplan area it is critical to consider the wider catchment infrastructure upgrade works, which are yet to be finalised. A detailed three waters infrastructure integrated assessment and design is proposed, to ensure that the best practicable solution for both the proposed masterplan area and the wider catchment is achieved.

Please note that subsequent to the drafting of this report Council has come to the realisation that they are not in a position to lead the centralised infrastructure approach identified in the draft October Te Pūtahi Ladies Mile masterplan due to funding constraints. At the date of this report landowners have also been unable to agree amongst themselves on the location and cost sharing of the centralised approach although it is understood that they are working together with Council input to find acceptable detailed stormwater solutions.

Council has made it clear to landowners that they are still expected to manage stormwater within the development area with no discharges to Lakes Hayes and that any publicly vested solution must provide a comprehensive approach to stormwater management that minimises a proliferation of stormwater devices. This is in line with the solutions proposed in the Three Water Infrastructure Plan. The addendum in part 9.0 of this report provides further details.

4 INTRODUCTION

The proposed Ladies Mile Te Pūtahi masterplan covers an area of approximately 185 hectares and is expected to deliver approximately 2,400 new dwellings, a primary school, a secondary school, sport and recreation facilities, and a town centre. The masterplan extents shown in Figure 5.1 below, are bounded by Slope Hill to the north, the existing residential developments of Shotover Country and Lake Hayes Estate to the south, Lake Hayes to the east and existing lifestyle blocks to the west. The Frankton – Ladies Mile Highway (SH6) runs through the middle of the masterplan area.

The existing land is owned by multiple landowners. It is predominantly covered in pasture and is generally used for grazing and lifestyle activities. Also present are a cemetery, the Queenstown Country Club Retirement Village, bed and breakfast accommodation establishments, and a series of lifestyle residential properties.

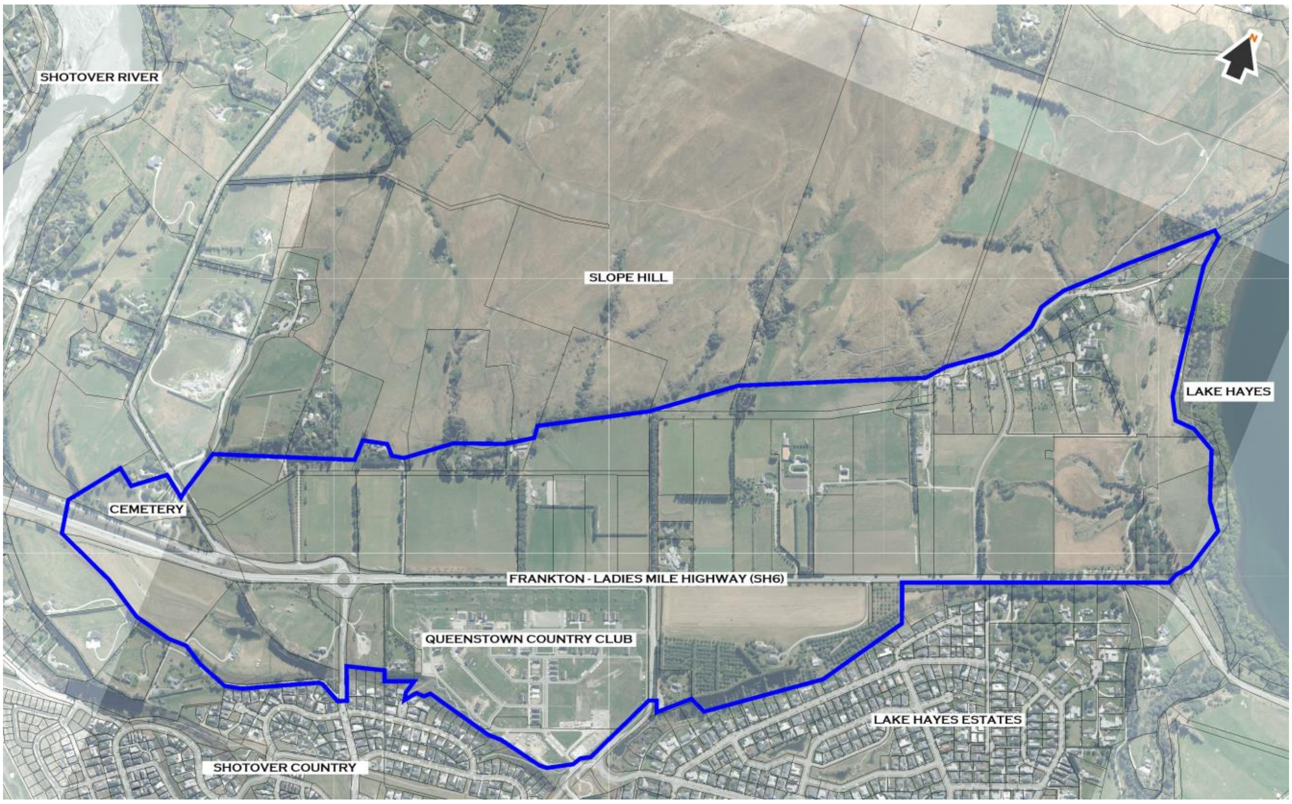


Figure 5.1 – Proposed masterplan location plan.

This report discusses the assessment of the existing and future proposed three waters infrastructure that will enable the development of the proposed masterplan area. The three waters infrastructure includes stormwater, wastewater, and water supply.

5 STORMWATER

The management of urban stormwater runoff has seen a significant shift in the past few decades. The approach in designing stormwater systems to primarily manage flooding has evolved to incorporate environmental, social, and cultural benefits. Through the application of collaborative and inter-disciplinary planning and design processes, these stormwater management opportunities include:

- Mimicking the natural water cycle
- Enhancing water quality
- Enhancing landscape and natural character
- Incorporating Te Mana o te Wai
- Promoting community wellbeing and safety
- Promoting water conservation
- Minimising infrastructure lifecycle costs

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

5.1 EXISTING SITE ASSESSMENT

To develop the stormwater management objectives and the stormwater management approach for the proposed masterplan area, a base level of information of the existing site features was required. An initial existing site appraisal was carried out that included the assessment of topography, geology, hydrology, ecology, and infrastructure.

5.1.1 TOPOGRAPHY, SLOPE AND ASPECT

The land generally slopes in a south-west to north-east direction at a grade of approximately 1%. Areas with steeper slopes, ranging up to approximately 10%, are present at the toe of Slope Hill. The south-western corner of the masterplan area slopes to the south-west, towards the Shotover River.

Steep terrace slopes are present on the southern boundary, where the elevation drops 10m to 20m, generally at a grade of approximately 50%. Steep slopes are also present on the eastern boundary, where the land drops approximately 20m down to Lake Hayes at varying slopes between 10% and 20%. An existing gully feature is also present in the north-eastern portion of the masterplan area. The masterplan area existing topography and slopes are shown in Figure 5.2 and Figure 5.3.

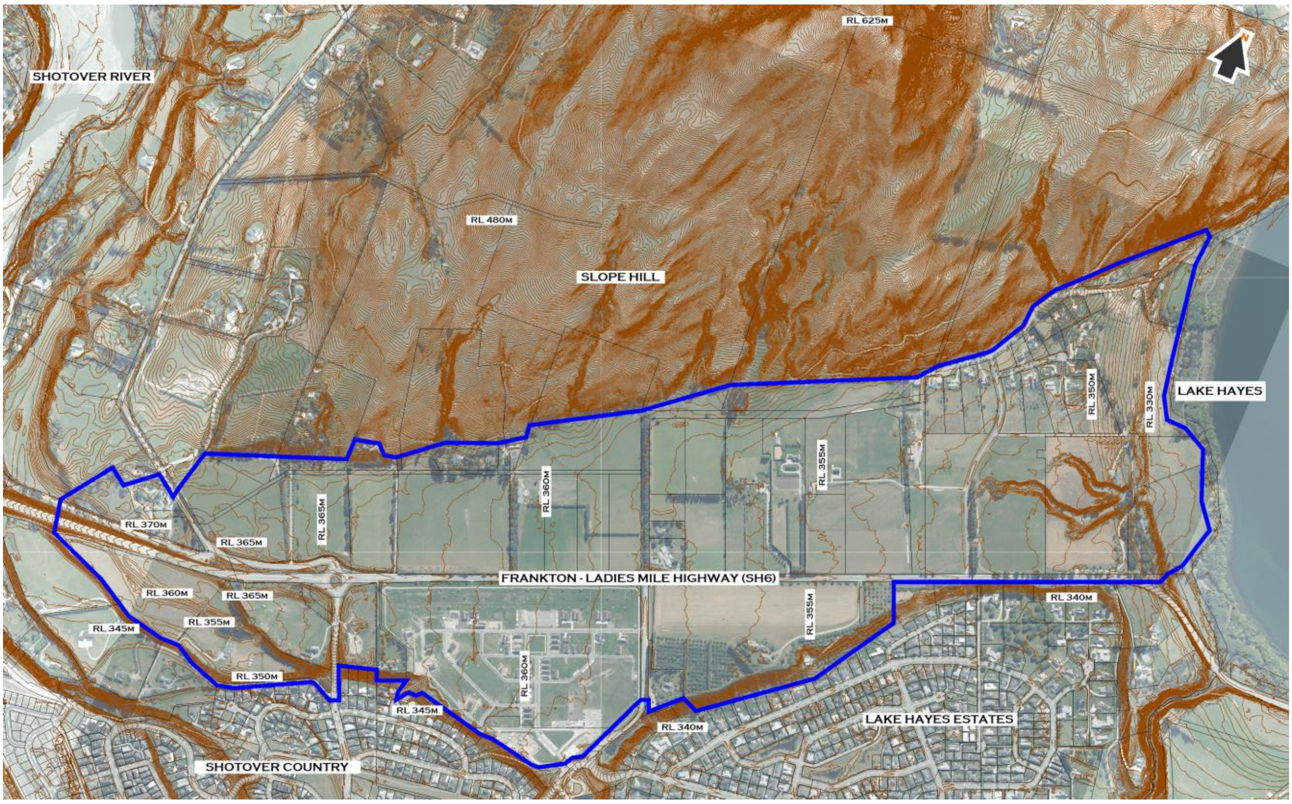


Figure 5.2 – Proposed masterplan existing topography.

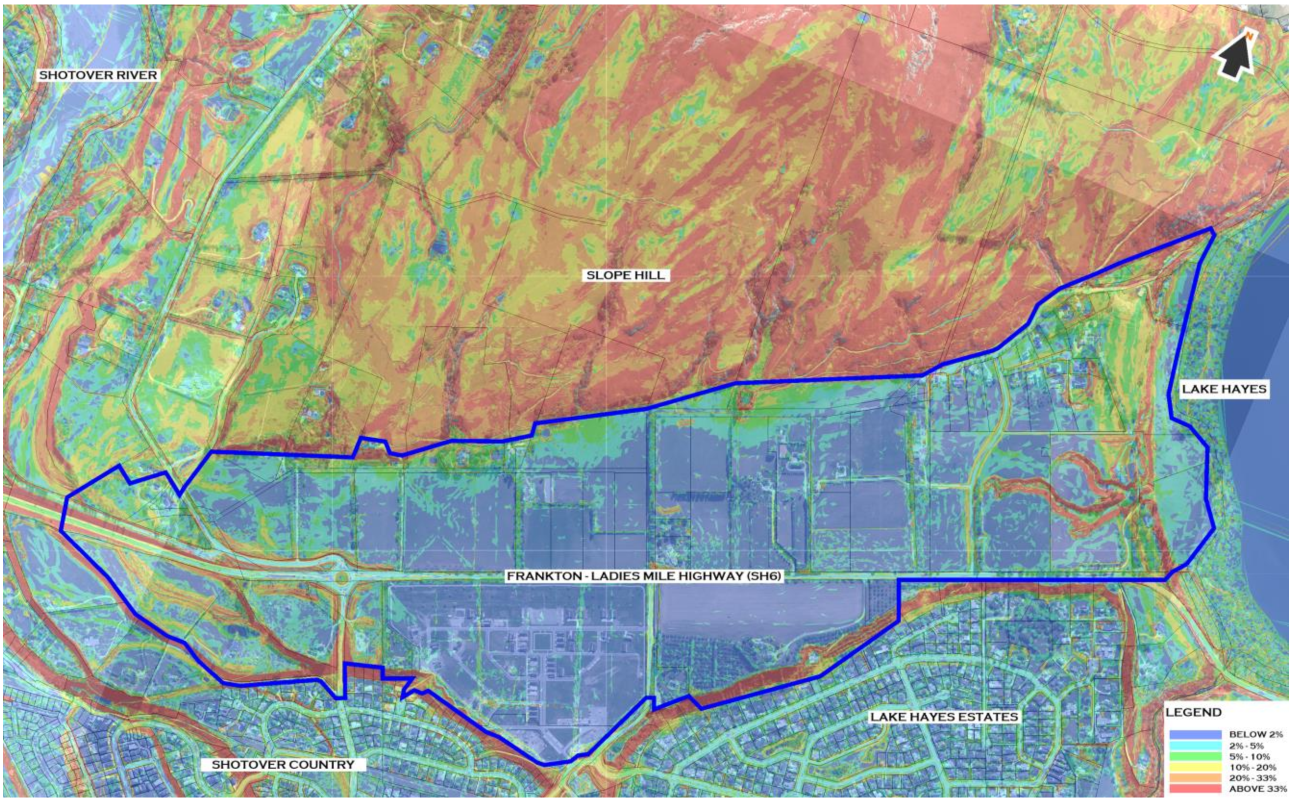


Figure 5.3 – Proposed masterplan existing slopes.

5.1.2 GEOLOGY AND SOILS

A preliminary geotechnical assessment for the masterplan area was carried out by Geosolve. The area is located in the Wakatipu basin and was predominantly formed by glacial advances. The existing ground profile for the majority of the masterplan area is expected to comprise topsoil, loess silt, localised alluvial silt, and deltaic/alluvial sand, gravel, and silt deposits. Localised alluvial fan depositional material and schist bedrock at depth is expected at the toe of Slope Hill. Underlying schist bedrock is also expected along terrace slopes in the south-western portion of the masterplan area. Exposed schist bedrock was observed in some locations on Slope Hill.

Landcare Research Soil Reports indicate the permeability of the soils underlying the masterplan area to vary from moderately slow to rapid (from 4mm/hr to over 72mm/hr). Slope Hill permeability is likely to be slow (below 4mm/hr). The geotechnical assessment estimates the soakage rates within the masterplan area to vary between 7.2mm/hr and 360mm/hr based on available historical soakage testing data.

Otago Regional Council prepared a report titled "An investigation into the Wakatipu Basin Aquifers" in July 2014. The report showed the masterplan area to be underlain by Windemeer Aquifer. The aquifer water table is expected to sit at approximately RL 320m next to lake Hayes and RL 310m at Shotover River and Kawarau River. This agrees with the findings from the geotechnical assessment, which located the groundwater at approximately 39m to 51m below the masterplan area ground level (reducing to 10m to 20m in the lower lying areas). The aquifer is expected to be predominantly recharged via infiltration of rainfall through ground. The estimated recharge is approximately 480,000 m³/year (consented groundwater extraction as of early 2013 is 55,000 m³/year). The inflow from Lake Hayes to the aquifer is expected to be minimal due to the likely presence of a low permeability layer comprising silt lake sediments. The aquifer is expected to have high transmissivity (ease of which water can move through an aquifer). The aquifer water levels are shown in Figure 5.4 below.

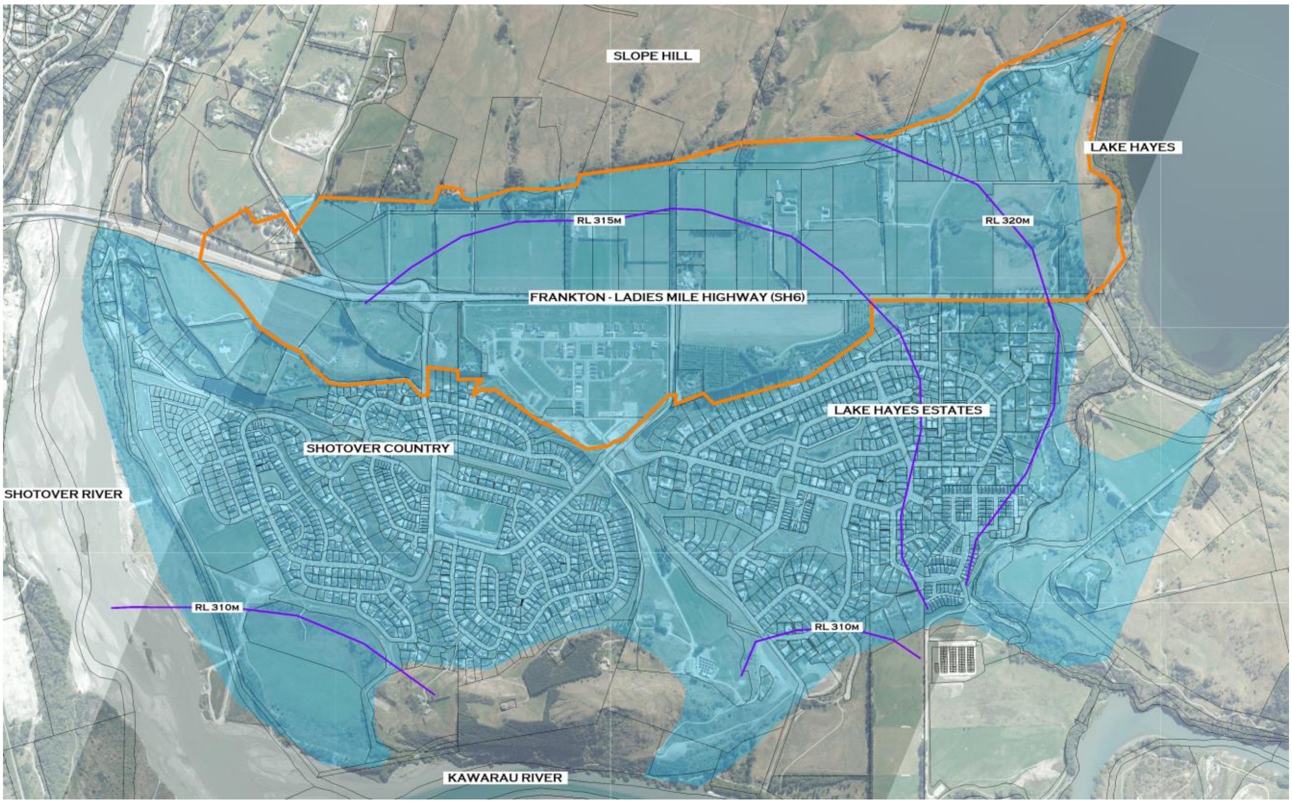


Figure 5.4 – Windemeer Aquifer extents and levels. Figure reproduced from Otago Regional Council Investigation into the Wakatipu Basin Aquifers (July 2014).

