REPORT

HOUSING INFRASTRUCTURE FUND: REVIEW OF "3 WATERS" INFRASTRUCTURE DETAILED BUSINESS CASE - LADIES MILE

PREPARED FOR MINISTRY OF BUSINESS, INNOVATION AND EMPLOYMENT

9 July 2018

Stantec

This document has been prepared for the benefit of Ministry of Business, Innovation and Employment. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval to fulfil a legal requirement.

QUALITY STATEMENT

PROJECT MANAGER

William Roberson

PREPARED BY

Derek Chinn .....

CHECKED BY

Peter White .....

REVIEWED BY

Peter White .....

APPROVED FOR ISSUE BY

Peter White .....

PROJECT MANAGER

PROJECT TECHNICAL LEAD

PREPARED BY

09/07/2018

CHECKED BY

..../...../.....

REVIEWED BY

..../...../.....

APPROVED FOR ISSUE BY

..../...../.....

QUEENSTOWN
134a Gorge Rd, Queenstown 9300

PO Box 13-052, Armagh, Christchurch 8141
TEL +64 3 450 0890, FAX +64 3 450 0891

REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by

Ministry of Business, Innovation and Employment
Housing Infrastructure Fund: Review of "3 Waters" Infrastructure Detailed Business Case - Ladies Mile HIF

CONTENTS

1. Introduction

The Housing Infrastructure Fund (HIF) is a nationwide high profile injection of capital into the local government sector for the purpose of financing infrastructure associated with key growth areas. The Ministry of Business, Innovation and Employment (MBIE) requires a review of the infrastructure proposed as part of the detailed business case process. The business case will be the basis for a decision by Ministers on any loan or funding agreement with councils for the proposed infrastructure.

Stantec has been requested to review the 3-waters inputs to the following Detailed Business Cases (DBC's) for the HIF proposed by Queenstown Lakes District Council (QLDC).

Council	Area	3 Waters Projects
Queenstown Lakes	Kingston	[new] WTP and Reticulation Network, [new] WWTP and Reticulation Network, [new] Stormwater Disposal Network
	Ladies Mile	Water – Bore field upgrades, Reservoir and Network Mains Upgrade, Wastewater - New Gravity Pressure Mains Stormwater - Network Mains and River Outlets
	Quail Rise South	Water Supply - Network Mains, Wastewater - Network Mains

This report summarises the review of DBC and other documents provided for the Ladies Mile proposal.

In undertaking this review, Stantec does not accept any liability in terms of the conclusions made or provide any guarantees or warranties in respect of such, or to the completeness or otherwise of the Review Materials. The review undertaken by Stantec, in no way reduces the liability of or transfers to Stantec the primary obligations of the original author of the Review Materials.

However, the review is limited by the extent of information required and full consideration of all matters has not been possible.

2. Background

The proposed Ladies Mile HIF development is bulk services for an approximately 55 Ha site with 1100 dwellings. The land areas and number of lots covered are as shown in the diagram from the Detailed Business Case below:

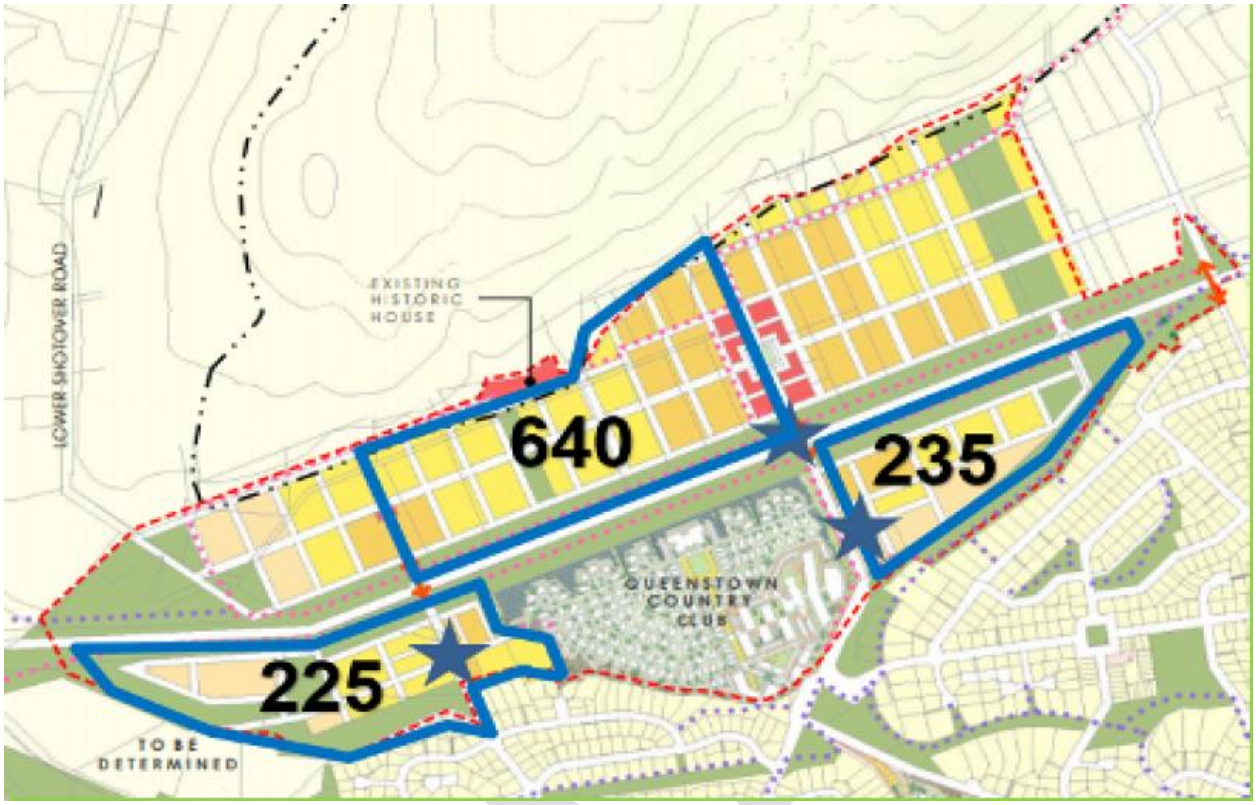


Figure 2-1: lot development areas and numbers of lots

Various documents provided to Stantec contain different descriptions of the extent of the development and different naming systems for different parcels of land within the development. This review report adopts the description and naming system in the latest DBC draft received (dated 3 July 2018 for the development areas shown in Figure 2-1, as follows:

- Glenpanel - Land north of Ladies Mile (640 residential units)
- Area A – Land south of Ladies Mile and west of Queenstown Country Club (225 residential units)
- Area B – Land south of Ladies Mile and east of Queenstown Country Club (235 residential units).

