Shotover Design Limited trading as
Clark Fortune McDonald & Associates
Licensed Cadastral Surveyors - Land Development - Planning Consultants

Quail Rise Estate Extension Plan Change

Conceptual Study
For
Wastewater, Stormwater & Water

February 2010

REGISTERED PROFESSIONAL SURVEYOR

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CSNZ THE CONSULTING SURVEYORS OF NEW ZEALAND

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1.0 EXECUTIVE SUMMARY

Clark Fortune McDonald & Associates (CFM) has been engaged by Quail Rise Estate Limited (QRE) to consider infrastructure options for a new residential development in the north Frankton Flats, adjoining Quail Rise and Ferry Hill. The proposal has been subject to a recent amendment reducing the site area. It is now known as the *Quail Rise Estate Extension Plan Change*. It was previously known as the Frankton Flats (North) Plan Change (*Frankton Flats North*).

The development area is 11.8ha which, allowing for roadways and open space, will contain approximately 40 residential units.

The *Quail Rise Estate Extension Plan Change* can be fully serviced with reticulated water supply, reticulated foul and stormwater sewerage. A summary of the report findings is given below:

1.1 Wastewater

Consideration has been given to several options for managing wastewater generated within the *Quail Rise Estate Extension Plan Change* development area. It is the view of Clark Fortune McDonald & Associates that the most appropriate method is to gravity reticulate all allotments using an internal pipe network and then to discharge to the Council Municipal Treatment Plant.

Refer to the Wastewater Concept Plan contained in Appendix 1.

1.2 Stormwater

Residential development of the Ferry Hill area has the potential to increase stormwater runoff and introduce contaminants into the receiving aquatic environment. The preferred stormwater management option is to incorporate traditional big-pipe methods with Low Impact Design (LID) and Sustainable Urban Drainage (SUD) approaches.

Roadway stormwater will be directed to a pipe network through a series of swales and conventional kerb. Stormwater from roofs and hard surfaces within residential allotments will be piped directly.

Stormwater will discharge through filters into a detention pond(s). Peak flows will be attenuated and clean stormwater will be discharged to the Shotover River at acceptable rates. Where ground conditions permit these ponds will allow for infiltration of clean stormwater direct to ground.

Discharging stormwater from a reticulated system to water or to ground is a restricted discretionary activity pursuant to Section 12.4.2 of the *Regional Plan: Water for Otago* so resource consent will be necessary.

Refer to the Stormwater Catchment Plan contained in Appendix 2.

1.3 Water Supply

The preferred option is to connect to and extend the proposed Plan Change 19 reticulation. This option is likely to have the lowest capital cost, require the least amount of land, have the lowest ongoing cost to the QLDC, and provide the most systematic, area wide solution for water supply.

2.0 WASTEWATER

2.1 Sewage Flows

Peak sewage flow expected to be generated by the *Quail Rise Estate Extension Plan Change* is approximately 2.4 l/sec. Assuming 40 residential allotments, and making allowance for some commercial facilities, and some minor commercial facilities, peak flow is based on the following:

No. of allotments:	40.
No. of dwelling equivalents:	40.
People per dwelling:	3.5*.
Flow per person:	300 l/day*.
Average dry weather flow:	42 m^3/day.
Diurnal peak factor:	2.5*.
Infiltration factor:	2.0*.
Total peak flow:	210 m^3/day.
	2.4 l/sec.

*Refer QLDC amendments to NZS4404:2004 dated September 2005.

The *Quail Rise Estate Extension Plan Change* catchment is as described below and as shown on the Wastewater Concept Plan contained in Appendix 1.

2.2 Disposal Options

Options available for wastewater disposal include:

- Onsite treatment on each lot.
- Community onsite treatment.
- Onsite primary treatment before pumping via small bore sewer to Council's sewer network.
- Discharge to Council's sewer network via Frankton Flats Plan Change 19 (*Plan Change 19*) gravity sewer pipework.
- Discharge direct to Council's sewer network via own gravity sewer pipework through *Plan Change 19*.
- Discharge direct to Municipal treatment Plant via own gravity sewer pipework.

2.2.1 Option 1 - Onsite Treatment on Each Lot

This option would involve individual allotment owners purchasing and installing a package treatment plant for the home. They would also be responsible for ongoing maintenance and operation which raises the following issues:

- Sizing of allotments to allow waste water to be disposed to land effectively.
- Controls need to be put in place to ensure a minimum level of treatment for each allotment is obtained.
- Land disposal will need to be designed and adequately sized to avoid adverse effects beyond each lot.
- No lot would be permitted to discharge within 50m of any waterway or bore.
- Lot owners would be responsible for ongoing maintenance and operation with loss of control from the Territorial Authority.

The amount of land required to dispose of wastewater onsite is in the vicinity of 200m^2 which is achievable based on the proposed allotment configuration. The cost of each onsite system

would be in the order of $15,000 – $20,000, which would equate to approximately $0.6M - $0.8M for 40 allotments. This cost would be transferred to the allotment owners which would be an advantage to the developer. It would however raise marketing issues. The Territorial Authority and the developer could also be open to criticism, given that the site is within close proximity to a municipal treatment plant, and the adjoining Quail Rise subdivision has a reticulated foul sewer pipe network. This option is not considered feasible.

2.2.2 Option 2 - Community Onsite Treatment

Waste water would be treated at a central community treatment plant. The plant would include 24 hours emergency storage, which would provide a buffer for diurnal variations in flow. Wastewater would then be disposed of via land treatment or discharged to the Shotover River.