5.1.3 HYDROLOGY

There are several smaller ponds present within the masterplan area. These are generally located adjacent to the toe of Slope Hill. No natural streams were observed within the masterplan area.

The majority of the surface water flow within the masterplan area is expected to be generated from rainfall. The total estimated catchment area shown in Figure 5.5 below includes both Slope Hill and the masterplan area. Due to the low expected soakage capacity, the majority of rainfall runoff from Slope Hill is expected to flow to the masterplan area through a network of existing gully features.

The high soakage capacity of the underlying soils within the masterplan area indicates that the rainfall and the surface water flow from Slope Hill will infiltrate into the ground. Based on the existing topography, excess rainfall from the areas north of SH6, which cannot infiltrate into the ground, will generally flow towards Lake Hayes. The excess rainfall from the areas south of SH6 will head towards Shotover River and Lake Hayes Estates. The magnitude of the rainfall event that will generate the surface water flows from the masterplan area is not known. Based on consultation with the existing landowners, regarding the historical flooding in the area, a rainfall event of a higher magnitude will be required. The likely surface water flows are indicated in Figure 5.5 below.

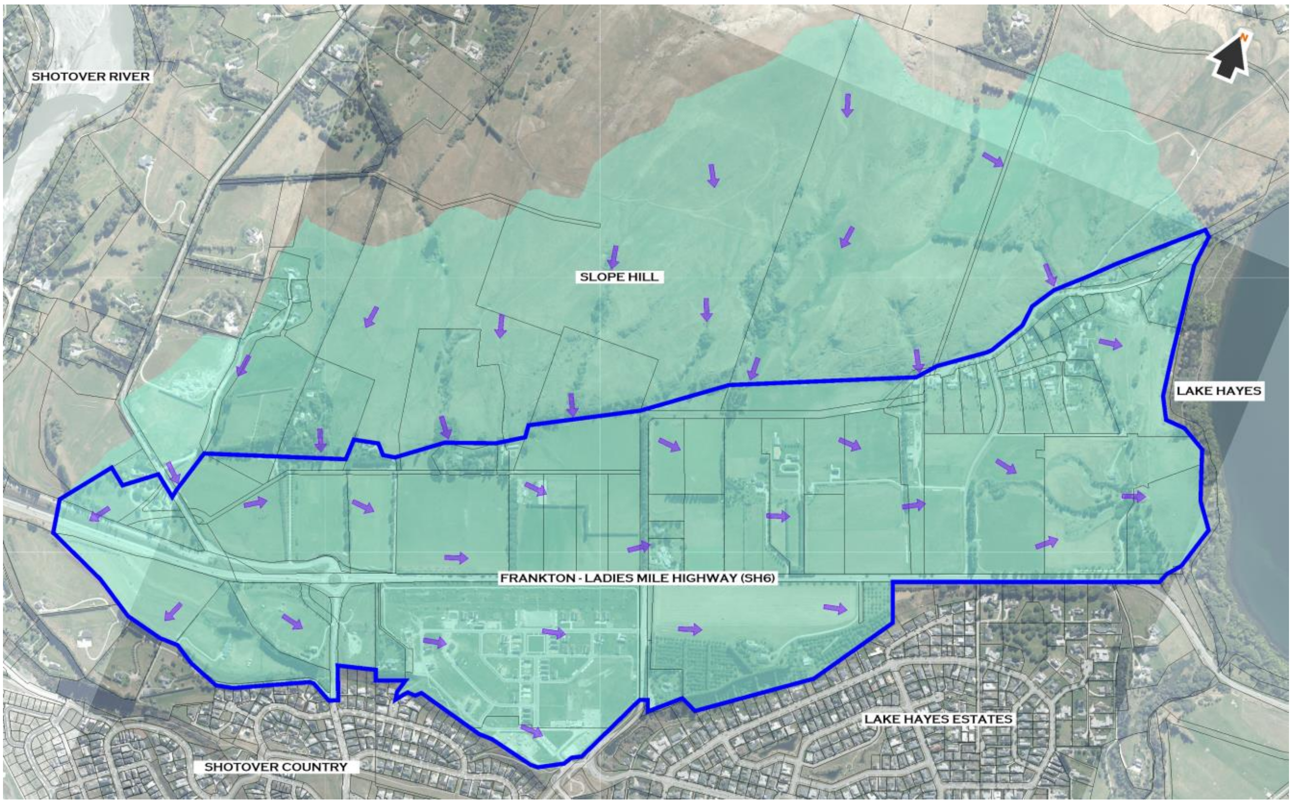


Figure 5.5 – Proposed masterplan catchment extent and likely surface water flow direction.

A Shotover Country River and Flooding Assessment prepared by David Hamilton and Associates Ltd in February 2010 estimated the Shotover River 100-year ARI flood levels at the location of SH6 bridge crossing to be at approximately RL 317.3m. The lowest elevation within the masterplan area is at the margins of Lake Hayes at approximately RL 327m. As such it is unlikely for the masterplan area to be subject to inundation from either the Shotover River or the Kawarau River during flood events. However, the lower lying areas immediately adjacent to Lake Hayes may be subject to inundation from the raised water levels in the lake during flood events. The areas adjacent to Lake Hayes are not proposed for urban development under this masterplan and will remain unchanged.

The estimated depth – duration and intensity – duration rainfall frequencies for the area, including the projected climate change adjustments for the RCP8.5 scenario (2081 – 2100), are shown in Table 5.1 and Table 5.2. The data was obtained from NIWA High Intensity Rainfall Design System V4 (HIRDS V4) on 1 September 2020.

Table 5.1 – HIRDS V4 depth-duration tables for the masterplan area.

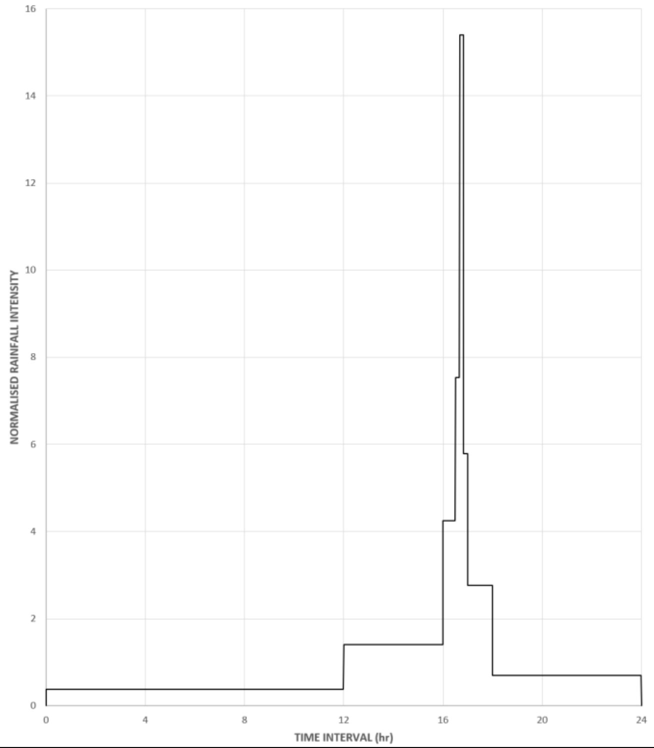
RAINFALL DEPTHS (mm) – HISTORICAL DATA													
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	2.78	4.36	5.63	8.59	12.8	22.8	31.5	42.1	54.2	61.6	66.8	70.9
2	0.5	3.12	4.88	6.29	9.56	14.2	25.1	34.6	46	58.9	66.8	72.3	76.6
5	0.2	4.43	6.84	8.75	13.1	19.2	33.3	45.2	59.4	75	84.4	90.9	95.9
10	0.1	5.53	8.46	10.8	16	23.2	39.7	53.4	69.5	87.1	97.5	105	110
20	0.05	6.78	10.3	13	19.2	27.6	46.6	62.2	80.3	99.7	111	119	125
30	0.033	7.6	11.5	14.5	21.2	30.4	50.9	67.7	86.9	107	119	127	133
40	0.025	8.22	12.4	15.6	22.8	32.5	54.1	71.7	91.7	113	125	134	140
50	0.02	8.73	13.1	16.5	24	34.2	56.6	74.9	95.6	117	130	138	145
60	0.017	9.16	13.7	17.2	25	35.6	58.8	77.5	98.8	121	134	142	149
80	0.012	9.87	14.7	18.5	26.8	37.9	62.3	81.8	104	127	140	149	155
100	0.01	10.4	15.6	19.5	28.1	39.7	65	85.3	108	132	145	154	160
250	0.004	13.1	19.3	24	34.3	47.9	77.1	100	125	151	165	175	181
RAINFALL DEPTHS (mm) – RCP8.5 FOR THE PERIOD 2081-2100													
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	3.63	5.7	7.36	11.2	16.5	28.3	38	49.7	62.3	69.7	74.9	79.1
2	0.5	4.11	6.42	8.27	12.6	18.5	31.4	42.1	54.5	68.1	76.2	81.8	86
5	0.2	5.9	9.1	11.6	17.4	25.3	42.3	56	71.3	88	97.9	104	109
10	0.1	7.4	11.3	14.4	21.4	30.8	50.7	66.5	84.1	103	114	121	126
20	0.05	9.11	13.8	17.5	25.8	36.7	59.9	77.8	97.3	118	130	138	143
30	0.033	10.2	15.4	19.5	28.6	40.5	65.6	84.8	106	128	140	148	154
40	0.025	11.1	16.6	21	30.6	43.3	69.9	90	112	134	147	155	161
50	0.02	11.8	17.7	22.2	32.4	45.6	73.2	94	116	140	153	161	167
60	0.017	12.3	18.5	23.2	33.8	47.5	76.1	97.5	120	144	158	166	172
80	0.012	13.3	19.9	24.9	36.1	50.7	80.6	103	127	152	165	173	180
100	0.01	14.1	21	26.3	38	53.2	84.3	107	132	157	171	180	185
250	0.004	17.7	26	32.4	46.3	64.1	100	126	153	180	195	204	210

Table 5.2 – HIRDS V4 intensity-duration tables for the masterplan area.

RAINFALL INTENSITIES (mm/hr) – HISTORICAL DATA													
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	16.7	13.1	11.3	8.59	6.4	3.8	2.63	1.76	1.13	0.855	0.696	0.59
2	0.5	18.7	14.7	12.6	9.56	7.09	4.18	2.88	1.92	1.23	0.927	0.753	0.638
5	0.2	26.6	20.5	17.5	13.1	9.6	5.54	3.77	2.47	1.56	1.17	0.947	0.799
10	0.1	33.2	25.4	21.5	16	11.6	6.61	4.45	2.9	1.81	1.35	1.09	0.917
20	0.05	40.7	30.9	26	19.2	13.8	7.76	5.19	3.35	2.08	1.54	1.24	1.04
30	0.033	45.6	34.4	29	21.2	15.2	8.48	5.64	3.62	2.24	1.66	1.33	1.11
40	0.025	49.3	37.1	31.2	22.8	16.2	9.01	5.97	3.82	2.35	1.74	1.39	1.16
50	0.02	52.4	39.3	32.9	24	17.1	9.44	6.24	3.98	2.45	1.81	1.44	1.2
60	0.017	54.9	41.1	34.4	25	17.8	9.8	6.46	4.11	2.52	1.86	1.48	1.24
80	0.012	59.2	44.2	36.9	26.8	18.9	10.4	6.82	4.33	2.64	1.95	1.55	1.29
100	0.01	62.7	46.7	38.9	28.1	19.9	10.8	7.1	4.5	2.74	2.01	1.6	1.34
250	0.004	78.6	57.8	48	34.3	24	12.8	8.33	5.22	3.15	2.3	1.82	1.51
RAINFALL INTENSITIES (mm/hr) – RCP8.5 FOR THE PERIOD 2081-2100													
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	21.8	17.1	14.7	11.2	8.25	4.72	3.17	2.07	1.3	0.968	0.781	0.659
2	0.5	24.6	19.3	16.5	12.6	9.23	5.24	3.51	2.27	1.42	1.06	0.852	0.717
5	0.2	35.4	27.3	23.3	17.4	12.6	7.05	4.66	2.97	1.83	1.36	1.09	0.91
10	0.1	44.4	34	28.8	21.4	15.4	8.45	5.54	3.5	2.14	1.58	1.26	1.05
20	0.05	54.6	41.5	35	25.8	18.4	9.98	6.48	4.05	2.46	1.81	1.44	1.19
30	0.033	61.3	46.3	39	28.6	20.3	10.9	7.06	4.4	2.66	1.94	1.54	1.28
40	0.025	66.4	49.9	41.9	30.6	21.7	11.6	7.5	4.65	2.8	2.05	1.62	1.34
50	0.02	70.6	53	44.4	32.4	22.8	12.2	7.83	4.85	2.91	2.12	1.68	1.39
60	0.017	74.1	55.5	46.4	33.8	23.8	12.7	8.13	5.02	3	2.19	1.73	1.43
80	0.012	80	59.7	49.9	36.1	25.3	13.4	8.58	5.28	3.16	2.29	1.81	1.5
100	0.01	84.7	63	52.6	38	26.6	14.1	8.96	5.5	3.27	2.37	1.87	1.55
250	0.004	106	78.1	64.8	46.3	32.1	16.7	10.5	6.38	3.76	2.71	2.13	1.75

The data obtained from HIRDS V4 was used to develop the temporal pattern for a 24-hour nested design storm shown in Table 5.3 below.

Table 5.3 – Proposed masterplan 24-hour nested design storm temporal pattern.

TIME INTERVAL (min)	NORMALISED RAINFALL INTENSITY[1]	DESIGN STORM PROFILE
720min	0.38	
240min	1.41	
30min	5.25	
10min	7.53	
10min	15.4	
10min	5.78	
60min	2.76	
360mn	0.69	

1. *Normalised rainfall intensity was obtained by dividing the time interval intensity with the 24-hour intensity.*

5.1.4 ECOLOGY AND ECOSYSTEM SERVICES

The margins of Lake Hayes, adjacent to the proposed masterplan area extents, have been identified as a Regionally Significant Wetland by the Otago Regional Council. The wetland provides a high diversity of indigenous flora and fauna including threatened native fish (Koaro), threatened swamp birds (Australasian Bittern and Crested Grebe) and endemic bird species. The wetland is also a breeding area for several waterfowl species (Grey Duck, Kuruwhengi, Marsh Crake and Australian Coot).

The proposed masterplan area is predominantly pasture with several scattered areas of established mature trees and shelter belts. A few smaller ponds are present at the toe of Slope Hill. An ecological assessment is being undertaken to identify the ecological values across the masterplan area.

Otago Regional Council has previously reported water quality issues within Lake Hayes. These are generally attributed to historical deposition of sediment and nutrients from the predominantly pastoral catchment.

5.1.5 INFRASTRUCTURE SERVICES

There are five existing public roads providing service to the proposed masterplan area. These include Lower Shotover Road, Spence Road, Stalker Road, Howards Drive, and the Frankton – Ladies Mile Highway (SH6). Several private roads have also been constructed to provide access to the existing dwellings. Based on the available information, the average daily traffic (ADT) is 212 vehicles per day (VPD) for Spence Road (2012 count year), 4,100 VPD for Lower Shotover Road

(2018 count year) and 16,000 VPD for SH6 (2018 count year). High traffic volume roads, particularly SH6, are expected to generate high levels of urban stormwater runoff pollutants. There is no water quality treatment currently being implemented on these roads.

Based on the information available on the Queenstown Lakes District Council GIS, there is no existing public stormwater infrastructure servicing the proposed masterplan area. Existing public stormwater infrastructure is present within the existing developments of Shotover Country, Queenstown Country Club Retirement Village, and Lake Hayes Estate. Private stormwater infrastructure, generally soakpits, are present in the eastern portion of the masterplan area.

There is an existing 1050mm diameter pipe located within Howards Drive, at the intersection with First Avenue. An infrastructure assessment report carried out by Opus in 2018, as part of the Ladies Mile Housing Infrastructure Fund (HIF), estimated this pipe to have a spare service capacity of approximately 1.5m³/s for the Ladies Mile development area. The invert of this pipe sits at approximately RL 355.8m.

5.2 STORMWATER MANAGEMENT

5.2.1 OBJECTIVES

Using the principles of Water Sensitive Urban Design (WSUD), the following stormwater management objectives were developed for the proposed masterplan area to integrate the existing features and natural processes with the future land use and layout.