Note that the nomenclature in the main supporting technical report by WSP Opus differs from this.

The wider area is shown in the figure below:

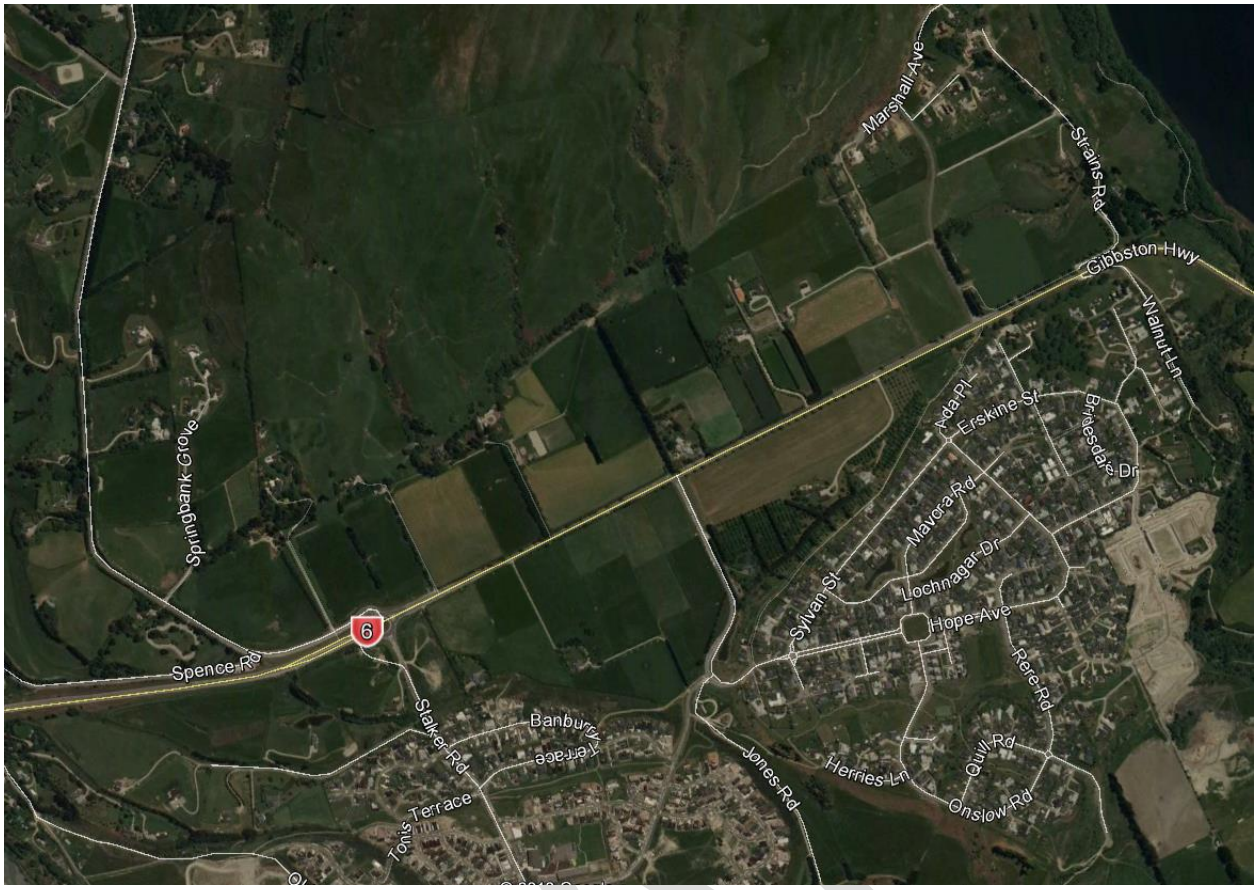


Figure 2-2: Ladies Mile aerial photo and road names

The scope of the proposal in the DBC provided covers:

- Bulk infrastructure for water supply including water source from Shotover Country and storage
- Bulk infrastructure for wastewater including transfer pumping to Shotover Treatment Plant
- Bulk infrastructure for stormwater drainage, and discharge to existing reticulation in Howards Drive

Some new road infrastructure is also included but is not covered by this review.

The development will also include additional piped systems within the township area – this is not generally covered by the proposal reviewed here. This is consequently not covered in this review, under the assumption that it will be funded separately.

The DBC should be referred to for details of the proposal, although a brief summary is in Section 4 following.

3. Scope of Review

MBIE has identified that the purpose of this review is to ensure value and best practice, with the following as key areas of focus for the infrastructure review:

- Information supporting the DBC to be reviewed to ascertain whether there has been a clear transparent assessment of viable options and that the proposed development forms part of a coherent development strategy for the local authority.
- An adequate assessment of risk has been undertaken throughout the proposal including the potential for cost increases.
- If the proposal represents appropriate value for money. To assess this, the overall development principal together with cost estimates will be reviewed.
- Review the technical aspects of the infrastructure proposal at a high level to confirm that the plan represents a reasonable approach to serviceability and does not go beyond what would normally be expected for a development of similar size and complexity.

This review is limited to desktop review of the provided documents. This review does not generally include further investigations outside of reviewing materials and does not offer counter opinions or alternative

valuations to those presented by the original author of the Review Materials. Detailed checks have not been undertaken, as the information / material supplied by the client for review was assumed to be all inclusive. However, some order-of-magnitude checks were undertaken where the information provided was limited.

3.1 Documentation received for review

It was expected that the following information (as stated in the terms of reference for this review) was to be provided for review:

- Technical assessments;
- Peer review of technical assessments;
- Detailed Business Cases; and
- Cost estimates (including parallel cost estimates).

Not all this information was received and the review is therefore constrained accordingly: the technical assessment is a high level report and additional memorandums, and no peer review was provided.

This information may not be essential for the assessment and documentation of the DBC proposal, but the absence of it made it more difficult for all matters requested by MBIE to be fully addressed by Stantec here and has made the assessments and conclusions of this review more limited than was anticipated in the terms of reference. However, in this report we have identified the main aspects that require further consideration.

Detailed cost estimates and checks on those are essential to support the proposal and we presume that this will be done and separately considered by MBIE.