1. Utilise stormwater management solutions that mimic the natural water cycle and enhance the water quality.
2. Employ an integrated stormwater management approach that supports connectivity to the natural environment and gives effect to Te Mana o te Wai and community wellbeing.
3. Manage flooding and surface water flow to safeguard the community and infrastructure in a sustainable manner.
4. Implement stormwater management solutions that deliver lifecycle operational and economic resilience.

5.2.2 PRINCIPLES

The general principles for stormwater management were developed for the masterplan area to achieve the set objectives.

As outlined in Section 5.1.3, the rainfall runoff from the proposed masterplan area is generally expected to infiltrate into the ground and recharge the underlying Windemeer aquifer. The aquifer is anticipated to be predominantly recharged by rainfall infiltration and is likely to be hydraulically connected with the Shotover River and Kawarau River. The development of the masterplan area will significantly increase the imperviousness of the area and decrease the ground infiltration capacity. Maintaining the hydrologic connection between the rainfall and the underlying soils will ensure that there are no long-term adverse effects on the replenishment and use of the Windemeer aquifer. This will support the concepts of Te Mana o te Wai by preserving the water cycle.

The proposed urbanisation of the masterplan area will alter and likely increase the generation of contaminants including suspended solids, hydrocarbons, organic matter, nutrients, heavy metals (mainly lead, zinc and copper), pathogens, gross pollutants (litter) and temperature. The implementation of stormwater quality treatment requirements, including installation of water quality treatment devices and restrictions on specific building materials, will ensure that there are no adverse effects on the receiving environment. Furthermore, the implementation of water quality treatment devices such as wetlands will also deliver additional wildlife habitat.

As outlined in Section 5.1.5, high traffic volume roads are expected to generate the highest levels of stormwater runoff pollutants in an urban environment. In order to achieve the best water quality management outcomes, water quality treatment should also be implemented for SH6 and the Lower Shotover Road, which currently have no or minimal treatment, where practicable. The overall implementation of water quality treatment will ensure that the health and Mauri of the groundwater are protected.

High density development is proposed for a large portion of the masterplan area. Integrating the stormwater management solutions within public roads and open spaces will maximise the available developable area while enhancing the aesthetic and recreational functions of public reserves. This will support the wellbeing of the community by encouraging the relationship to water and the natural environment and give effect to Te Mana o te Wai.

A stormwater management approach that intercepts and controls the runoff from Slope Hill will be used to minimise the impact and risk from flooding for the masterplan area. Safety from flooding for people, property, and infrastructure will be managed through the implementation of designated overland flow path corridors, minimum finished floor levels, and safety limits on the depth and velocity of surface flood flows.

The stormwater management solutions will be developed in collaboration with a variety of specialist consultants and stakeholders and will be implemented through a Best Practicable Option (BPO) assessment approach that considers long-term environmental, social, cultural, and economic outcomes (lifecycle cost analysis), and constructability.

5.2.3 CATCHMENT DELINEATION

Based on the topography, existing infrastructure, proposed land use and the landowner’s initiative to develop, the proposed masterplan area was split into five distinct stormwater management catchments as shown in Figure 5.6. The extent of the Slope Hill catchment that drains to the masterplan area is shown in Figure 5.6 as well.

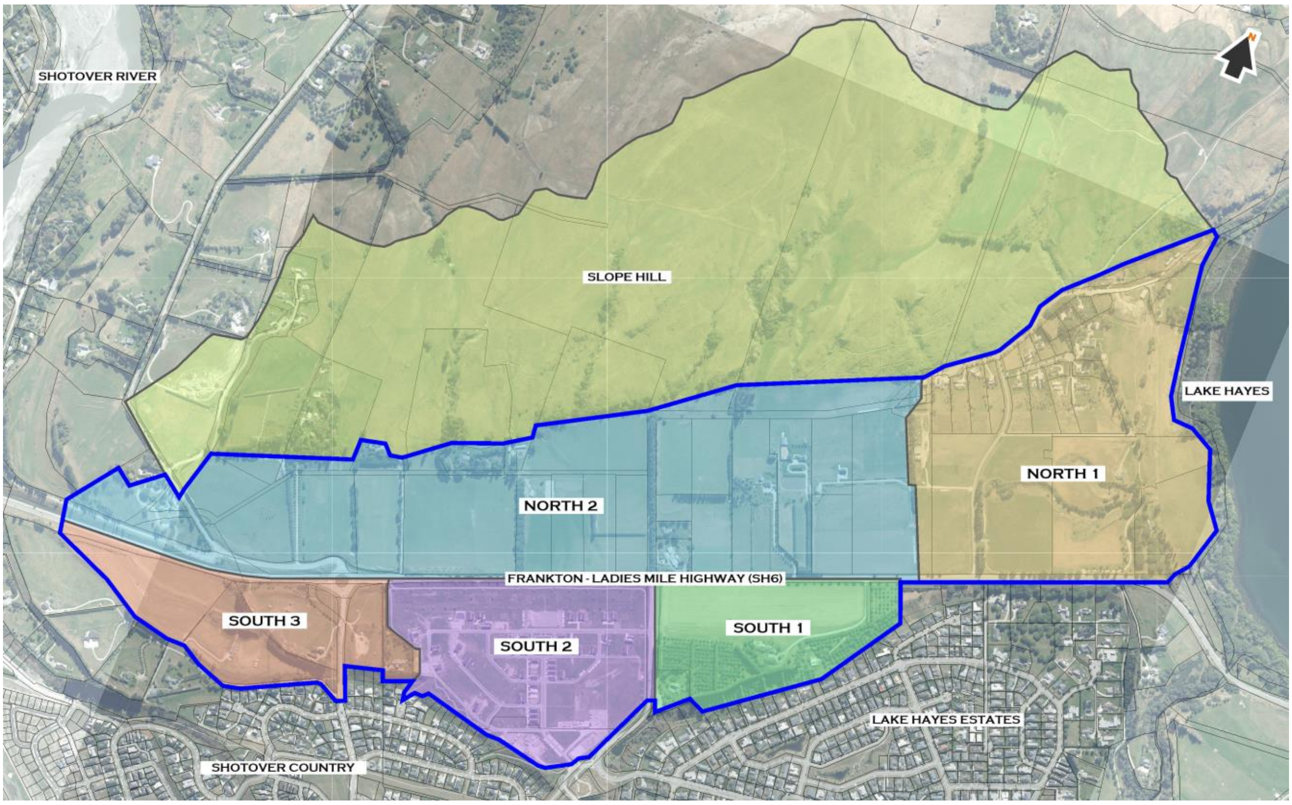


Figure 5.6 – Proposed masterplan stormwater management catchment delineation.

The masterplan area was generally split into catchments north and south of SH6, which acts as a ridgeline. The catchment to the north naturally falls towards Lake Hayes. The catchment to the south naturally falls towards the existing residential developments.

The northern catchment was further split into North 1 and North 2. There are no stormwater management initiatives proposed for area North 1, as the land use for this area will remain unchanged under this masterplan.

The southern catchment was split into South 1, South 2, and South 3. South 1 is predominantly owned by QLDC, excluding a small residential property, and is intended to be developed as a sports and recreation facility with low imperviousness. South 2 contains the Queenstown Country Club Retirement Village, which is serviced by the existing stormwater infrastructure. South 3 represents the remainder of the southern catchment, which generally lies below SH6, and it is not feasible to connect it hydraulically with the catchments to the north.

5.2.4 STORMWATER MODELLING METHODOLOGY

A preliminary rainfall runoff modelling was carried out for the masterplan area to inform the initial stormwater management assessment.

A 24-hour nested storm, with the peak at approximately 0.7 of the storm duration, was created for the area using the HIRDS v4 rainfall data for the RCP8.5 scenario. This rainfall distribution was adopted as a conservative approach to modelling the soakage in the area anticipating saturating of the underlying soils prior to the peak of the storm and was considered appropriate for the purpose of this preliminary assessment.

The majority of the stormwater modelling was carried out using the HEC-HMS software. Auckland Regional Council Technical Publication 108 (TP108) runoff modelling methodology was used. This methodology uses modified United States Department of Agriculture Soil Conservation Service (SCS) excess rainfall modelling guidelines. Based on the available soil permeability information, the masterplan area was given a pervious hydrologic soil group number (CN) of 39 and Slope Hill was given a CN of 74.

A preliminary two-dimensional rainfall on grid model using TUFLOW was also developed to assist with the initial understanding of the existing surface stormwater movements within the masterplan area. To model the surface runoff, an initial-continuous loss infiltration method was used. Based on the available soil infiltration information, the model input data for the masterplan area was estimated at 5 mm initial loss and 15 mm/hr continuous loss. The input data for the Slope Hill was estimated at 5 mm initial loss and no continuous loss.

As outlined in Section 5.1.3, the magnitude of the rainfall event that will at present generate surface water flows from the masterplan area is not known. Based on the preliminary modelling results obtained from the two-dimensional TUFLOW model, the existing ground soakage capacity may be exceeded during rainfall events above the 1.58-year ARI. This indicates that surface water flows during a rainfall event are highly likely to be generated annually. However, based on the discussions with the existing landowners, surface flows beyond localised ponding have not been observed during historical rainfall events. Further investigation and detailed modelling are recommended to better determine the existing ground soakage capacity and better inform the future detailed design work.

The development of the masterplan area will alter the existing surface water flow regimes. Due to the preliminary nature of the modelling, and the associated uncertainties of the modelling results, a conservative approach was adopted for the purpose of the initial assessment, where all stormwater runoff up to the 100-year ARI rainfall event, including the effects of climate change, is contained within the masterplan area. The 100-year ARI rainfall event is the current QLDC code of practice design storm for the management of surface water flows.

5.2.5 STORMWATER MANAGEMENT ASSESSMENT

A preliminary assessment was carried out to develop the stormwater management approach for the masterplan area. Based on the existing site appraisal, the major stormwater management constraints were associated with water quantity management. These can be summarised as follows:

- Delivering a sufficient level of ground infiltration to ensure the ongoing replenishment of the Windemeer Aquifer.
- Managing the high peak flows and stormwater runoff volumes expected to flow into the masterplan area from Slope Hill. The total runoff for the 24-hour 100-year ARI rainfall event was estimated at approximately 97,000m^3. The estimated peak flows from some of the individual Slope Hill gully features could be up to approximately 3.5m^3/s.
- Providing discharge points for the primary stormwater systems. The existing primary stormwater system in the area, including the 1050mm diameter stormwater pipe located within Howards Drive, does not have the capacity to service the proposed masterplan area.
- Providing discharge points for the secondary stormwater systems. The management of surface water flows from area North 2 to the nearest water body is precluded by area North 1. The management of surface water flows from South 1, South 2, and South 3 are limited by the steep terrace slopes and the existing developments.
- Secondary stormwater flows which currently flow towards Lake Hayes cannot be redirected across State Highway 6. To redirect flows to the south of the highway they would need to be routed underneath the highway.
- Lake Hayes margins have been identified as a regionally significant wetland by the Otago Regional Council. In addition to this, Lake Hayes has been targeted for water quality rehabilitation as a part of the ORC long term plan, and subsequently as a part of Jobs for

Nature programme with funding from the Department of Conservation. The sensitive nature of these receiving waters will make it difficult to discharge to this location.

- There are a large number of different landowners within the plan change area. Coordination and alignment of development timelines will be required for large diversion options.

Several water quantity management approach options were considered. These approaches were developed based on the stormwater management principles set for the proposed masterplan area. The options are included in a separate memo attached to this report.

The major constraints noted above for all options are predominantly associated with water quantity treatment. As such, the assessment of options for water quality management was generally carried out in support of the water quantity management approaches. This will not impinge on the overall objectives for the masterplan area.

5.2.6 WATER QUANTITY MANAGEMENT

5.2.6.1 CENTRALISED STORMWATER MANAGEMENT AREAS

Following the assessment of the existing stormwater management constraints, ground soakage for all stormwater runoff up to the 24-hour 100-year ARI rainfall event was considered as a suitable stormwater management approach. This will maintain the hydrologic connectivity to the aquifer whilst delivering discharge points for the primary and secondary stormwater systems within the masterplan area itself. The primary stormwater reticulation within the masterplan area, including pipes and swales, will be designed to cater for the 20-year ARI design storm, including the effects of climate change, as per QLDC code of practice. The secondary stormwater system, including designated overland flow path corridors, such as public roads, accessway and swales, will be designed to cater for the 100-year ARI design storm, including the effects of climate change, as per QLDC code of practice. The stormwater runoff from Slope Hill will be incorporated into the network of conveyance swales. The proposed stormwater conveyance management is further discussed in Section 5.2.6.2.

The centralised stormwater management approach was the focus for North 2 where high-density development is proposed.

A preliminary assessment was carried out to estimate the size of the required stormwater management areas. A part of this assessment included a comparison between an approach where each individual landowner will implement stormwater management for their site only, and an approach where a centralised stormwater management arrangement will be used.

For the purpose of this assessment some of the smaller landowners were disregarded and a total of eight different stormwater management areas were assumed for an individual landowner management approach. For the centralised stormwater management approach, a total of two stormwater management areas were considered. The first stormwater management area was positioned north of the intersection of Howards Drive and SH6, so that it can be hydraulically connected to the existing 1050mm diameter stormwater pipe. The second stormwater management area was positioned adjacent to the eastern boundary of North 2.

All stormwater management areas were considered to include both water quality and quantity components. For the purpose of this assessment, the devices considered were:

- Infiltration basins for water quantity management for both approaches.
- Wetlands for water quality management for both approaches.
- Central conveyance swale to manage the flows from Slope Hill for the centralised approach.
- Internal swale system to manage flows from Slope Hill for the individual landowner approach.

The conceptual layouts for both approaches are shown in Figure 5.7 and Figure 5.8.

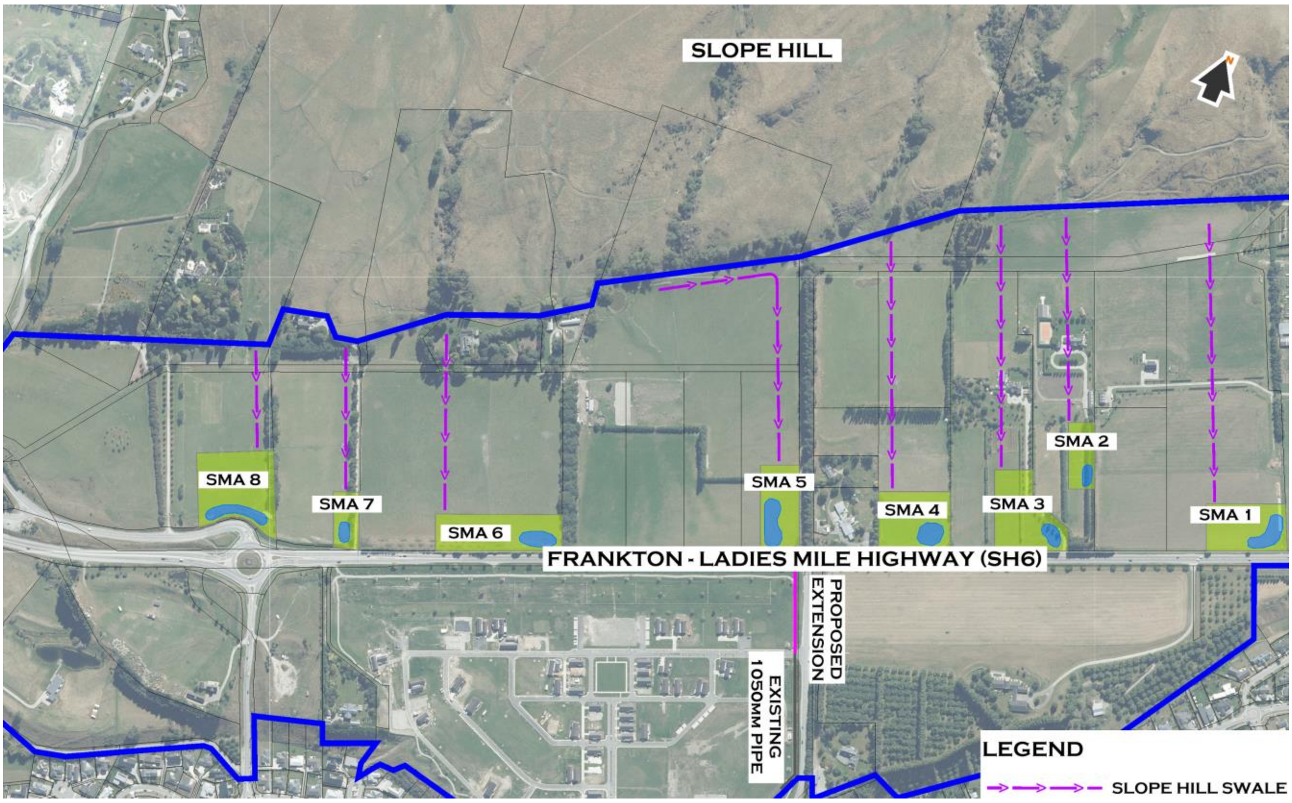


Figure 5.7 – Individual landowner stormwater management area conceptual layout plan for North 2.

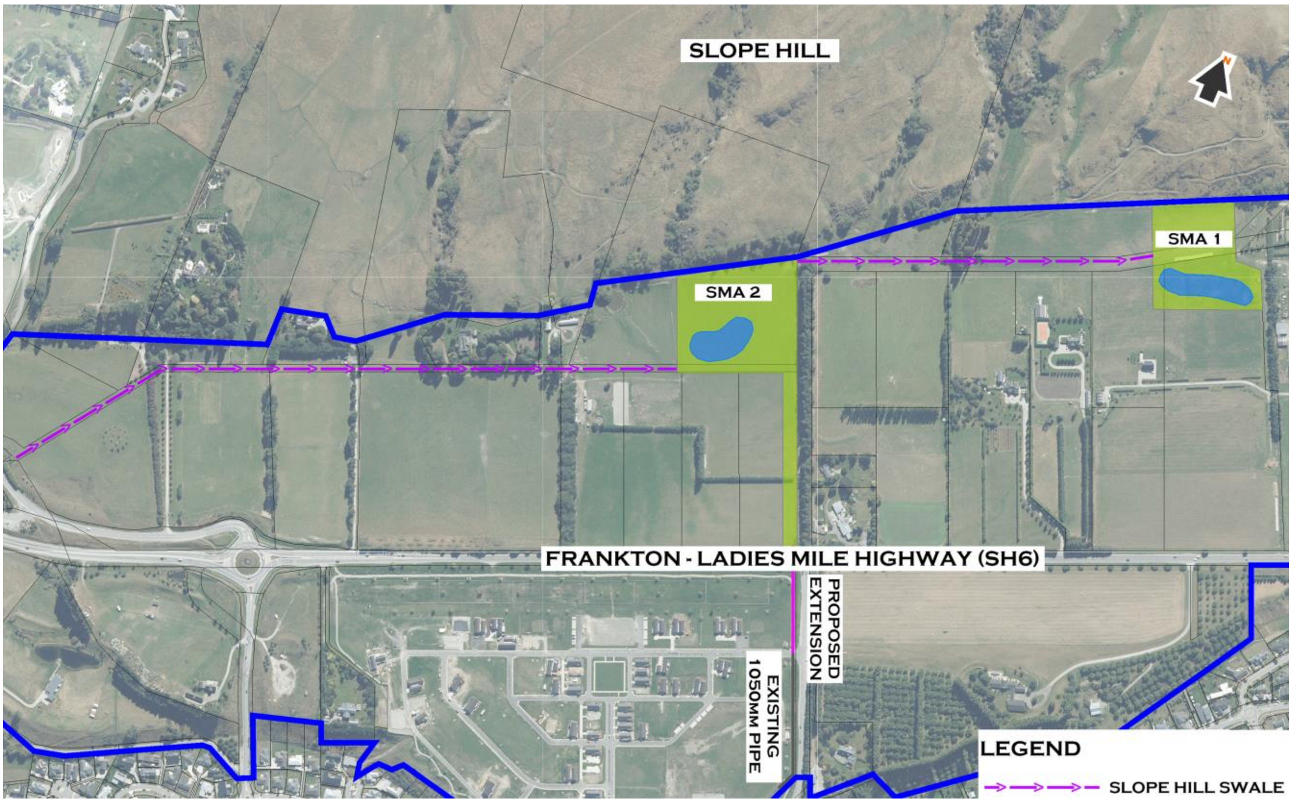


Figure 5.8 – Central stormwater management area conceptual layout plan for North 2.

QLDC commissioned stormwater soakage testing within the plan change area in April 2021. The findings are included in the GeoSolve Preliminary Stormwater Soakage Testing Report, May 2021 (Ref: 200353.01). This formed the basis of the soakage analysis for the individual and centralised management approaches. The spare discharge capacity of the 1050mm Howards Drive stormwater pipe, utilised in both approaches, was assumed at 1.5m³/s as per the historical infrastructure reports for the area.

The assessment has shown that by utilising two centralised stormwater management areas the overall required footprint of the stormwater management areas could reduce by approximately 60%. This reduction assumes that all stormwater management areas are generally constructed using 1 in 5 average cut slopes. The footprint of the Slope Hill swale conveyance systems was not included in the assessment. A summary showing the stormwater management area footprint comparison for the two approaches is shown in Table 5.4.

Table 5.4 – Summary of North 2 stormwater management area footprint assessment.

STORMWATER MANAGEMENT APPROACH	ESTIMATED STORMWATER MANAGEMENT FOOTPRINT	STORMWATER MANAGEMENT DEVICES
Centralised	5.4 hectares	Two stormwater management areas including infiltration basins and wetlands.
Individual	8.8 hectares	Eight stormwater management areas including infiltration basins and wetlands.

By reducing the total stormwater management area footprint, the centralised stormwater management approach is expected to increase the overall development yield, whilst maintaining and potentially improving the environmental outcomes. The improvements in environmental outcomes are anticipated due to the conglomeration of land set aside for stormwater management. This allows for a greater opportunity to accommodate natural habitat, visual amenity, and recreation. Furthermore, the conglomeration of land will also reduce the total construction and long-term maintenance costs. For these reasons, the individual landowner approach was not considered further.

Table 5.5 summarises the proposed stormwater management approach for the masterplan area utilising ground infiltration and the centralised stormwater management. The selection of final stormwater management devices is subject to detailed design. It is important to maintain the number of stormwater management areas in accordance with Table 5.5 to ensure the envisaged outcomes are ultimately achieved.

Table 5.5 – Proposed centralised stormwater management approach for the masterplan area using ground infiltration.

STORMWATER MANAGEMENT CATCHMENT	ESTIMATED STORMWATER MANAGEMENT AREA FOOTPRINT	STORMWATER MANAGEMENT APPROACH
North 1	Not Assessed	Site-specific stormwater management – the land use is expected to remain unchanged.
North 2	5.4 hectares	Two centralised stormwater management areas – possible solution includes infiltration basins/swales and wetlands.
South 1	0.5 hectares	Stormwater management integrated into the informal recreation areas and sports fields – possible solution includes underground infiltration trenches and swales.
South 2	Not Assessed	Site-specific stormwater management – the existing infrastructure is expected to be utilised.
South 3	Not Assessed	Site-specific stormwater management – limited number of landowners and lower development density allows for more flexibility.

The stormwater management areas are proposed to comprise three zones as per Figure 5.9. The permanently wet zone includes wetland areas with a permanent pool of water, predominantly providing water quality treatment for the development. The rain wet zone includes landscaped areas which will be regularly inundated during rainfall events and will serve as the primary infiltration areas. These areas are expected to contain and discharge stormwater runoff for rainfall events up to the 20-year ARI without overtopping. The dry zone includes informal recreation areas which will provide additional storage and infiltration area during extreme rainfall events. These areas are expected to only become inundated in rainfall events exceeding the 20-year ARI.

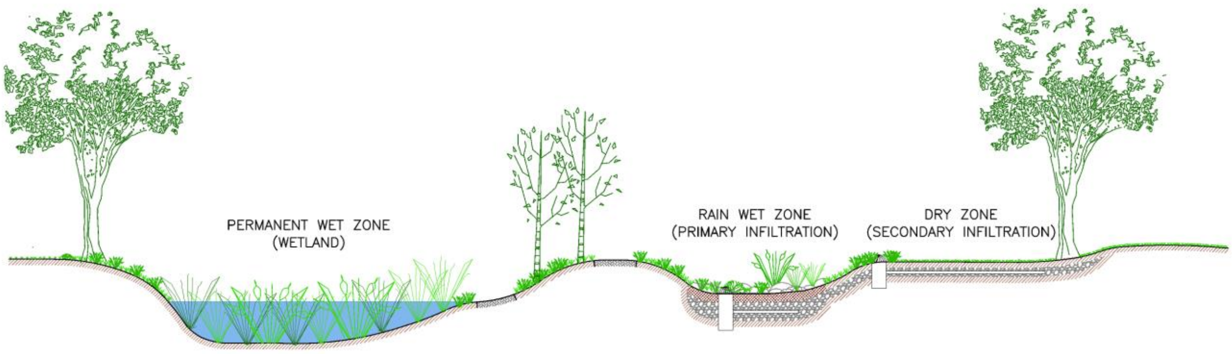


Figure 5.9 – Stormwater management area zone layout.

The estimated location and footprint of the proposed stormwater management areas is preliminary only. The final location and footprint will depend on the existing ground infiltration rate and the potential ground soakage capacity. In order to confirm the size and location of the proposed centralised stormwater management areas, infiltration testing will need to be carried out in the area. Furthermore, as the centralised stormwater management area will be infiltrating large volumes of water into the ground within a relatively concentrated area, it is recommended that the final sizing and detailed design is carried out in conjunction with a hydrogeological assessment.

The construction of the centralised stormwater management areas and the associated stormwater infrastructure for North 2 will be one of the critical elements that will enable the development of the masterplan area. The design and construction programme for these areas will need to be developed in conjunction with the upgrades of other services including wastewater, water supply and utilities (and roading). The streamlining of all the required infrastructure design works will allow the establishment of an effective staging plan for the overall development and ensure that an efficient and cost-effective design and construction process can be achieved.

In case the timing of the construction of the centralised stormwater management areas is significantly delaying the development, temporary stormwater management areas are proposed to be implemented for North 2. The temporary stormwater management areas will be designed and constructed by individual developers to accommodate both the water quality treatment and disposal of stormwater until the centralised stormwater management areas are constructed. The temporary stormwater management will be implemented in a way that it can be redeveloped and connected to the centralised stormwater management areas and the associated infrastructure once these are completed.

5.2.6.2 STORMWATER CONVEYANCE MANAGEMENT

The management of stormwater conveyance can be generally split into primary and secondary systems.

The primary stormwater system within the masterplan area is proposed to include pipes and swales that will collect and convey stormwater runoff to the centralised stormwater management areas, where it will be treated. Following water quality treatment, it will be infiltrated to ground, or conveyed to an alternative location for discharge. The system will be designed to cater for the 20-year ARI design storm, including the effects of climate change, as per QLDC code of practice.

The secondary stormwater system will consist of designated overland flow path corridors, which will include public roads, accessways, and swales. The secondary system will generally convey flows in excess of the primary system capacity. In some cases, the primary and secondary system may be contained within the same network, such as a conveyance swale. The secondary system will cater for the 100-year ARI design storm, including the effects of climate change, as per QLDC code of practice.

As outlined in Section 5.2.5, high peak flows and runoff volumes are expected to run into the masterplan area (North 2) from Slope Hill. As shown in Figure 5.10, a central swale conveyance system is proposed to collect the runoff from Slope Hill and convey it to the stormwater management areas. The swale is anticipated to function as the primary and secondary stormwater system for Slope Hill as well as the secondary system for the proposed development. The swale has been estimated at approximately 1.5m deep and varying in width between 10m and 12m. As shown in Figure 5.11, the width of the swale connecting into the existing Howards Drive stormwater reticulation is proposed to be wider at approximately 19m. This swale will be utilised as an infiltration system and will be an extension of the stormwater management area rain wet zone.

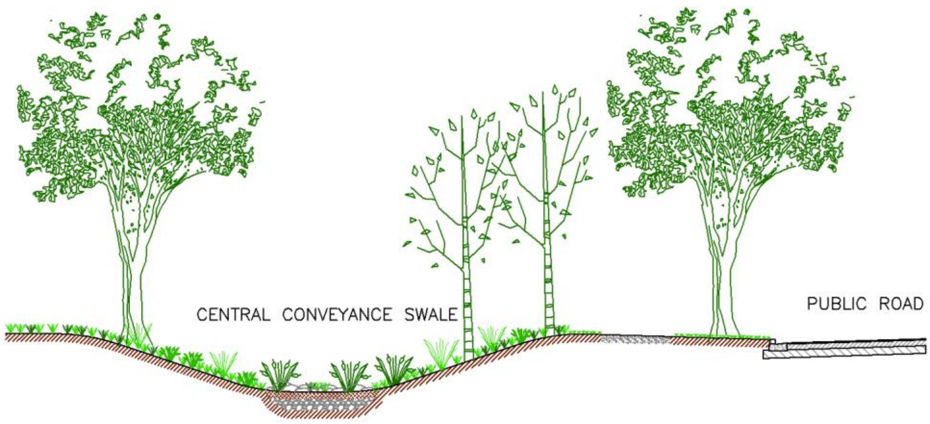


Figure 5.10 – Slope Hill central conveyance swale.

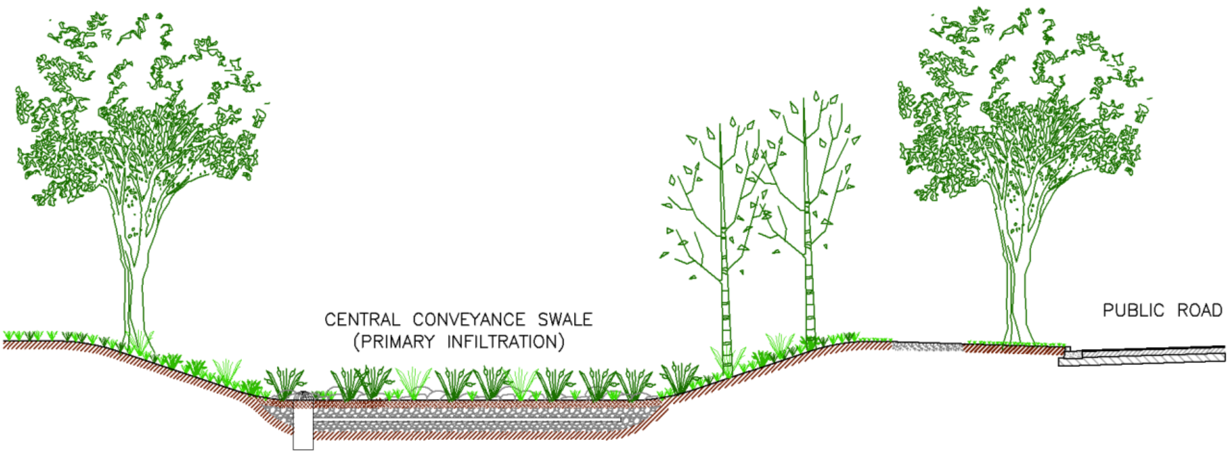


Figure 5.11 – Slope Hill central conveyance swale infiltration section.

The development areas to the north of the central conveyance swale will be required to manage the runoff from Slope Hill to the swale.

5.2.6.3 BULK STORMWATER SYSTEM FOR SECONDARY FLOWS (ALTERNATIVE)

Due to the importance of maintaining hydraulic connectivity to the Windemeer Aquifer, infiltration to ground is required for the masterplan area. As such, stormwater management areas providing a sufficient level of ground infiltration to the ongoing recharge of the aquifer are considered to be the best practicable option.

The stormwater management approach discussed in Section 5.2.6.1 is utilising solely ground soakage and is consequently yielding a relatively high overall stormwater management footprint. There is potential to reduce the footprint of these areas by constructing a supplementary bulk stormwater pipe reticulation.

To service North 2 and South 1 the bulk stormwater pipe could be constructed along SH6 and discharge into the watercourse connecting Lake Hayes and Kawarau River. This is considered to be the most direct route, as discharging directly to Lake Hayes is not considered appropriate due to the presence of a Regionally Significant Wetland along the lake margins and due to the reported water quality issues in the lake. The indicative bulk stormwater pipe route is shown in Figure 5.12.

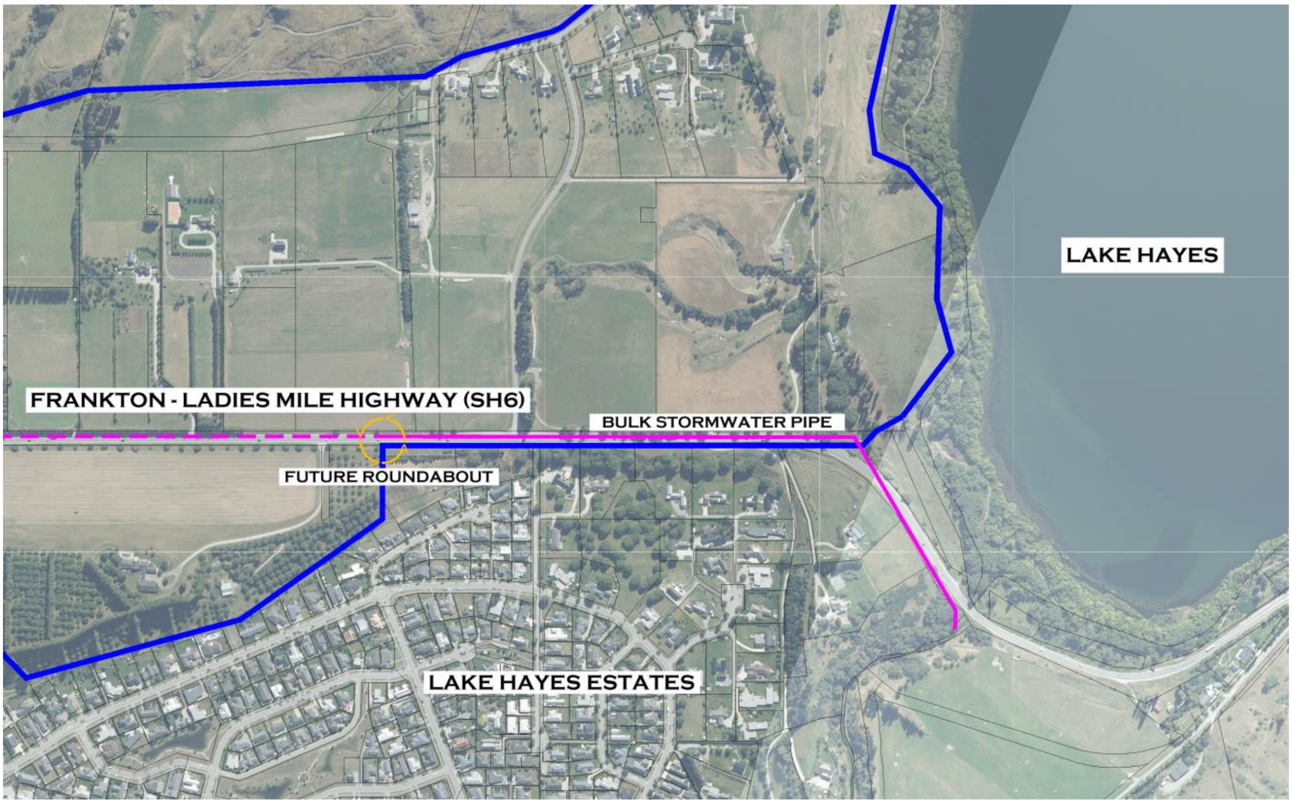


Figure 5.12 – Indicative bulk stormwater pipe route.