The following information was received for review:

- Detailed Business Case – Ladies Mile, 3 July 2018 (Draft Final for Review)
- Ladies Mile HIF Concept Design Report 28 June 2018 (WSP Opus)
- Appendix A Ladies Mile HIF DBC Long List Options
- Appendix B Modelling Memos (relates to traffic modelling and is thus not relevant to this review of three waters)
- Appendix C Intersection Designs (not relevant to this review of three waters)
- Appendix D Three Waters Alignment and Capacity Maps
- Appendix E Ladies Mile Howard Drive Roundabout Cost Estimate (not relevant to this three waters review)
- Appendix E Ladies Mile Shotover Road T Junction Cost Estimate (not relevant to this three waters review)
- Appendix E Ladies Mile McDowel Drive Roundabout Cost Estimate (not relevant to this three waters review)
- Appendix F Ladies Mile 3 Waters Cost Estimate
- Appendix G Shotover Bridge Live Load Assessment under New Proposed Services
- Appendix H Queenstown Country Club Trunk Stormwater pipeline Design Report
- Appendix I Queenstown Country Club Stormwater Pipeline Design Plan
- Separate files covering Appendices 2, 3, 6, 7, 8. 12. 15, 16 and 17
- Report Addendum, appended to this report as Appendix A

Documents for review were provided as a number of separate digital files. We are therefore not able to confirm that the full or correct proposal was received.

3.2 Scheme Description

The proposals in the DBC include for the following components of 3 waters infrastructure.

Water Supply

- New rising main between the Shotover Country bore field and the reservoir site
- New water storage reservoir on Slope Hill
- Trunk water main from the storage reservoir to SH6

The bore field upgrades are a separate project and are not included in the works

Wastewater

- Two new secondary pump stations
- Connection to the existing waste water reticulation which drains to the Shotover Waste Water treatment plant

Stormwater

- Stormwater pipes draining from the development areas to the existing stormwater pipeline along Howards Drive which discharges to the Kawarau River

4. Peer review

No peer review of the technical proposals was provided, and our understanding is that none has been undertaken. A peer review is not necessarily required for any project. This is a matter for MBIE to consider as to whether they continue to require it to be provided by QLDC for their consideration of the funding approval. However, in this case we believe that a peer review would be beneficial given the limited stage to which technical proposals have been developed and that the key aspects that still require further definition, if further work is not to be done on the concept prior to detailed design. A peer review would entail more detailed assessment of proposals, including some independent checks and discussions with the report authors.

We note that Section 10.2.2 of the DBC should refer to Stantec as technical adviser to MBIE. The review contained in this report is limited to the scope identified in Section 3 above, and is not a peer review of the technical proposals.

5. Consideration of options

The technical report from WSP Opus does not explore alternative options for the three waters. Single solutions are presented for each of these services.

6. Appropriateness of infrastructure proposed

6.1 Water Infrastructure Appropriateness

Stantec have not been provided a single coherent document and we have received a number of separate documents at different times. On 28 June 2018 we received a further addendum to the WSP Opus report which included the Queenstown Country Club in the water supply scheme. There are economies for both the proposed Ladies Mile Development and the Queenstown Country Club by combining the infrastructure for water supply. The addendum included the following revised table of revised figures relating to the water supply scheme (the table is included here as it was presented in the addendum, with marked changes to the figures):

Calculation of Reservoir Sizing:	
Water Demand per dwelling	1000 l/day

Fire Demand from reservoir	3000 l/min
Total number of dwellings	~~1100~~ 1432
Average water usage	~~1100 m³/day (13 l/s)~~ 1432 m³/day (17 l/s)
Average water usage including fire demand	~~63 l/s~~ 67 l/s
Storage of 6 hours average demand + fire demand	1360 m³
Calculation of pipeline sizing:	
Peak flow (rising main to reservoir)	~~33 l/s~~ 44 l/s
Peak flow (falling main from reservoir)	~~61 l/s~~ 66 l/s
Pipe size – Rising main to reservoir	~~DN280 PE~~ DN315 PE
Pipe size – Falling main from reservoir	~~DN315 PE~~ DN355 PE (allows for fire demand flow)
Velocity of rising main	0.75 m/s
Velocity of falling main	0.9 m/s

Figure 6-1: tabulated flow data included in the WSP Opus report addendum

The WSP Opus report states that the design water demand is 1,000 l/dwelling/day and references confirmation from QLDC on 4th May 2018, An email from Stuart Pile confirming average day demand of 1000 l/property/day and peak day demand of 2,000 l/property/day was provided to us on request but was not included within the WSP Opus report appendices. We have included this email for reference in appendix B of this report.

QLDC's current Land Development and Subdivision Code of Practice is for an average of 700 l/person/day with an occupancy of 3 people, thus an average demand of 2,100 l/lot/day and a Peak Hour factor of up to 4.0 for Queenstown and 6.6 for other places. The Code of Practice allows for an average demand of 250 l/p/d when alternative modelling is approved by Council, and a resulting demand of 750 l/dwelling/day is the minimum that Council may accept. We believe the lower design standard that has been adopted is appropriate.

6.1.1 Water Abstraction and Treatment

We are advised that the upgrade of the Shotover Country Borefield is a separate project and is excluded from the scope of the DBC. Thus no specific information was available regarding the proposed bore field upgrades necessary. Such upgrades may include power upgrades, additional bores and additional treatment capacity. However, we are not able to confirm that the upgrade of the bore field is feasible. The feasibility of upgrading the borefield should be identified as a key risk if the HIF proposal moves ahead.

6.1.2 Water Rising Main

6.1.2.1 Rising main flow rate

The addendum to the WSP Opus report identifies the peak flow in the rising main as 44 l/s.

- Rising mains are generally designed to convey the peak day demand over 20 hours in order that the pumps are not operating continuously.
- The report identifies the peaking factor between Average Day Demand (ADD) and Peak Day Demand (PDD) as 2.0 and identifies the rising main as being sized for 1.33 times the PDD as below;
    - Peak Day Demand (PDD) is Average Day Demand x 2.0
    - Trunk rising main sizing is based on PDD x 1.33

Thus we have assessed the flow rate in the rising main necessary to supply the PDD as follows;

Rising main flow = 1,432 dwellings x 1,000 l/dwelling/day x 2.0 x 1.33 = 3,809,120 l/day

Over 20 hours = 3,809,120 l/d / 20 hours / 60 minutes / 60 seconds = 50.9 l/s

This flow figure is approximately 25% higher than the 44 l/s figure in the WSP Opus report.

We therefore recommend that the size of the rising main is reviewed and increased if needed.