With this approach, the centralised stormwater management areas will continue to provide water quality treatment and a level of ground infiltration that is equivalent to the pre-development state (volumes being infiltrated at present). The volume not being infiltrated into the ground will discharge to the bulk stormwater pipe. Runoff from Slope Hill will still be intercepted by a network of conveyance swales and will be discharging the flows to the infiltration areas. The proposed stormwater conveyance management is discussed in Section 5.2.6.2.

The total length of the bulk stormwater pipe, measured from the new proposed Sylvian Street connection roundabout to the watercourse, will be approximately 950m. Based on the existing topography, the estimated bulk stormwater pipe size required to convey the 20-year ARI design storm, including the effects of climate change, is estimated to be 1800mm diameter.

In order to determine whether the bulk stormwater pipe construction is feasible, it is recommended to carry out a detailed lifecycle cost-benefit analysis in conjunction with the detailed design of the centralised stormwater management areas. The design and sizing of the two components is closely related and a detailed feasibility assessment will allow for a holistic final solution to be developed for the masterplan area.

5.2.6.4 AT-SOURCE ROOF SOAKAGE

The potential implementation of private at-source soakage for roof areas was also assessed to estimate the effects on the internal public stormwater infrastructure and the centralised stormwater management areas. It is anticipated that the private soakage will infiltrate the stormwater runoff from rainfall events up to the 20-year ARI, including climate change. As the water quality treatment is proposed to be carried out in the centralised stormwater management areas, at-source soakage could be implemented for the roof areas. By enforcing the use of inert roofing and spouting materials that generate low levels of urban contaminants, as discussed in Section 5.2.2, the runoff from roof could be infiltrated directly to ground without prior water quality treatment.

By implementing private soakage for roof areas only, the public stormwater reticulation could on average reduce by a pipe size and the centralised public stormwater quality treatment devices could reduce by approximately 25%. The footprint of the centralised stormwater management areas will not be significantly affected where the ultimate solution for the disposal of the 100-year ARI rainfall event is provided solely via soakage.

Further infiltration testing will need to be carried out in the area to confirm the suitability of the at-source roof soakage. Similar to the bulk stormwater system feasibility discussed in Section 5.2.6.3, the implementation of at-source roof soakage is recommended to be carried out in conjunction with the detailed design of the centralised stormwater management areas to allow for a holistic final solution to be developed for the masterplan area.

5.2.6.5 RAINWATER HARVESTING

The proposed stormwater management approach for the masterplan area is generally focused on the infiltration of rainwater back into the ground. As such, the benefits of rainwater harvesting are mostly associated with a reduction on the potable water supply demands, and the contribution towards the water supply operational resilience.

A preliminary assessment was carried out to investigate whether rainwater capture and reuse could be implemented across the proposed masterplan area. Rainwater harvesting will be carried out by capturing the stormwater runoff from roof areas and reusing it for the purpose of non-potable supply. This includes reuse for toilets and laundry, or irrigation of landscaped areas.

Historical rainfall data at the Queenstown Airport gauge, dating back to 1982, was obtained from the NIWA National Climate database. The QLDC average daily household water consumption is estimated at 700 litres/person/day. This number is very high compared to the national average daily demand. Based on the QLDC code of practice wastewater average dry weather flow (250 litres/person/day) it was assumed that the high consumption can be mainly attributed to outdoor use (large gardens and landscaped areas). As such, a lower average daily consumption was assumed, at 250 litres/person/day, for a more representative assessment of likely indoor water use.

A preliminary assessment was completed, limited to the non-potable use for toilets and laundry. Generally, approximately 40% (100 litres/person/day) of the average daily consumption is used in the laundry and toilet.

The high-density development proposed for the majority of the masterplan area envisages a large number of multi-story apartments. Based on the preliminary assessment of the historical rainfall data, and the average daily consumption for non-potable water supply, it has been identified that rainwater reuse tanks may not be feasible for multi-story apartments. This is due to the average non-potable daily demand significantly exceeding the historic daily rainfall events that can meet that demand. Although domestic non-potable water reuse may not be feasible for multi-story apartments, rainwater harvesting may still be utilised for irrigation of landscaped areas around the multi-story apartment complexes. The summary of the preliminary assessment is shown in Table 5.6.

Table 5.6 – Summary of the estimated average non-potable daily demand and the number of daily rainfall events that can meet that demand, for a particular house typology.

HOUSE TYPOLOGY	ROOF AREA (m^2)	NUMBER OF DWELLINGS	NUMBER OF PEOPLE	AVERAGE NON-POTABLE DAILY DEMAND (litres)	REQUIRED DAILY RAINFALL DEPTH TO MEET DEMAND (mm)	AVERAGE NUMBER OF RAINFALL EVENTS PER YEAR THAT MEET DEMAND[4]
Terrace/Zero Lot[1]	100	1	3	300	3	60
Townhouse/Maisonette[2]	150	2	6	600	4	50
Three-Story Apartment[3]	200	6	16	1600	8	30
Six-Story Apartment[3]	600	36	97	9700	16	10

1. *Assuming one dwelling with three people per dwelling.*
2. *Assuming two dwellings with three people per dwelling.*
3. *Assuming a mixture of dwellings with two people for one-bedroom apartment, and three people for two- and three-bedroom apartments.*
4. *Based on the historic rainfall data at the Queenstown Airport gauge from 1982 to 2021.*

As per Table 5.6, the reuse tanks are estimated to be generally empty for a minimum of approximately 305 days per year. As such, the reuse tanks could be connected to the public water supply system to provide additional water supply storage capacity for the area during periods of no or little rainfall. This could reduce the demand on the public water supply system during the peak hours.

Further investigation into the feasibility of rainwater harvesting is recommended. This includes a detailed assessment of practicable tank sizes in relation to seasonal variation in rainfall and water demands, potential connection of rainwater tanks to public water supply system to reduce peak hourly demands, and the quantification of potential net positive effects on the overall potable water supply network.

5.2.6.6 FLOOD RISK MANAGEMENT

The proposed stormwater systems and management areas will be designed to ensure the risk of flooding to people, property and infrastructure will be avoided, minimised, or otherwise mitigated. The development within the masterplan area will adhere to the QLDC code of practice design criteria, including the implementation of minimum freeboard requirements and the management of overland flow path depth and velocity requirements.

5.2.7 WATER QUALITY MANAGEMENT

As discussed in Section 5.2.2, the urbanisation of the masterplan area will alter and likely increase the generation of contaminants, including suspended solids, hydrocarbons, organic matter, nutrients, heavy metals (mainly lead, zinc and copper), pathogens, gross pollutants (litter) and temperature. The stormwater quality management approach for the proposed masterplan area is to implement an improve-minimise-mitigate approach.

To improve the discharge of contaminants within the masterplan area it is proposed to include Lower Shotover Road and in particular SH6 into the proposed water quality treatment regime where practicable. This can be carried out either at-source, or by connecting the existing road catchments into the centralised water quality treatment areas. Both roads currently have no or minimal treatment, and are likely generating a high level of contaminants (in particular SH6) due to the high traffic volumes.

To minimise the generation of urban stormwater contaminants a restriction on the use of specific building materials is proposed. This will restrict the use of exposed roofing, spouting, and cladding materials that generate high levels of heavy metals such as zinc and copper. Examples of such materials include unpainted galvanised steel roofs and copper spouting.

To mitigate the generation of urban contaminants water quality treatment will be implemented for all developed areas within the masterplan area. A number of WSUD devices are considered appropriate and mainly include living roofs, bioretention devices, swales, and wetlands.

5.2.7.1 LIVING ROOFS

Living roofs comprise of a vegetation layer, growing medium and a waterproof membrane. There are two types of living roofs: intensive and extensive. Intensive living roofs support a wider range of plants and can be accessible for residents as open spaces. Extensive living roofs support mostly drought-resistant vegetation and are non-accessible.

Living roofs provide only limited water quality treatment. However, they can enhance building design, provide open spaces in high density developments, act as noise and temperature insulators, and provide habitat for birds.

5.2.7.2 PERMEABLE PAVING

Permeable paving consists of hardstand surfaces constructed with pervious materials that allow water to pass through and infiltrate into the underlying soils.

Permeable paving reduces the stormwater runoff during smaller rainfall events and can reduce the size of downstream water quality devices. It provides limited levels of water quality treatment on its own and is not recommended for trafficable areas. Furthermore, due to the high risk of clogging, permeable paving should also be avoided where high sediment runoff is expected, such as adjacent to steeper grassed and landscaped areas.

5.2.7.3 BIORETENTION DEVICES

Bioretention devices comprise specific soils and plants that remove stormwater contaminants using filtration and biological treatment processes. They can also accommodate ground infiltration. The common devices include raingardens, tree pits and planter boxes.

Further to water quality treatment, bioretention devices provide visual amenity value and habitat for bird, lizard, and skink species.

5.2.7.4 SWALES

Swales are grassed or planted engineered channels that treat stormwater runoff through sedimentation and filtration processes. Swales can also accommodate ground infiltration.

In addition to water quality treatment, swales can be used as above ground stormwater conveyance systems. They provide visual amenity value and can accommodate a wide range of plant species similar to those associated with ephemeral watercourses.

5.2.7.5 WETLANDS

Wetlands are complex natural systems that comprise a permanent pool of water covered by water-loving plant species. They provide stormwater quality treatment through sedimentation and biological treatment processes.

Further to water quality treatment, wetlands can deliver a habitat for a wide range of aquatic and bird species and provide visual amenity value.

5.2.7.6 SELECTION OF DEVICES

The selection of the water quality device is based on a number of different parameters including size of the catchment, sediment loading, topography, type of contaminants, maintenance requirements, lifecycle costs, etc. The selection of a devices should be supported by a BPO assessment.

One of the key considerations for the selection of the appropriate water quality management device is the contributing catchment area. This is due to the different contaminant removal processes utilised by the devices (sedimentation, filtration, biological treatment). The recommended treatment areas for different devices are shown in Figure 5.13.

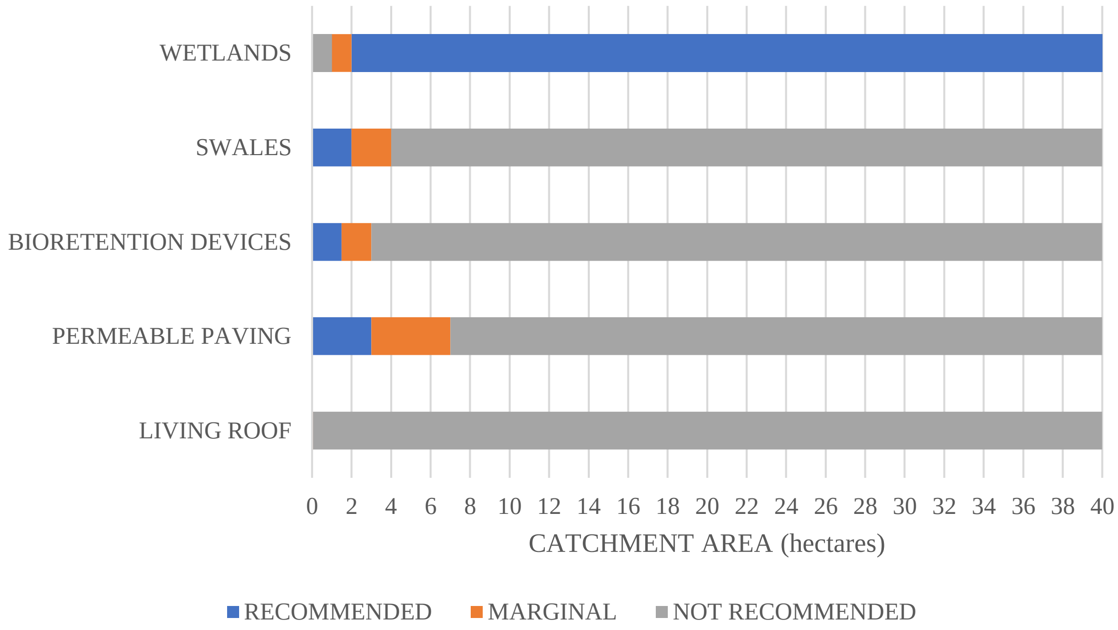


Figure 5.13 – Recommended catchment areas for different water quality treatment devices. Figure reproduced from Auckland Regional Council Technical Publication 10 (May 2003).

As outlined in Section 5.2.6.1 centralised stormwater management areas are expected to reduce the total footprint required for devices. This is also applicable to water quality treatment devices, in particular wetlands and bioretention devices. Furthermore, centralised devices are generally found to be associated with lower construction and lifecycle maintenance costs.

Due to the catchment size of the proposed centralised stormwater management devices, wetlands are proposed to be used as the primary water quality treatment devices within North 2. A degree of filtration will also be accomodated with the proposed vegetated conveyance swales. Other areas within the proposed masterplan extent can utilise a range of WSUD devices discussed above, supported by a BPO assessment.

5.2.8 STORMWATER MANAGEMENT SUMMARY

A preliminary assessment was carried out to develop the proposed stormwater management approach for the masterplan area. The assessment was based on the existing site appraisal and the known stormwater management constraints. A summary of the proposed stormwater management is shown in Table 5.7 below.

Table 5.7 – Summary of proposed stormwater management for the masterplan area.

<table>
<tr><th rowspan="2">STORMWATER MANAGEMENT CATCHMENT</th><th colspan="3">WATER QUANTITY MANAGEMENT</th><th rowspan="2">WATER QUALITY MANAGEMENT</th></tr>
<tr><th>STORMWATER CONVEYANCE</th><th>STORMWATER DISPOSAL</th><th>FLOOD RISK MANAGEMENT</th></tr>
<tr><td>North 1</td><td>• Primary stormwater system, incorporating pipes and swales, to convey flows for rainfall events up to 20-year ARI to the stormwater management areas.
• Secondary stormwater system, incorporating designated overland flow path corridors (public roads, private accessways and swales), to convey flows in excess of primary network capacity to the stormwater management areas. To be designed for rainfall events up to 100-year ARI.</td><td>• Site-specific stormwater management approach for all developed areas that incorporates ground soakage equivalent to the pre-development state.
• Potential implementation of at-source soakage for roof areas to reduce the size of internal primary stormwater reticulation system.
• Potential implementation of rainwater harvesting to improve public potable water supply resilience.</td><td rowspan="2">• Minimum freeboard for habitable floor levels and management of overland flows through depth and velocity limitations.</td><td>• Avoiding (or otherwise treating) the use of exposed high contaminant generating building materials such as exposed unpainted galvanised steel and copper.
• Site-specific stormwater management approach for all developed areas that incorporates WSUD treatment devices and practices referenced in Section 5.2.7.</td></tr>
<tr><td>North 2</td><td>• Primary stormwater system, incorporating pipes and swales, to convey flows for rainfall events up to 20-year ARI to the stormwater management areas.
• Secondary stormwater system, incorporating designated overland flow path corridors (public roads, private accessways and swales), to convey flows in excess of primary network capacity to the stormwater management areas. To be designed for rainfall events up to 100-year ARI.
• A central swale system to convey flows from Slope Hill to the stormwater management areas.</td><td>• Two centralised stormwater management areas providing discharge to ground for rainfall events up to 100-year ARI via infiltration basins and swales.
• Potential installation of bulk stormwater system discharging to the watercourse connecting Lake Hayes and Kawarau River to minimise the stormwater management areas' footprint, whilst maintaining ground soakage equivalent to the pre-development state.
• Temporary stormwater management areas to enable for individual development to occur prior to the completion of the centralised stormwater management areas.
• Potential implementation of at-source soakage for roof areas to reduce the size of internal primary stormwater reticulation system.
• Potential implementation of rainwater harvesting to improve public potable water supply resilience.</td><td>• Avoiding (or otherwise treating) the use of exposed high contaminant generating building materials such as exposed unpainted galvanised steel and copper.
• Wetlands located within the centralised stormwater management areas.
• Potential implementation of other at-source WSUD treatment devices referenced in Section 5.2.7 to complement the masterplan development objectives including living roofs, permeable paving, and swales.</td></tr>
</table>

<table>
<tr><th rowspan="2">STORMWATER MANAGEMENT CATCHMENT</th><th colspan="3">WATER QUANTITY MANAGEMENT</th><th rowspan="2">WATER QUALITY MANAGEMENT</th></tr>
<tr><th>STORMWATER CONVEYANCE</th><th>STORMWATER DISPOSAL</th><th>FLOOD RISK MANAGEMENT</th></tr>
<tr><td>South 1</td><td rowspan="3">• Primary stormwater system, incorporating pipes and swales, to convey flows for rainfall events up to 20-year ARI to the stormwater management areas.

• Secondary stormwater system, incorporating designated overland flow path corridors (public roads, private accessways and swales), to convey flows in excess of primary network capacity to the stormwater management areas. To be designed for rainfall events up to 100-year ARI.</td><td>• Integration of stormwater management into informal recreation areas and sports fields providing discharge for rainfall events up to 100-year ARI via underground infiltration trenches and swales.