6.1.2.2 Rising main flow velocity

The WSP Opus report addendum identifies the rising main diameter as 315mm and identifies the velocity in the rising main as 0.75 m/s. Based on the previous analysis the flow velocity required to supply the PDD over a period of 20 hours within this pipeline, the resulting velocity is calculated as follows:

Velocity = 50.9 l/s /1000/ (π 0.1575^2) = 0.653 m/s

This velocity figure is lower than the figure of 0.75 m/s in the WSP Opus report.

6.1.3 Storage Reservoirs

6.1.3.1 Reservoir Storage Volume

The WSP Opus report recommends two 1,000 m^3 reservoirs (i.e. a total of 2,000 $m^{3)}$. QLDC's Land Development Code of Practice identifies that if a development is large and includes its own water source then the reservoirs shall be designed to 'WSA 03'. The requirements for reservoir storage volume according to this document are;

- Six hours of average demand plus firefighting demand

Thus the reservoir volume is calculated as follows:

- Average daily demand = 1,000 l/lot/day X 1,432 lots / 24 hours / 60 minutes / 60 seconds = 16.6 l/s
- Firefighting demand (we are unable to confirm this figure is correct) = 3000 l/min / 60 seconds = 50 l/s
- Total minimum storage requirement = (16.6 l/s + 50 l/s) X 60 seconds X 60 minutes X 6 hours = 1,439 m3

This figure is somewhat less than the 2,000 m3 proposed by WSP Opus, but the proposed reservoir size of 2,000m^3 appears to be appropriate.

As an additional check we have compared the proposed reservoir storage to Councils previous standards for reservoir sizing. Council's previous standards (which were revised as they were not considered to be sufficient in some circumstances) were the sum of the following:

- Firefighting storage (we have assumed W5) = 540m^3
- Emergency storage of 4 hours of Peak Day Demand = 1 m3/lot X 1,432 lots X 2 /24hours X 4 hours = 477 m^3
- Working Storage of 8 hours Average Daily Flow Rate = 1 m3 X 1,432 lots /24 X 8 hours = 477 m^3

Thus the total storage recommended by Councils previous standards = 540m^3 + 477 m^3 + 477 m^3 = 1,494 m^3. Thus 2,000m3 of reservoir storage is sufficient to exceed the minimum of WSA 03 and Councils previous standards.

6.1.3.2 Reservoir Elevation

WSP Opus identify the level of the reservoir to be RL 423 to match the existing quail rise reservoir. No specific location for the reservoir has been identified so far. As can be seen in the figure below this reservoir elevation appears to be an appropriate selection;

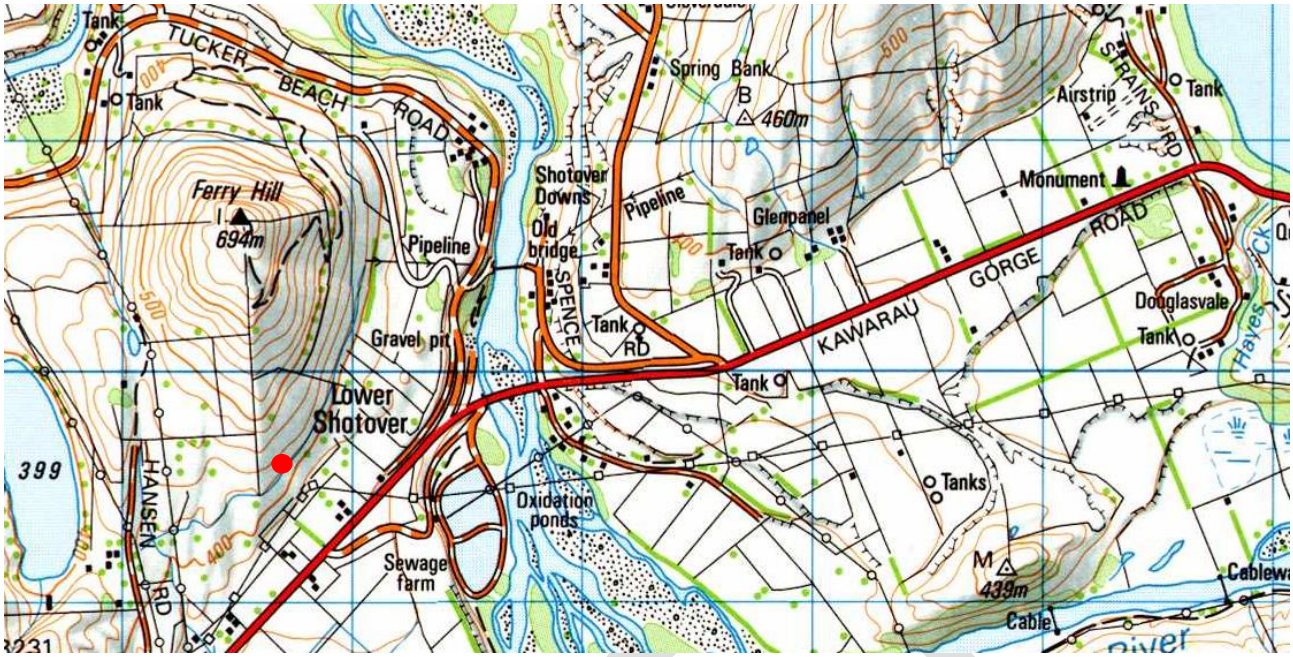


Figure 6-2: reservoir elevation of 420m to match the existing quail rise reservoir (marked in red)

6.1.3.3 Reservoir Location

The location of the reservoirs is proposed for private land on Slope Hill. Acquisition of land at the required elevation is therefore a key risk for the project.

6.1.4 Water Falling Main

The WSP Opus report addendum identifies a peak flow in the falling main as 66 l/s and identify 355 mm diameter pipeline as being required. There are no clear guidelines given in QLDC's Land Development and Subdivision Code of Practice regarding the specific sizing of falling mains. Previously Councils standards required the greater of either the Peak Hour flow rate or the Peak Day Flow rate plus the Firefighting flow. We have undertaken the following checks;

The Peak Daily Demand plus the Fire Fighting flow is calculated as follows:

- 1,000 l/lot/day X 1,432 lots X 2 /24 hours/60 min /60 sec + 50 l/s firefighting = 83 l/s

The Average Daily Demand plus the Firefighting flow is calculated as follows:

- 1,000 l/lot/day X 1,432 lots / 24 hours / 60 min /60 sec + 50 l/s firefighting = 66.6 l/s

Thus the figure identified by WSP Opus for the falling main design flow, 66 l/s is the Average Daily Flow rate plus the firefighting flow and is somewhat less than Peak Day Flow rate plus firefighting flow.