• Potential installation of bulk stormwater system discharging to the watercourse connecting Lake Hayes and Kawarau River to minimise the stormwater management area footprint, while maintaining ground soakage equivalent to the pre-development state.

• Potential implementation of at-source soakage for roof areas to reduce the size of internal primary stormwater reticulation system.

• Potential implementation of rainwater harvesting to improve public potable water supply resilience.</td><td rowspan="3">• Minimum freeboard for habitable floor levels and management of overland flows through depth and velocity limitations.</td><td>• Avoiding (or otherwise treating) the use of exposed high contaminant generating building materials such as exposed unpainted galvanised steel and copper.

• Site-specific stormwater management approach for all developed areas that incorporates WSUD treatment devices and practices referenced in Section 5.2.7.</td></tr>
<tr><td>South 2</td><td>• Utilisation of existing stormwater network incorporating ground soakage equivalent to the pre-development state.

• Potential implementation of at-source soakage for roof areas to reduce the size of internal primary stormwater reticulation system.

• Potential implementation of rainwater harvesting to improve public potable water supply resilience.</td><td>• Avoiding (or otherwise treating) the use of exposed high contaminant generating building materials such as exposed unpainted galvanised steel and copper.

• Utilisation of existing downstream water quality treatment devices.

• Site-specific stormwater management approach for all developed areas that incorporates WSUD treatment devices and practices referenced in Section 5.2.7. in case the existing downstream water quality treatment devices are inadequate.</td></tr>
<tr><td>South 3</td><td>• Site-specific stormwater management approach for all developed areas that incorporates ground soakage equivalent to the pre-development state.

• Potential implementation of at-source soakage for roof areas to reduce the size of internal primary stormwater reticulation system.

• Potential implementation of rainwater harvesting to improve public potable water supply resilience.</td><td>• Avoiding (or otherwise treating) the use of exposed high contaminant generating building materials such as exposed unpainted galvanised steel and copper.

• Site-specific stormwater management approach for all developed areas that incorporates WSUD treatment devices and practices referenced in Section 5.2.7.</td></tr>
</table>

5.3 RECOMMENDED FUTURE WORK

The stormwater management assessment carried out for the proposed masterplan area enables the structuring of a stormwater management approach that will support the development of the masterplan area whilst achieving the stormwater management objectives and principles outlined in Section 5.2.1 and 5.2.2. Due to the scope and limitations of the assessment, future work is recommended to be carried out to finalise the proposed stormwater management approach and develop the final solutions for the masterplan area. The recommended future work includes:

- Detailed hydraulic and hydrological modelling work is recommended for the masterplan area to establish the existing ground soakage capacity. This will determine the volume of rainfall runoff that is required to be infiltrated into the ground to maintain the existing recharge of the Windemeer aquifer. It will also quantify the rainfall runoff from Slope Hill and the masterplan area to inform the detailed design and sizing of the vegetated conveyance swales and stormwater management areas.
- Infiltration testing is recommended to inform the detailed design, sizing and location of the stormwater management areas and the feasibility of at-source roof soakage.
- Hydrogeological assessment is recommended to support the detailed design, sizing and location of the centralised stormwater management areas. This will determine the effects of infiltrating large volumes of water within a relatively concentrated area on the ground soakage capacity.
- A detailed lifecycle cost-benefit assessment is recommended for the stormwater management areas. For the centralised stormwater management devices, the assessment will be based on a holistic approach incorporating all elements of the stormwater management system discussed in Section 5.2.6 and Section 5.2.7.
- An integrated assessment and design of all infrastructure works (and roading), including stormwater, is recommended. This will support the staging and determine the best practicable location and alignment for the new stormwater infrastructure.
- Detailed assessment of practicable tank sizes in relation to seasonal variation in rainfall and water demands, potential connection of rainwater tanks to public water supply system to reduce peak hourly demands, and the quantification of potential net positive effects on the overall potable water supply network.

6 WASTEWATER

6.1 EXISTING SITE ASSESSMENT

Based on QLDC GIS maps, the existing active public wastewater infrastructure within the proposed masterplan area extent is shown in Figure 6.1 and generally consists of:

- A 355mm diameter PE rising main is operational and connects into an existing downstream 300mm diameter PVC rising main at the intersection of SH6 and McDowell Drive. The 300mm diameter PVC rising main runs west along SH6, upsizing to a 350mm diameter PE main for a relatively short length around the Stalker Road roundabout.
- A 150mm diameter PVC rising main that services multiple sub catchments runs north along Crawford Place and west along SH6. The rising main upsizes to a 250mm diameter PE main after combining the Lake Hayes #4 and Jones Ave pump station the 250mm diameter rising main continues west towards the Stalker Road roundabout, and connecting to a 375mm diameter PVC gravity main located on the western arm of the Stalker roundabout. This main connects into the 300mm PVC rising main along SH6 noted above.
- A 150mm diameter PVC rising main that services Shotover Country running north along Stalker Road, connecting to the 375mm diameter PVC gravity main noted above.
- A short length of a 150mm diameter PE rising main is terminated into the future Ladies Mile Development at the northern quadrant of the Stalker Road Roundabout. This rising main is connected to the 375mm diameter PVC gravity main noted above.
- A small wastewater pump station on Jones Avenue that services the Queenstown Country Club and the associated internal gravity mains and the 160mm diameter PE rising main that run north and connects to the 250mm diameter PE rising main noted above.
- A wastewater pump station on the margins of Lake Hayes that services the Threepwood development and the associated internal gravity mains and 75mm diameter PVC rising main. This rising main connects to a 150mm diameter PVC gravity main that runs south across SH6 and along Crawford Place.

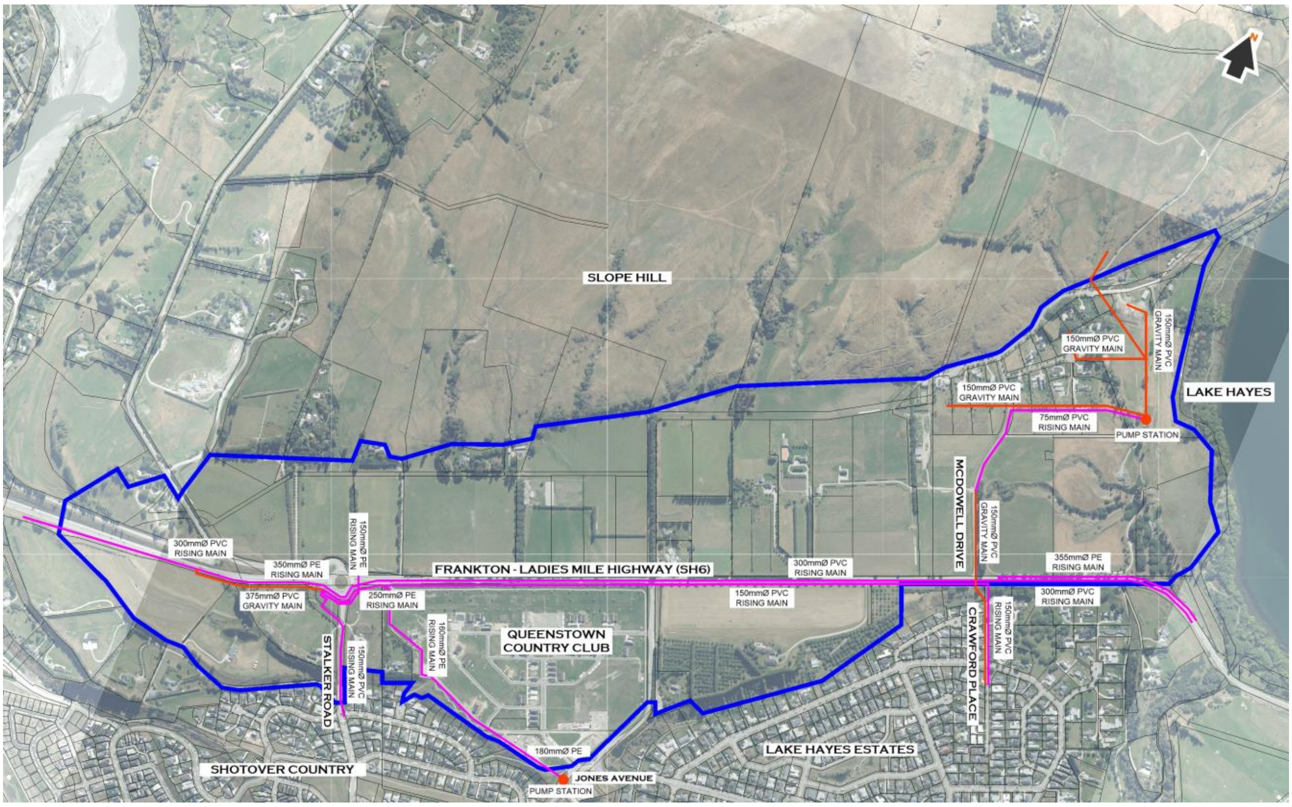


Figure 6.1 – Existing public wastewater infrastructure within the masterplan area.

Based on the information provided by QLDC, the existing public wastewater system that runs through the proposed masterplan area crosses the Shotover Bridge to the Shotover Wastewater Treatment Plant (STSP). It services a relatively large wastewater catchment that includes Lake Hayes Estates, Shotover Country, Queenstown Country Club (QCC), Threepwood, Lake Hayes, Millbrook and Arrowtown. The bulk wastewater conveyance system from this catchment to the wastewater treatment plant consists of several wastewater pump stations and associated interconnected rising and gravity mains. The growth anticipated within this wastewater catchment will ultimately be restricted by the capacity of the Shotover Bridge crossing. The existing capacity constraints with the rising mains on approach to the treatment plant are known and are actively being planned for upgrade by QLDC.

The Millbrook and Arrowtown wastewater network, and the Lake Hayes wastewater network feed into the Arrowtown – Lake Hayes Road pump station (ARTN-LAKE-HAYES-PS). The rising mains from the Arrowtown – Lake Hayes pump station run along Arrowtown – Lake Hayes Road onto SH6 and through the masterplan area as noted previously.

The Threepwood pump station (SPW7), servicing the Threepwood development, connects into the Lake Hayes Estates pump station (SPL4) that also serves as the main pump station for the Lake Hayes Estates. The rising main from this pump station runs up Crawford Place and along SH6 through the masterplan area as noted above (150mm diameter PE main).

The Stalker Road pump station (SPSC) services the Shotover Country development. The rising main from this pump station runs up Stalker Road and along SH6 through the masterplan area as noted above (150mm diameter PE main).

The indicative extents of the overall wastewater service area, including the pump stations, are shown in Figure 6.2.

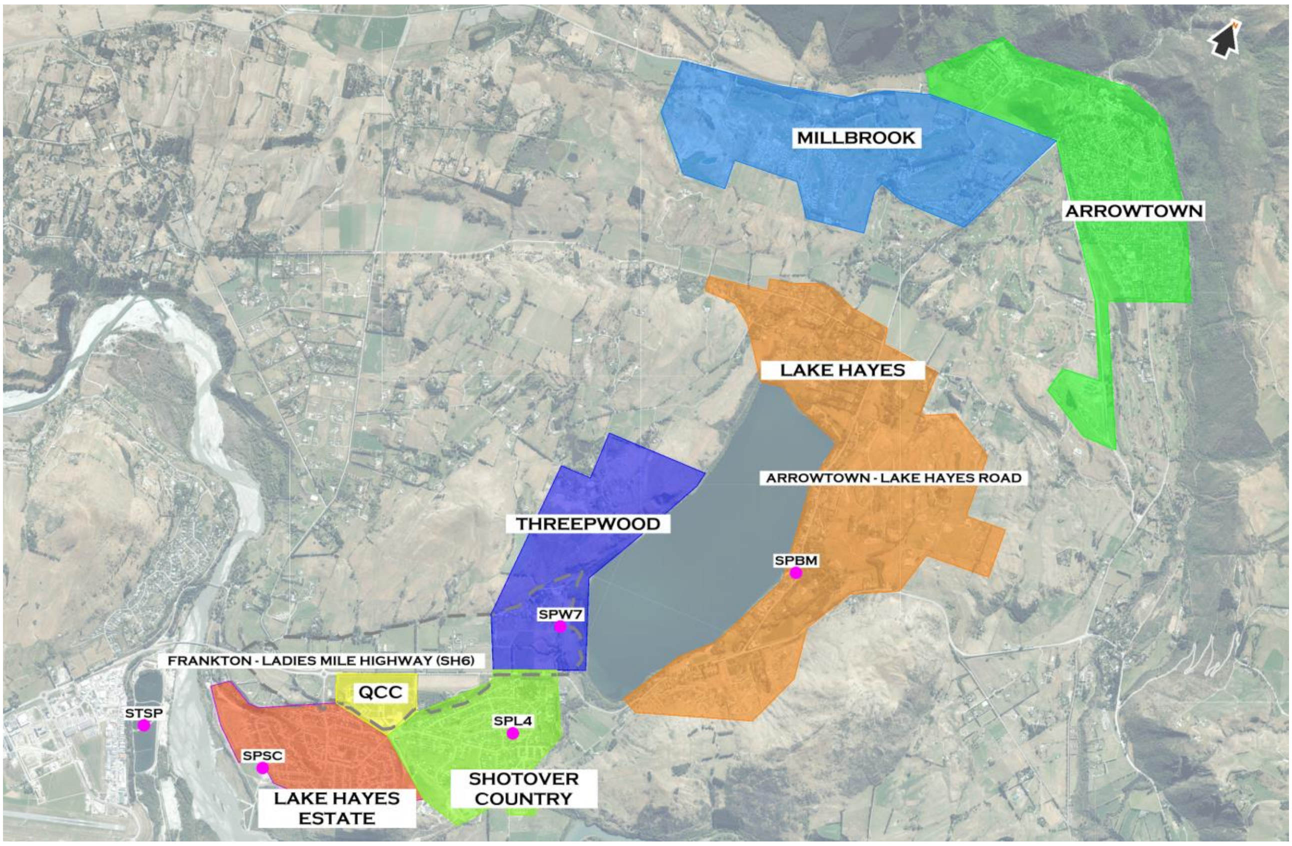


Figure 6.2 – Indicative existing public wastewater service areas.

6.2 WASTEWATER FLOWS

The proposed masterplan area is expected to yield a maximum of approximately 2,400 new dwellings. This corresponds to approximately 6,672 people, based on an average occupancy of 2.78 people/dwelling. The estimated density of 2.78 people/dwelling was adopted from the Hobsonville Development in Auckland, which has a similar housing density layout. The masterplan area will also deliver a primary school, a secondary school, sport and recreation facilities, and a 2.1-hectare town centre.

The total peak dry and wet weather flows for the proposed masterplan area are estimated at 51.8 l/s and 103.5 l/s, respectively. This is generally based on the QLDC code of practice minimum wastewater design flow.

For residential areas, an average dry weather flow of 250 litres/person/day, a peaking dry weather diurnal factor of 2.5 and a peaking wet weather factor of 2 was used. For the town centre, a medium commercial water usage of 0.7 litres/second/hectare was assumed as the overall average (expecting a mixture of shops, restaurants, and cafes), which includes the dry weather diurnal peaking factor. The same usage was also adopted for the sport and recreation facilities.

There are no flows specified for schools within the QLDC code of practice. As such, the estimated dry weather flows were adopted from the Watercare Code of Practice for the Auckland region. For the primary school (maximum 900 students and 65 staff assumed) 15 litres/student/day and 45 litres/staff/day was used. For the secondary school (maximum 1800 students and 130 staff assumed) 20 litres/student/day and 45 litres/staff/day was used.

6.3 STAGING AND DESIGN

QLDC is looking to carry out a comprehensive wastewater network study on the wastewater catchment service area that includes Lake Hayes Estates, Shotover Country, Queenstown Country Club, Threepwood, Lake Hayes, and Arrowtown. The scope of the study is to prepare a network optimisation plan for the existing wastewater infrastructure, by assessing the effects of the projected catchment growth and reviewing any potential existing network performance issues. The staging and the wastewater infrastructure required to service the proposed masterplan area should ideally be carried out in conjunction with this study.

The wastewater reticulation will be designed and sized in accordance with QLDC Code of Practice. The design of the system will be dependent on the final bulk wastewater solution.

As previously outlined in Section 5.2.6.1 the alignment and design of the trunk wastewater mains and associated infrastructure (pump stations) for the masterplan area will need to be carried out in conjunction with the upgrade requirements of other existing services including stormwater, wastewater, and utilities (and roading). This will allow for the streamlining of all required infrastructure upgrade works and ensure that an efficient and cost-effective design and construction process can be achieved. The streamlining of the integrated infrastructure upgrade works will drive the overall development staging of the masterplan area. The most likely trunk wastewater alignment will be within the SH6 road corridor as this is the most direct route to the wastewater treatment plant and is where the existing bulk wastewater network is located. An alternative location, depending on the final wastewater reticulation scheme, will be along the masterplan area “spine” road, which incorporates the proposed central stormwater conveyance swale as discussed in Section 5.2.6.2.

Three potential options were considered for wastewater disposal from the masterplan area that will enable the development of the area whilst accommodating the projected growth within the wider catchment and possibly alleviating any potential existing network performance issues. The areas within the masterplan extents to the south of SH6 are generally expected to be serviced by the existing wastewater infrastructure. The existing QLDC owned land, proposed to be developed as open space and sports fields, and 466 Frankton-Ladies Mile Highway may need to be included into the new masterplan wastewater reticulation scheme. This will depend on the outcomes of the comprehensive wastewater assessment and the consequent effects on the Lake Hayes Estates pump station (SPL4).

6.3.1 SINGLE PUMP STATION

The construction of a large pump station at the intersection of McDowell Drive and SH6 will enable the servicing of the majority of the masterplan area, excluding the areas anticipated to be serviced by the existing reticulation outlined in Section 6.3. The servicing of the masterplan area will be via a bulk gravity main running east to the pump station. A preliminary assessment estimated the size of this main to be up to 375mm and up to 4m deep. The assessment assumed this main will be positioned within the SH6 road corridor. A new rising main from the pump station will run west and connect to the existing wastewater network at some point before the Shotover Bridge, depending on the capacity of the existing system. The rising main is expected to be installed at the same time as the gravity main. Depending on the final spatial staging of the development, the existing rising mains within SH6 road corridor could be utilised for the initial stages.

The proposed pump station location will be strategically positioned at the convergence of several existing wastewater infrastructure mains outlined in Section 6.1. This includes the 300mm diameter PE rising main from ARTN-LAKE-HAYES-PS, the 150mm diameter PE rising main from Lake Hayes Estate (SPL4) and the Threepwood catchment. As such, this can be a suitable location to accommodate the optimisation of the wider wastewater network infrastructure. Furthermore, QLDC owns a section of land at this location that could be utilised for the pump station.

6.3.2 MULTIPLE PUMP STATIONS

The single pump station at McDowell Drive intersection with SH6, discussed in Section 6.3.1, is considered to be a desirable strategic location, as it can service the bulk of the masterplan area and allows for the optimisation of the existing wastewater network.

To serve the whole of the masterplan area, the construction of a single pump station will result in larger upfront infrastructure costs. If the development of the masterplan area is staged, an additional pump station, or multiple pump stations, could be included into the proposed masterplan wastewater servicing scheme to reduce the upfront costs. The benefit of multiple pumpstations also adds in resilience and offers more flexibility during operation and maintenance of the network. The feasibility of multiple pump stations will be closely related to the overall development staging of the masterplan area.

A detailed assessment comparing a single wastewater pump station to a multiple wastewater pump station servicing scheme should be carried out to assess the overall effects on the infrastructure lifecycle costs, including construction and long-term operation and maintenance.

6.3.3 VACUUM AND LOW – PRESSURE SYSTEMS

The potential wastewater pump station schemes discussed in Section 6.3.1 and Section 6.3.2 are perceived as somewhat inefficient for flat sites as they rely on conveyance of wastewater towards centralised pump stations via gravity reticulation systems. Flat sites and long gravity reticulation flow paths results in the pump stations and lines needing to be installed deep, before being pumped up and into the pressurised rising main network.

The use of vacuum or low – pressure wastewater systems in conjunction with a gravity wastewater reticulation could be used to reduce the overall depth of wastewater network.

A vacuum system consists of a central vacuum system pumping station, a reticulated vacuum network and several collection chambers. The wastewater from dwellings is drained to a collection chamber. No electrical components are required for the collection chambers as these operate using a mechanical valve system. The wastewater from the collection chambers is sucked into the vacuum network and ultimately to the central vacuum station.

A low-pressure system consists of several grinder pumps and a reticulated pressure network. The wastewater from the dwellings is drained to a grinder pump and pumped into a combined pressurised network to the point of discharge.

Further to the conveyance inefficiencies, an advantage of both the vacuum and low – pressure systems include generally smaller and shallower pipes (approximately 1m to 1.5m deep). The vacuum system also has very low risk of exfiltration and consequently low risk of ground contamination through leakages.

A disadvantage of the vacuum system is that the system is generally limited to a total head loss of 4m and will only be able to cover a portion of the masterplan area. Furthermore, due to the complexity of the system, careful construction and high levels of construction monitoring are required to ensure effective long – term operation.

A disadvantage of a low – pressure system is that there are generally lower levels of system control by the local authorities as the multiple grinder pumps are owned and maintained by the private landowners. Furthermore, the system is prone to failure during power cuts.

Another disadvantage of both the vacuum and low – pressure systems is that in case of a system failure there is less control on the system overflow as it occurs at – source (at the dwelling).

A detailed assessment of the vacuum and low – pressure systems is recommended to be carried out in conjunction with the gravity and pump station wastewater scheme to assess the overall effects on the infrastructure lifecycle costs, including construction and long-term operation and maintenance.

6.4 FUTURE WORK

The wastewater assessment carried out for the proposed masterplan identified the potential wastewater management schemes that would enable the development of the proposed masterplan area and accommodate the optimisation of the wider wastewater network service area. The assessment also identified the projected domestic and commercial peak wastewater flows from the masterplan area. Due to the scope and limitations of the assessment, future work is recommended to be carried out to finalise the wastewater solution for the masterplan area. The recommended future work includes:

- Comprehensive wastewater network optimisation study for the Lake Hayes Estates, Shotover Country, Queenstown Country Club, Threepwood, Lake Hayes, and Arrowtown catchment. This will ensure that any upgrade works for the wider area are coordinated with the construction of the infrastructure required to support the development of the masterplan area.
- A detailed assessment of the wastewater management schemes, including lifecycle costs. This assessment should be carried out in conjunction with the wider catchment wastewater study noted above.
- An integrated assessment and design of bulk infrastructure works (and roading), including wastewater, for the masterplan area. This will support the staging and determine the best practicable location and alignment for the new infrastructure.
- QLDC have completed investigation into the rising main and treatment plant capacity. Future upgrades to the network will be required as designed by QLDC prior to the Ladies Mile Development becoming fully developed.

7 WATER SUPPLY

7.1 EXISTING SITE ASSESSMENT

Based on QLDC GIS maps, the existing active public water infrastructure within the proposed masterplan area extent is shown in Figure 7.1 and generally consists of:

- A 150mm diameter PVC pipe within the eastern berm on Stalker Road. This line terminates after crossing SH6 at the Stalker Road roundabout and provides a future connection for the north side of Ladies Mile.
- A 180mm diameter PE pipe within the western berm of Jones Avenue supplying the Queenstown Country Club.
- A 150mm diameter PVC pipe within Crawford Place extending under SH6. This pipe connects to a 175mm diameter PVC pipe heading east on SH6, connecting into the Lake Hayes water supply system and a 225mm diameter PVC pipe heading west and transitioning to a 200mm diameter PVC pipe up McDowell Drive to service the existing Threepwood development along the margins of Lake Hayes.

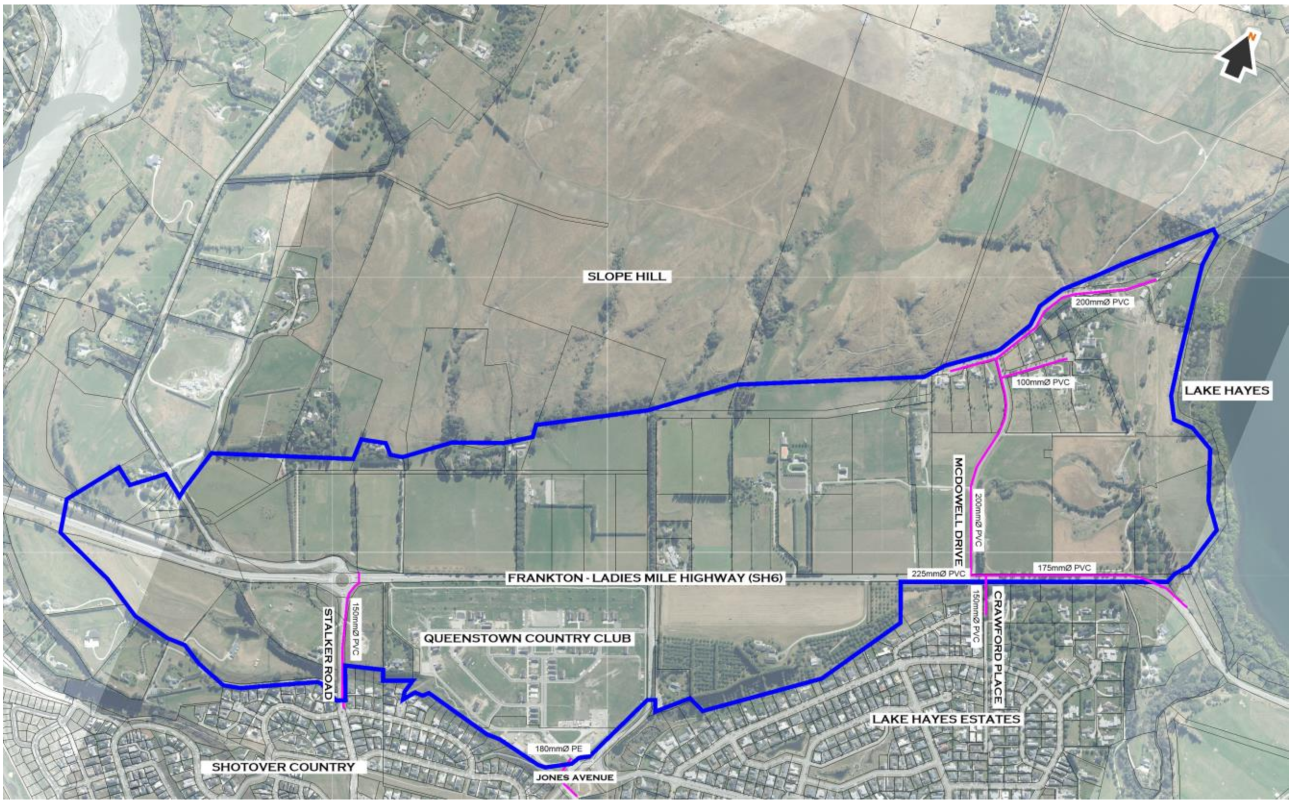


Figure 7.1 – Existing public water supply infrastructure within the masterplan area.

The proposed masterplan area is located across two public water supply service areas: The first servicing Lake Hayes and the second serving Shotover Country and Lake Hayes Estate. The indicative water supply service area extents are shown in Figure 7.2.

The Lake Hayes water supply service area is supplied by the Lake Hayes bore and pump station (WPLH). The water from WPLH is pumped to the Lake Hayes water treatment plant (WTLH) and Lake Hayes reservoir (WRLH) that service the developments around Lake Hayes.

Shotover Country and Lake Hayes Estate water supply service area is supplied by The Shotover bore and water pump station (WPSC). This asset will be referred to as the Shotover Country (SOC) Borefield throughout this document. The water from WPSC is pumped to the Lake Hayes Estates water treatment plant (WTLE), Lake Hayes Estate reservoir (WRLE) and Shotover reservoir (WRSC), that service the existing developments of Shotover Country, Lake Hayes Estate and Queenstown Country Club. There is an additional water pump station (WPL1) located to the south of Widgeon Place. An assumption has been made that this pump station connects to the overall Lake Hayes Estate water supply system.

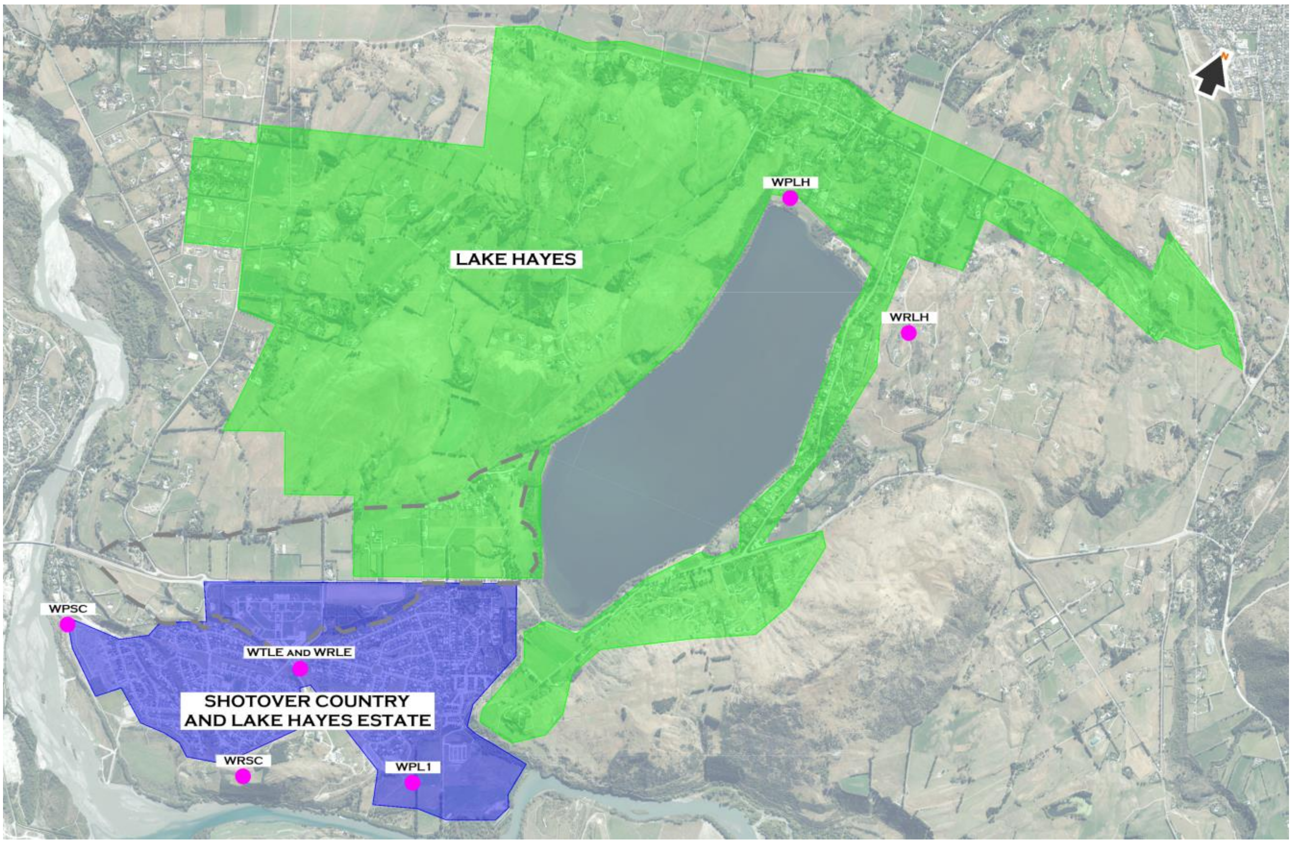


Figure 7.2 – Indicative existing public water supply service area including the location of the pump stations, treatment plants, and reservoirs.

7.2 QLDC INFRASTRUCTURE UPGRADES

QLDC are planning to reconfigure the existing water supply network and increase the area serviced by the SOC. The planned upgrades will allow for the SOC to supply not only Shotover Country and Lake Hayes Estate but also Frankton, Quail Rise, Kelvin Heights, and a section of the Southern Corridor that is currently within the QLDC scheme boundary. These areas are currently supplied by Kelvin Heights pump station that is sourcing water from Lake Wakatipu. The main driver behind the network reconfiguration is drinking water compliance. However, the upgrades will also allow the projected growth and improvements in the level of service (LOS) to Lake Hayes Estate and Shotover Country. The reconfigured SOC indicative public water supply service area is shown in Figure 7.3.

The proposed upgrades to achieve the above are summarised below, and are currently in delivery and programmed to be completed within the next three years:

- Shotover Country Borefield upgrades
- Shotover Country Water Treatment Plant
- Shotover Country Bridge water supply pipeline
- Increase storage capacity at Quail Rise Reservoir

- Water supply reticulation upgrades to accommodate the new infrastructure and the service area expansion.

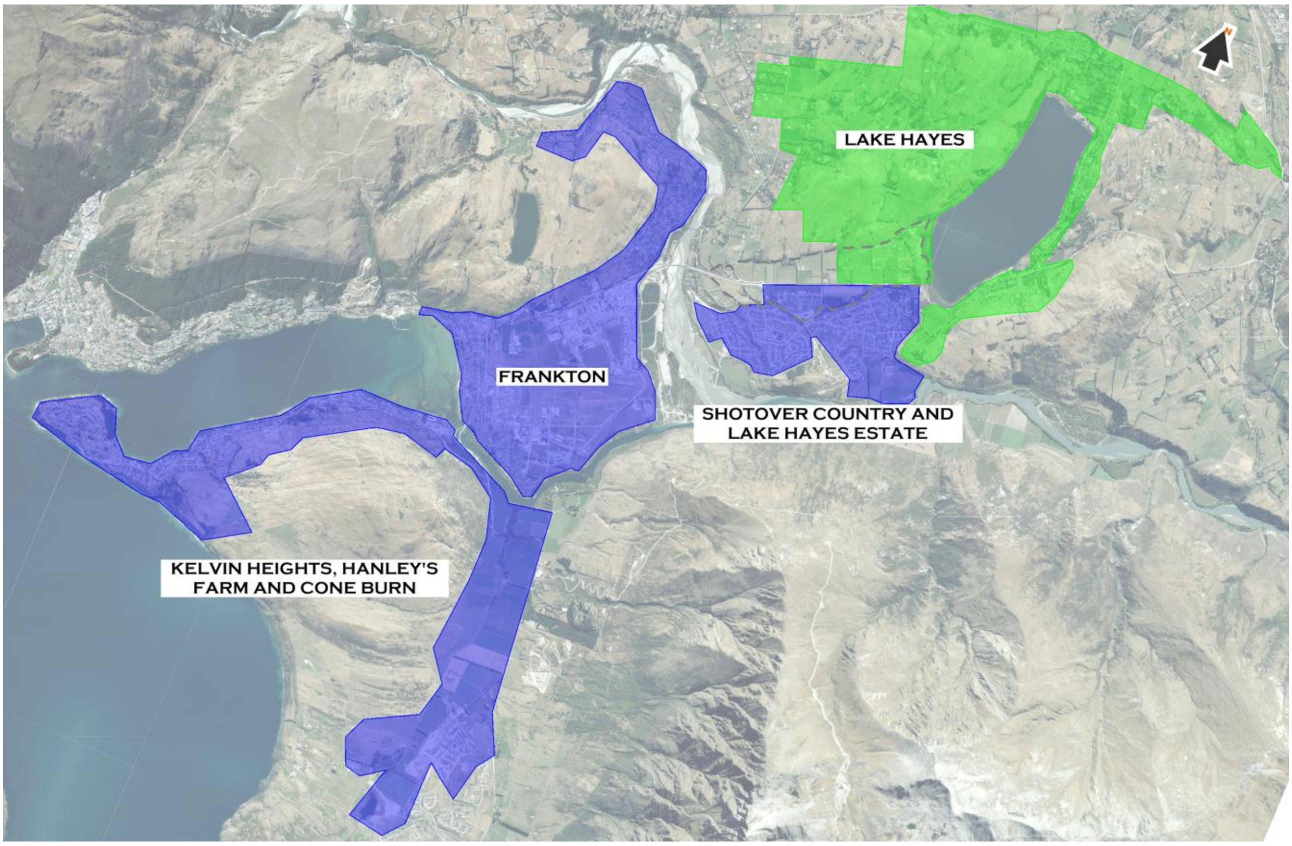


Figure 7.3 – Reconfigured SOC indicative public water supply service area.