The corresponding velocities in the proposed 355mm diameter pipeline are

- For the Peak Daily Flow plus Firefighting; 83 l/s /1000 l/m^3 / (π 0.178^2) = 0.833 m/s
- For the Average Daily Flow plus Firefighting; 66.6 l/s / 1,000 l/m^3 / (π 0.178^2) = 0.669 m/s

The addendum to the report identifies the velocity in the falling main as 0.9 m/s which is similar to the Peak Daily Flow plus firefighting flow result calculated above.

6.2 Appropriateness of Wastewater infrastructure proposed

Wastewater drainage from each of the three development areas is proposed to be pumped into the existing piped trunk system which drains across the Shotover Bridge to the Shotover Wastewater Treatment Facility.

6.2.1 Wastewater Treatment and Disposal

The proposed system relies on pumping wastewater generated from the development to the Shotover Wastewater Treatment Facility.

6.2.2 Wastewater Capacity on Existing Shotover Bridge

Stantec have requested and obtained confirmation from QLDC regarding both the capacity of the pipeline within the Shotover Bridge to convey the increased flows and confirmation of the capacity of the bridge to support the increased loads.

Confirmation of the structural capacity of the bridge to support the pipeline is included in the report Appendix G of the WSP Opus report.

Confirmation of the capacity of the hydraulic existing pipes within the bridge has been sought and obtained from Council by Stantec and this is included in appendix C to this report.

6.2.3 Wastewater Pumping

Wastewater drainage from each of the three development areas is proposed to be pumped into the existing piped drainage system. Two new pump stations are proposed. The locations of these two pump stations are marked in the figure below:

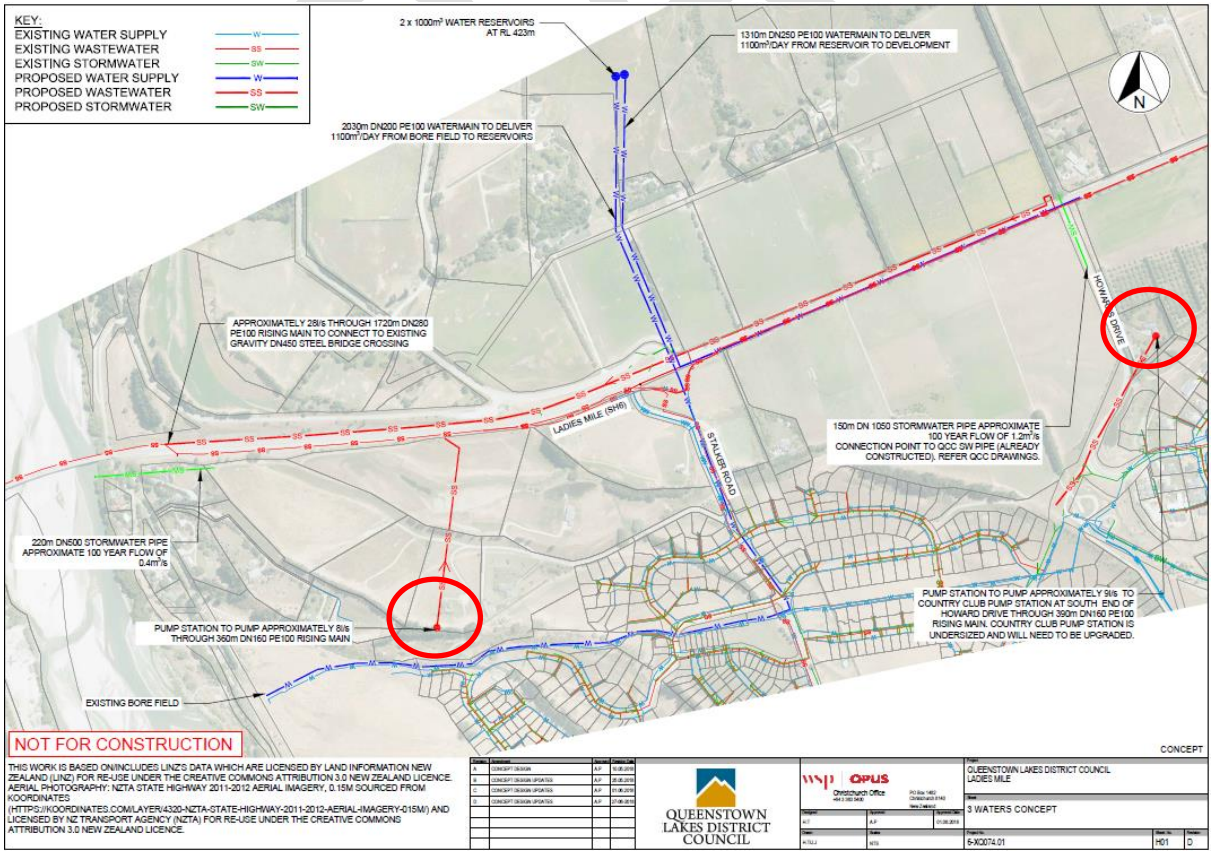
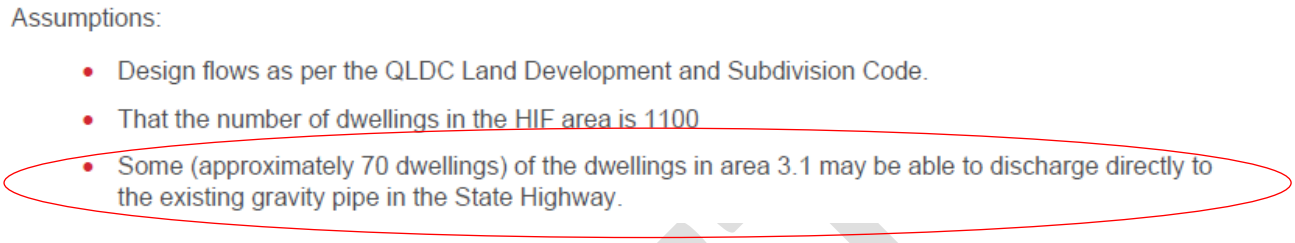


Figure 6-3: Location of proposed new wastewater pump stations (circled in red)

One or more additional (larger) pump stations will also be required for the Glenpanel development north of Ladies Mile. This is to be provided separately by the land developer.

No specific details of the pump stations has been provided. Issues such as emergency storage, standby generation, necessity for odour control and power reticulation remain to be addressed. These issues are common technology and do not present significant technical problems.

The WSP Opus report identifies that approximately 70 properties may discharge directly to 'the existing gravity pipe in the State Highway'. This section is reproduced in the figure below. No supporting information has been provided for this assumption and we are not certain that this is possible as we understand that the wastewater pipeline rises to a high point on the Queenstown side of the Stalker Road roundabout.


Assumptions:

- Design flows as per the QLDC Land Development and Subdivision Code.
- That the number of dwellings in the HIF area is 1100
- Some (approximately 70 dwellings) of the dwellings in area 3.1 may be able to discharge directly to the existing gravity pipe in the State Highway.

Figure 6-4: assumptions from WSP Opus report identifying 70 dwellings may connect to the sewer in the State Highway

We note that the WSP Opus report references 12hours storage and the cost estimate includes for 70 – 75 m^3 of emergency storage as shown below:

3.2	**Pump Stations**				
3.2.1	12 l/s Capacity (~4.5kW)	ea	2	$ 550,000.00	$ 1,100,000.00
3.2.2	Upgrade to Country Club pump station	LS	1	$ 50,000.00	$ 50,000.00
3.3	**Storage for Pump Stations (provisional item)**				
3.3.1	Tank of approximately 70-75 m3	ea	2	$ 200,000.00	$ 400,000.00
3.3	**Testing & Inspections**				
3.3.1	Testing and Commissioning	LS	1	$ 50,000.00	$ 50,000.00

Figure 6-5: part of the estimate with allowance for emergency storage

7. Appropriateness of Stormwater infrastructure proposed

7.1 Proposals for Stormwater

Proposals for stormwater are addressed in the WSP Opus report dated 28 June 2018.

The naming of areas within the reports is inconsistent. For clarity we have adopted the area names used in the Detailed Business Case and these areas are as follows:

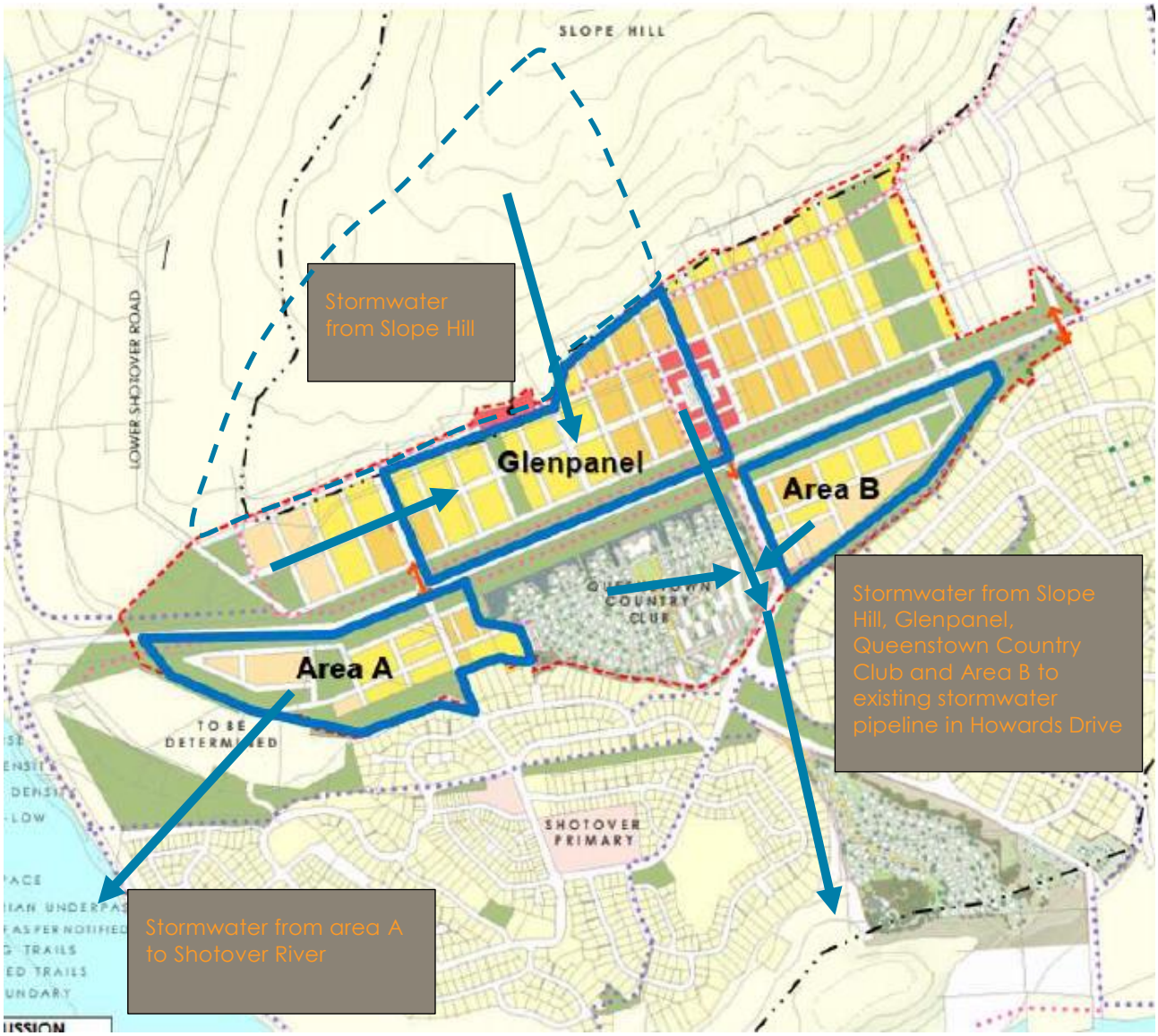


Figure 7-1: Catchment areas, nomenclature and stormwater flow

WSP Opus propose stormwater drainage which involves:

- the Glenpanel area of the development north of SH 6 will discharge into the existing stormwater pipeline laid in Howards Drive and then towards the Kawarau River
- Area B will also discharge to the same pipeline
- Area A will discharge to a new pipe west to the Shotover River
- Flows from the Slope Hill catchment above the Glenpanel area are proposed to be diverted around the Glenpanel development to separate discharge points – this is discussed further below.

The initial draft WSP Opus report received by Stantec included an assumption that runoff from Slope Hill was cut off before reaching the Glenpanel area and diverted west to Shotover River by an assumed channel, and that the remaining runoff from Glenpanel could then be passed by surplus capacity in the new stormwater from Queenstown Country Club. When Stantec pointed out that this cut off likely did not exist, the report was amended to report that runoff from Slope Hill instead discharges east of Glenpanel following "natural secondary flow path", and then to Lake Hayes.