The proposed mid-term infrastructure upgrades, planned for the next 10 years (2031), include a new Ladies Mile reservoir located on Slope Hill. In addition to this, QLDC plans to service the Southern Corridor from an alternative water supply source, removing the demands of this area from the SOC.

The proposed long-term infrastructure upgrades, planned for the next 30 years (2051), will further increase the pumping, treatment, and storage capacity of the existing water supply system. QLDC will further expand the area serviced by the SOC bores to include Lake Hayes, and the bore currently servicing Lake Hayes area (WPLH) will be decommissioned. The indicative long-term public water supply service area is shown in Figure 7.4. The proposed upgrades for the 30-year plan include:

- Staged upgrades of SOC Borefield and Shotover Country Water Treatment Plant
- Increased Storage at Ladies Mile Reservoir
- Increased Storage at Quail Rise Reservoir
- Increased Storage at Kelvin Heights Reservoir
- Water supply reticulation upgrades to accommodate the new infrastructure and the service area expansion.

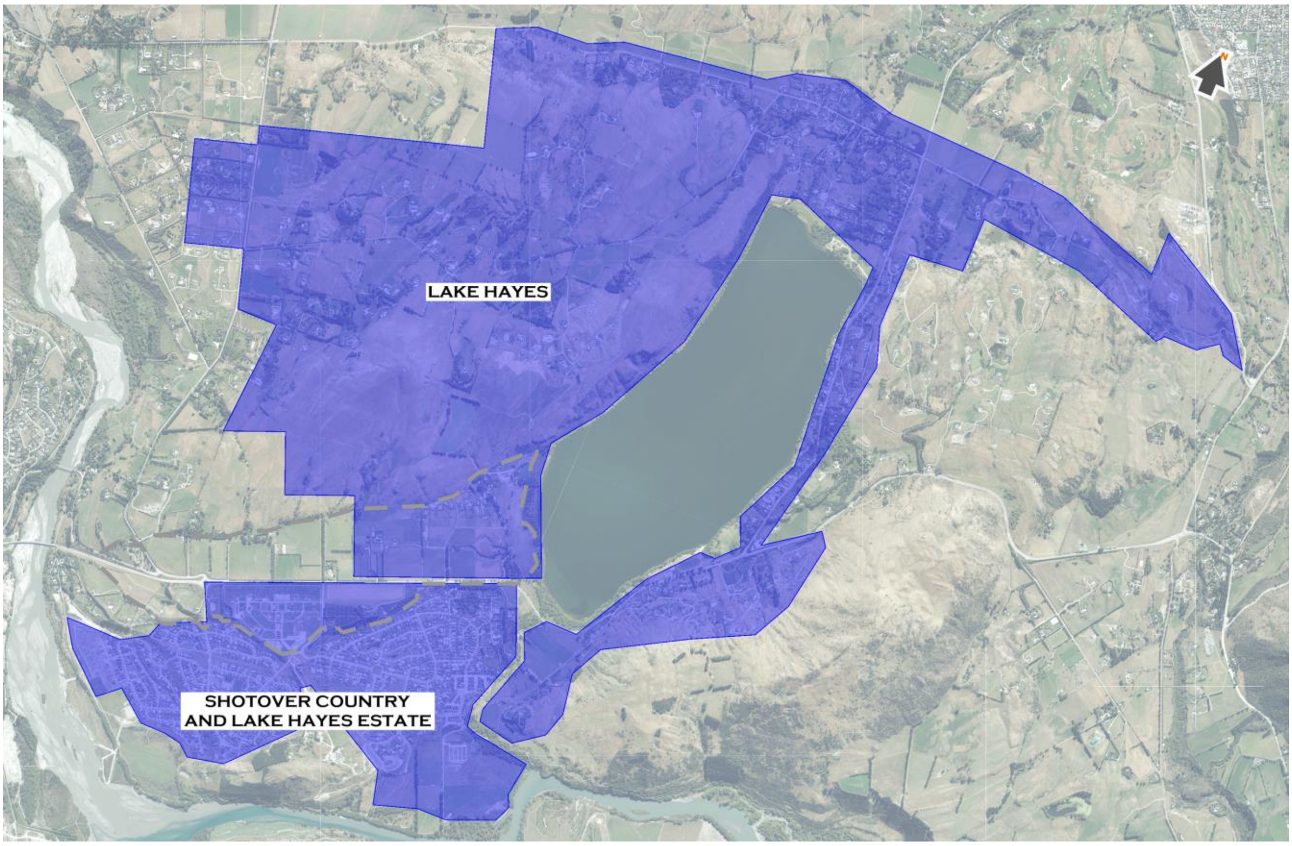


Figure 7.4 – Indicative long-term projected infrastructure upgrade public water supply service area.

7.3 WATER SUPPLY DEMANDS

As outlined in Section 6.2, the proposed masterplan area is expected to yield a maximum of approximately 2,400 new dwellings (6,672 people), a primary school, a secondary school, sport and recreation facilities, and a 2.1-hectare town centre.

The total peak domestic water supply demand for the proposed masterplan area is estimated at 221.4 l/s. This is generally based on the QLDC code of practice minimum water demand for daily water consumption.

For residential areas, an average daily water demand of 700 litres/person/day and a peak hour factor of 4 was used. As briefly discussed in Section 5.2.6.5, the QLDC daily water consumption considerably exceeds the national average and is assumed to be attributed to the outdoor use (watering of large gardens and landscaping areas). As the masterplan area proposes a higher density housing development, including multi story apartments, the expected daily water consumption for the proposed high-density and medium-density residential zones is expected to be significantly less due to the reduction in high water use outdoor areas. It is likely that an average daily consumption of 250 litres/person/day will be more appropriate, which coincides with the QLDC wastewater average dry weather flow. Using this demand, the total peak domestic water supply demand for the proposed masterplan area is estimated at 82.4 l/s.

For the town centre, a medium commercial water usage of 0.7 litres/second/hectare was assumed as the overall average (expecting a mixture of shops, restaurants, and cafes), which includes the peaking factor. The same usage was also adopted for the sport and recreation facilities.

There are no average daily demands specified for commercial areas and schools within the QLDC code of practice. For the town centre and the sport and recreation facilities, the equivalent of the wastewater flow rate outlined in Section 6.2 of 0.7 litres/second/hectare was adopted. It should be noted that the overall demand is likely to be higher due to the expected large areas of sports fields with sprinklers. For the schools, the estimated dry weather flows were adopted from the Watercare Code of Practice for the Auckland region. For the primary school (maximum 900 students and 65 staff assumed) 20 litres/student/day and 50 litres/staff/day was used. For the secondary school (maximum 1800 students and 130 staff assumed) 25 litres/student/day and 50 litres/staff/day was used.

A further assessment on the daily water consumption within other higher density residential areas within the Queenstown area should be carried out to determine a more representative average demand for the masterplan area. Furthermore, the effect of sprinklers on the school and sports fields on the overall demand should also be assessed. The final overall masterplan area water supply demand will inform the development staging and the water supply infrastructure design, respectively.

Due to the multi-story apartment development (including a town centre) proposed for the majority of the masterplan area, the firefighting classification under the firefighting New Zealand Fire Service firefighting water supplies code of practice (SNZ PAS 4509:2008) is likely to be FW2 with the implementation of sprinkler systems.

7.4 STAGING AND DESIGN

The staging of the development within the proposed masterplan area will need to be carried out in conjunction with the overall QLDC water supply infrastructure upgrades that are servicing the area. The capacity of the public water supply system will affect the total number of dwellings and the population increase it can support at any point in time. As such, growth restrictions for the proposed masterplan area, in relation to the water supply infrastructure upgrade milestones, may need to be implemented. This will ensure that the water supply demands can be met for the duration of the masterplan area development.

The water supply reticulation will be designed and sized to accommodate both the domestic and firefighting water supply demands in accordance with QLDC Code of Practice and the SNZ PAS 4509:2008 minimum requirements. The design of the system will be dependent on the available and future projected flows and pressures in the public water supply system for the area.

As outlined in Section 5.2.6.1 and Section 6.3, the alignment and design of the trunk water supply mains for the masterplan area will need to be carried out in conjunction with the upgrades of other services and development staging. Furthermore, the alignment of the future water supply mains will also need to be carried out in conjunction with the overall QLDC infrastructure upgrades, in particular the construction of the new Ladies Mile reservoirs and associated reticulation, which are proposed to be located on Slope Hill. The preliminary location of the proposed Ladies Mile reservoirs is shown in Figure 7.5. As per Section 6.3, the likely trunk water supply main alignments include the SH6 road corridor and the masterplan area “spine” road.

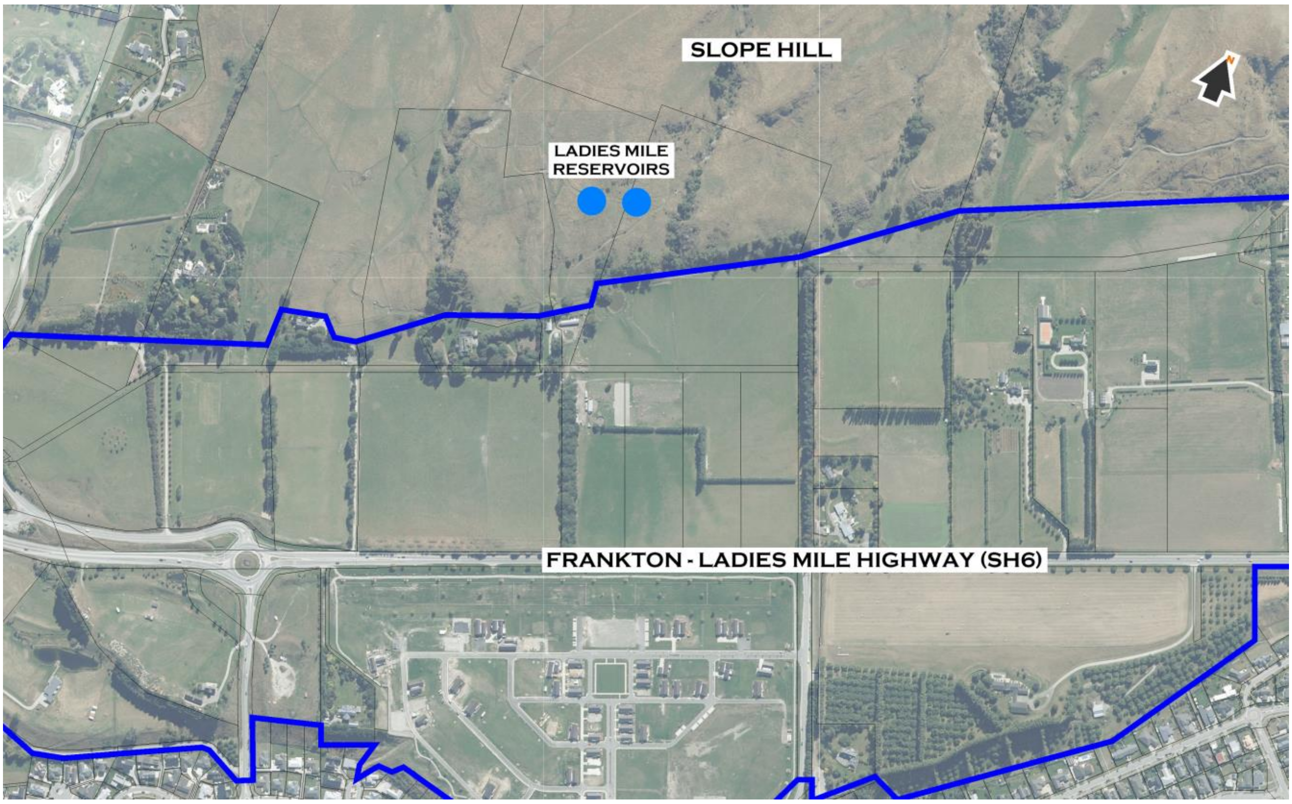


Figure 7.5 – Preliminary location for the proposed Ladies Mile reservoirs.

7.5 RECOMMENDED FUTURE WORK

The water supply assessment carried out for the proposed masterplan summarised the wider infrastructure upgrade works planned by QLDC and identified the projected domestic and commercial water supply demands and the likely firefighting classification requirements under SNZ PAS 4509:2008. Due to the scope and limitations of the assessment, future work is recommended to be carried out to finalise the water supply solution for the masterplan area. The recommended future work includes:

- An assessment of the average daily water consumption within other higher density areas in Queenstown, as well as the effects of sprinklers on sport and school fields on the overall water demand. This will determine a more representative masterplan area daily water consumption demands and inform the development staging and design (sizing) of the water supply infrastructure.
- The alignment of the masterplan area development growth forecasting with the expected QLDC public water supply infrastructure upgrades. This will determine the staging of the development and potential development growth restriction requirements across the masterplan area to ensure domestic and firefighting demands (to the appropriate firefighting classification) are met.
- An integrated assessment and design of bulk infrastructure works (and roading), including water supply, for the masterplan area. This will support the staging and determine the best practicable location and alignment for the new infrastructure.

8 CONCLUSION

The stormwater management proposed for the Ladies Mile Te Pūtahi masterplan area is supported by a comprehensive site appraisal and was developed in collaboration with several specialist consultants and stakeholders. It will ensure that the water quality treatment, conveyance, and the discharge of stormwater is carried out following good engineering practice and in accordance with the QLDC code of practice.

The proposed wastewater management approach was developed considering the optimisation of the wider wastewater infrastructure catchment planned by QLDC and the masterplan development plan. The implementation of the final wastewater management scheme will be carried out in conjunction with the future wider wastewater network optimisation upgrades and will be in accordance with the QLDC code of practice.

The water supply management approach proposed for the masterplan area was developed considering the wider water supply infrastructure works proposed by QLDC and the masterplan development plan. The implementation of the final water supply solution will be carried out in conjunction with the future wider water supply network capacity upgrades and the QLDC code of practice.

The three waters assessment carried out for the masterplan area demonstrated that the stormwater, wastewater, and water supply infrastructure required to service the proposed development can be provided. However, due to the limitations of this report, future work is recommended to finalise the proposed three waters management approach and consequently develop a staging plan for the masterplan area.

A detailed three waters infrastructure integrated assessment and design is proposed to ensure that the best practicable solution for both the proposed masterplan area and the wider catchment is achieved.

9 ADDENDUM

Subsequent to the original drafting of this report QLDC adopted the Ladies Mile Te Pūtahi masterplan at their October 2021 meeting but noted that the matters relating to stormwater management and funding were yet to be resolved. Upon further consideration, Council has come to the conclusion that it is not in a position to lead the centralised infrastructure approach identified in the draft October masterplan due to funding constraints. To date landowners have also been unable to agree amongst themselves on the location and cost sharing of the centralised approach although it is understood that they are working together with Council input to find acceptable detailed stormwater solutions.

As a consequence of this, the specific locations for the centralised stormwater approach have been removed from the Ladies Mile Te Pūtahi masterplan. At the date of this report Council has made it clear to landowners that they are still expected to manage stormwater within the development area with no discharges to Lakes Hayes and that any publicly vested solution must provide a comprehensive approach to stormwater management that minimises a proliferation of stormwater devices. This is in line with the solutions proposed in the Three Water Infrastructure Plan.

In particular the following guiding principles shall inform the detailed stormwater solutions for the Ladies Mile area.:

- Utilise stormwater management solutions that mimic the natural water cycle and enhance the water quality.
- Employ an integrated stormwater management approach that supports connectivity to the natural environment and gives effect to Te Mana o te Wai and the community wellbeing.
- Manage flooding and surface water flow to safeguard the community and infrastructure in a sustainable manner.
- The hydrological regime in the area is replicated such that the maximum rate of discharge and peak flood levels post development are no greater than pre-development
- That there are no overland flows from attenuation systems or soak pits for 1% AEP events or less unless there is a defined and acceptable overland flow path
- Ensure that there is a maximum 24-hour drain-down for any attenuation systems basis/soak pits for 1%AEP events
- That there are no overland flows across SH6 for all events up to and including the1% AEP
- That there are no direct discharges from the development area into Lake Hayes
- That runoff from all roads is managed through appropriate treatment device(s)
- Avoid a proliferation of multiple stormwater management systems and devices. Depending on location and land ownership structures this may necessitate co-operation of multiple landowners to ensure an acceptable approach
- Implement stormwater management solutions that deliver lifecycle operational and economic resilience.
- Align 'blue' stormwater solutions and the wider 'green' landscape and open space strategies wherever possible