The latest WSP Opus report states that "*The overland flow paths from the contours show flow from the hill passing through the site and through to the adjoining development area towards Lake Hayes. It is best practice to continue to allow the flow paths to follow these pre-existing paths. In the future QLDC will need to construct a new SW pipe from this other development area through to Lake Hayes, and the developers should design swales, paths or roads to allow these secondary flow paths.*" Section 7.3 includes comment on Stantec assessment of stormwater drainage patterns.

While the report states an assumption that no stormwater attenuation or soakage is being included within the development, separate discussion in the report indicates that the authors do anticipate attenuation or soakage being needed, and being possible on site by rain gardens, swales or attenuation basins or local roads.

The report also includes an assumption that treatment of stormwater will be provided within the development.

7.2 Analysis of Stormwater Quantities

Analysis of catchment runoff and stormwater flows was not provided to support the stated figures in the WSP Opus report.

We have therefore undertaken our own preliminary storm water analysis to make an 'order of magnitude' check of the figures within the WSP Opus report. The design report on the existing pipeline which serves the Queenstown Country Club development identifies that the pipe is designed for the following:

- 1 hour duration storm
- 1% AEP (Annual Exceedance Probability) or a 1/100 year event
- The WSP Opus report identifies that there is 'capacity in the stormwater pipe to accommodate up to 1.5 m3/s from the Ladies Mile HIF development'. However the ARI for such an event is not identified. The longer the ARI the less surplus capacity that will be available.

In our analysis we have used the following storm values from HIRDS and the areas indicated below;

Results for Ladies Mile

Depth-Duration-Frequency results (produced on Tuesday 3rd of July 2018)
Sitename: Ladies Mile
Coordinate system: NZMG
Easting: 2174342
Northing: 5567662

Rainfall depths (mm)

		Duration									
ARI (y)	**aep**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	0.633	2.9	4.6	6.1	9.8	14.4	26.3	38.4	56.2	67.5	75.2
2.00	0.500	3.1	5.1	6.7	10.7	15.6	28.3	41.2	60.0	72.1	80.3
5.00	0.200	4.1	6.5	8.6	13.9	20.0	35.5	51.1	73.6	88.5	98.5
10.00	0.100	4.8	7.8	10.2	16.5	23.5	41.3	59.0	84.3	101.3	112.8
20.00	0.050	5.7	9.2	12.1	19.4	27.5	47.8	67.7	95.9	115.3	128.4
30.00	0.033	6.3	10.1	13.3	21.3	30.1	51.9	73.2	103.3	124.3	138.4
40.00	0.025	6.7	10.7	14.2	22.8	32.0	55.0	77.4	108.9	131.0	145.9
50.00	0.020	7.0	11.3	14.9	24.0	33.7	57.6	80.8	113.4	136.4	151.9
60.00	0.017	7.3	11.8	15.6	25.0	35.0	59.8	83.7	117.3	141.0	157.0
80.00	0.012	7.8	12.6	16.6	26.7	37.3	63.4	88.5	123.6	148.6	165.5
100.00	0.010	8.3	13.3	17.5	28.1	39.2	66.3	92.3	128.7	154.7	172.3

Figure 7-2: HIRDS rainfall data for the site

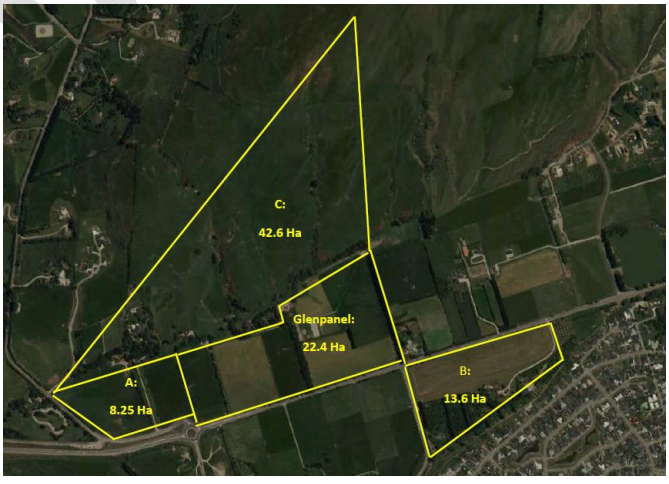


Figure 7-3: Catchment areas

The results of our preliminary analysis are summarised in the table below;

Table 7-1: calculation of approximate runoff entering existing stormwater pipeline in Howard Drive

Area Name	Approximate area (Ha)	Runoff coefficient C	Rainfall Intensity (mm/h) for 1 hour event	Runoff Q (m^3/s)
			100 YEAR ARI	
B	13.6	0.5	28.1	0.53
Glenpanel	22.4	0.5	28.1	0.87
A	8.25	0.3	28.1	0.19
C	42.6	0.3	28.1	1.00
TOTAL FLOW GENERATED IN 100 YEAR ARI				**2.60**
			20 YEAR ARI EVENT	
B	13.6	0.5	19.4	0.37
Glenpanel	22.4	0.5	19.4	0.60
A	8.25	0.3	19.4	0.13
C	42.6	0.3	19.4	0.69
TOTAL FLOW GENERATED IN 20 YEAR ARI				**1.79**
TOTAL STATED SURPLUS CAPACITY IN EXISTING PIPE IN 100 YEAR ARI EVENT				**1.50**

The analysis above is preliminary only. A complete analysis will require an assessment of the stormwater flow from the Ladies Mile HIF site *plus* the flow from the Queenstown Country Club site for different event durations and different ARI values. The total flow resulting from these scenarios will need to be compared to the hydraulic capacity of the stormwater pipeline to the Shotover River. Thus the critical ARI event and duration can be identified. We are not in receipt of results of such an analysis.

We note that WSP Opus have indicated that they have used a C value (runoff coefficient) of 0.6 which is higher that we have used in our preliminary analysis above. This difference is not material for the purposes here.

The preliminary analysis above does not account for attenuation on site. Thus this analysis could provide a conservative value of the volume of stormwater generated on the HIF site if attenuation is feasible. However this analysis indicates that further design is necessary to confirm the reliability of the piped stormwater system to serve both the Queenstown Country Club and the Ladies Mile HIF site.

The report on the Queenstown Country Club stormwater system, prepared by Fluent Solutions Limited, is included in Appendix H of the WSP Opus report. No confirmation of the level of the existing stormwater pipe in Howards Drive is included and thus we cannot undertake an independent check that there is sufficient depth to connect areas of the proposed development to that existing stormwater pipeline.

Our analysis confirms that attenuation or diversion of the stormwater will be necessary within or adjacent to the development site to prevent overwhelming the existing pipeline in Howards Drive and to prevent flooding in the development and adjoining areas and/or additional stormwater infrastructure will be needed for the new development other than that proposed.

7.3 Existing Catchment Drainage

Assumptions have been made by WSP Opus on catchment drainage patterns but no specific assessment appears to have been undertaken and the information reported is not clear.

We therefore inspected the site and, from this and previous experience in the area, we infer that:

- The catchment includes the proposed development areas adjacent to Ladies Mile, as well as a part of Slope Hill (see Figure 7-2)
- Runoff from Slope Hill currently discharges over pasture in the Glenpanel area and is dispersed in the first instance. Overland flow is then east in the direction of Lake Hayes, including to the water table alongside the State Highway
- WSP Opus have provided a plan to us indicating flow channels across the land either side of Ladies Mile, but our view is that dispersed overland flow and ponding instead applies in the area for development and further east. Thus there are no defined flow paths that could channel surface flows through new development, nor systems downstream to accommodate concentrated flows from diversion paths through or around the development.

Conversion of the pasture areas to urban would increase the potential impacts and risks resulting from runoff in this catchment.

7.4 Conclusions and Risks

We consider that the stormwater requirements for the development have not been adequately assessed, with reliance placed on unconfirmed and, in some cases, incorrect assumptions and models. While the information provided has correctly identified that additional infrastructure will be needed for stormwater beyond the connection to the existing pipeline in Howards Drive, the proposed solutions are not assessed or shown to be feasible. There are also significant potential additional costs associated with these solutions that are not allowed for.

We comment in the following table on the feasibility and implications of various concepts for additional infrastructure solutions noted in the WSP Opus report:

Potential additional stormwater infrastructure	**Challenges for implementation**
Diversion of runoff from Slope Hill through Glenpanel area to adjoining land to the east	New channels will need to be constructed and will concentrate flows discharging to neighbouring property. This will potentially cause flood and scour damage to neighbouring land and is unlikely to be permissible. Space will be needed within the development area for diversion works, potentially reducing housing yield.
Extended diversion through land east of Glenpanel, and discharge to Lake Hayes	Previous Environment Court decision for nearby Threepwood forbad discharge of stormwater to Lake Hayes. Given ongoing water quality problems in Lake Hayes discharge, this discharge is unlikely to be permissible. There is a significant likely cost in piping that is not included.
Extended diversion through land east of Glenpanel, and discharge to outlet stream from Lake Hayes	There is a significant likely cost in piping that is not included. Potential impacts on stream (including erosion and adequate channel capacity) are unknown. Resource consent for the discharge to the stream will be required.
On-site detention to reduce flows to the capacity of downstream pipes	This will require a significant area of land for storage that has not been allowed for. If this is on the developed land, then housing yields are likely to be significantly below those assessed. If this is located on adjacent land, then land acquisition will be needed. No consideration has been given to the feasibility and costs of this.

On-site soakage disposal	This will require a significant area of land for soakage that has not been allowed for. If this is on the developed land, then housing yields are likely to be significantly below those assessed. If this is located on adjacent land, then land acquisition will be needed. Experience at Threepwood was depth to free draining soils of up to 8m through lower permeability overburden soils. This will increase the costs of construction and maintenance of soakage systems. No consideration has been given to the feasibility and costs of this.

We note that several of these potential solutions may require significant areas of land. We are not able to assess the impact of this on housing yield if that is within the proposed development. However, the proposed development density is relatively high, and any associated reduction in housing yield could be significant.

WSP Opus have suggested that construction of a new pipe outlet to Lake Hayes by QLDC could be left for future implementation. We are not confident that this is the case given the issues noted above.

WSP Opus have made an assumption about pipe levels in Howards Drive and assumed that gravity connection from Glenpanel and Area B is possible. If this assumption is wrong then drainage of all the developed area may not be possible. The existing pipe level needs to be measured and then the extent of land able to drain to this point should be determined.

We believe that there are significant unknowns and consequents risks associated with the infrastructure needed for stormwater management and disposal for the proposed development, and we recommend investigation of these to scope feasible solutions.

8. Design and cost estimates

We understand that review of the cost estimates is being undertaken be another party, along with a parallel review of these. We have not received these reviews. The scope of this report does not include review of the adequacy of the cost estimates.

9. Procurement and construction timeframes

Insufficient information on programming of the works has been received to make any detailed statement regarding programme.

A basic schedule for implementation of the project is included in the draft DBC, on which we have the following preliminary comments:

- An immediate start to procurement of design services is assumed. Further concept development is likely to be needed before this is possible, particularly for stormwater.
- There is no provision for land acquisition for the water reservoir
- The programme does not identify timing of the water bore headworks which is critical to the project
- There is no provision for timing of stormwater works needed outside the development area
- There is no provision for consents, nor for approvals by other parties (e.g. NZTA)
- The timing of completion of 3-waters bulk infrastructure is not linked to when it is needed for release of land titles.

10. Risk identification and analysis

Section 8 of the WSP Opus report contains a list of 10 risks. There risks are of a general nature and no response or mitigation measures are identified.

There is a more comprehensive risk assessment in the DBC draft but coverage and analysis of technical risks is also limited.

We consider the assessment of risk should be developed in more detail at this time to reduce the actual risk to QLDC and that other project proponents. Of most significance is that the uncertainties and risks associated with stormwater management and disposal are not recognised.

11. Conclusion

This project is at an early stage of project planning and we recognise that high level assessments are warranted. However, we consider that further consideration is needed of several aspects for this stage to reduce the risks to QLDC and project stakeholders.

We consider that the assessment of stormwater is not sufficiently covered, and recommend that further assessment is made of the requirements for stormwater management and disposal.

We consider that the risk assessment and the programme schedule for implementation need more consideration. Aside from stormwater, key risks to feasibility of the development are in obtaining a site for water reservoirs and upgrade of the Shotover Country borefield.

Appendix A WSP Opus Report Addendum 28/06/2018

Appendix B Water Demand Supporting Information

Appendix C Confirmation of the Capacity of Wastewater Pipeline on the Shotover Bridge

Dunedin
Level 3 John Wickliffe House, 265 Princes Street
Dunedin 9016
PO Box 13-052, Armagh
Christchurch 8141
Tel +64 3 477 0885
Fax +64 3 477 0616

Please visit **www.stantec.com** to learn more about how Stantec design with community in mind.

Stantec