The development site contains areas below the transmission lines which could accommodate the large areas of land required to ensure appropriate hydraulic, biological and nutrient loading rates. The total land area required for disposal would be in the order of 0.9 ha.

Resource consent from the Otago Regional Council would be required to discharge treated effluent to land or water. It is unlikely that consent would be granted, given the availability of other cheaper options which are more favourable to the QLDC.

2.2.3 Option 3 - Small Bore Sewers to Council Sewer

This option would involve individual allotment owners purchasing and installing a package grinder pump for the home. They would also be responsible for ongoing maintenance and operation.

This option is considered appropriate for small clusters of housing which are reasonably close to a Council main, but which are not able to discharge by gravity. It is not likely to be feasible in this instance.

2.2.4 Option 4 - Discharge to Council Sewer Network via Frankton Flats Plan Change 19 Pipework

Plan Change 19, while not complete at this time, has a proposed connection to the Council trunk sewer immediately north of the airport runway.

The *Plan Change 19* connection is shown on the Wastewater Concept Plan contained in Appendix 1. The proposed connection point is suitably placed for this development, and it would be practical to construct a gravity connection to the Council trunk main.

This option is reliant upon execution of a satisfactory stakeholder's agreement in relation to cost sharing and timing of construction of the connecting pipework. We anticipate that each contribution to the cost of the pipeline construction would be determined pro rata, based on the discharge of each development.

This option assumes that the Council trunk sewer has sufficient capacity to receive flows from the *Quail Rise Estate Extension Plan Change* and *Plan Change 19.*

2.2.5 Option 5 - Discharge Direct to Council Sewer Network via Own Gravity Sewer Pipework Through Plan Change 19.

This option involves construction of a gravity sewer connection as per option 4 above, but with only sufficient capacity for the *Quail Rise Estate Extension Plan Change* discharge. This option would be appropriate if the development of *Plan Change 19* did not proceed. It is reliant upon an easement agreement being obtained over the intervening land.

Minimum 150mm diameter pipework would be required providing that gradients specified in NZS4404:2004 can be achieved. The construction cost for this option would be in the vicinity of $150K - $180K.

This option assumes that the Council trunk sewer has sufficient capacity to receive flows from the *Quail Rise Estate Extension Plan Change.*

This option does not provide capacity for an ultimate development scenario of the Plan Change 19 development area. Accordingly it is considered appropriate only as a last resort.

2.2.6 Option 6 - Discharge Direct to Municipal Treatment Plant

This option involves construction of gravity sewer pipework falling from the western end of the development area towards the north east. A gravity connection from the eastern end of Frankton Flats would then be made to the Queenstown waste water treatment plant.

The proposed route of the gravity connection would follow the Ladies Mile Highway, and then down to the Municipal Treatment Plant beside the Shotover River. This option is reliant upon NZTA approving construction of a pipeline route within the legal boundaries of the Ladies Mile Highway.

Minimum 150mm diameter pipework would be required. Preliminary investigations at this time indicate that the proposed pipeline route is feasible.

The construction costs for this option would be in the vicinity of $50K - $70K.

2.3 Preferred Option

After consideration of the options specified above Option 6, Discharge Direct to Municipal Treatment Plant, is preferred as it is likely to:

- Have the lowest capital cost,
- Require the least amount of land,
- Have the lowest ongoing cost to the QLDC;
- Require no stakeholder agreement.

The wastewater concept plan is included in Appendix 1.

2.4 Construction Estimates

Guideline estimates for a gravity connection with capacity for the *Quail Rise Estate Extension Plan Change* would be in the vicinity of $150/m. The construction cost would be around $60K for a pipeline route approximately 400m in length.

The above estimate relates only to the connection of the development area pipe network to the QLDC manhole in the vicinity of the treatment plant. The estimate to construct the reticulation within the development area is in the vicinity of $100K.

More accurate cost estimates can be provided during the detailed design phase of the project, when roading layouts and exact development figures are known.

2.5 Consents

The preferred option does not require discharge of waste water to land or water. Consent to connect to the QLDC manhole will be required. Engineering approval of the design plans will also be required.

2.6 Headworks fees

Headworks fees would be assessed by Council, and levied as part of a development contribution, in accordance with the Local Government Act 2002. At this time, Council's Development Contributions and Financial Contributions Policy (2008/09) demonstrates funding requirements, for waste-water, of $3,856 per dwelling equivalent in Queenstown. This equates to a total headworks fee of $154K for 40 proposed residential units. However, it is anticipated that headworks fees would be negotiated with Council during the resource consent application phase of the project.

3.0 STORMWATER

3.1 Hydrological Analysis

The development proposal is still in the planning stage and the subdivision scheme is still being developed. As such, broad assumptions have been made in order to provide estimates of runoff from the study area. Main sources of runoff from residential developments typically come from roads, hardstand areas and roofs.

The project area is contained within a larger catchment. This catchment has been divided into two sub-catchments, as described below, and as shown on the Stormwater Catchment Plan contained in Appendix 2.

The two catchments area:

- The Hillside Catchment: 18ha of undeveloped hillside steeper than 20%.
- The Flats Catchment Area Catchment: 11.8ha between 5%-10%.

The analysis considers different storms of varying duration for pre-development and post development scenarios. In this way it is possible to estimate:

- Peak discharge for both pre and post-development scenarios; and
- The increase in stormwater discharge based on the increase in impervious surfaces.

The analysis has been carried out using the parameters and assumptions set out below.

3.1.1 Key Parameters

Provide a system which replicates the pre-development hydrological regime*.

Provide a system which provides collection and controlled stormwater disposal from the development area together with any upstream catchments*.

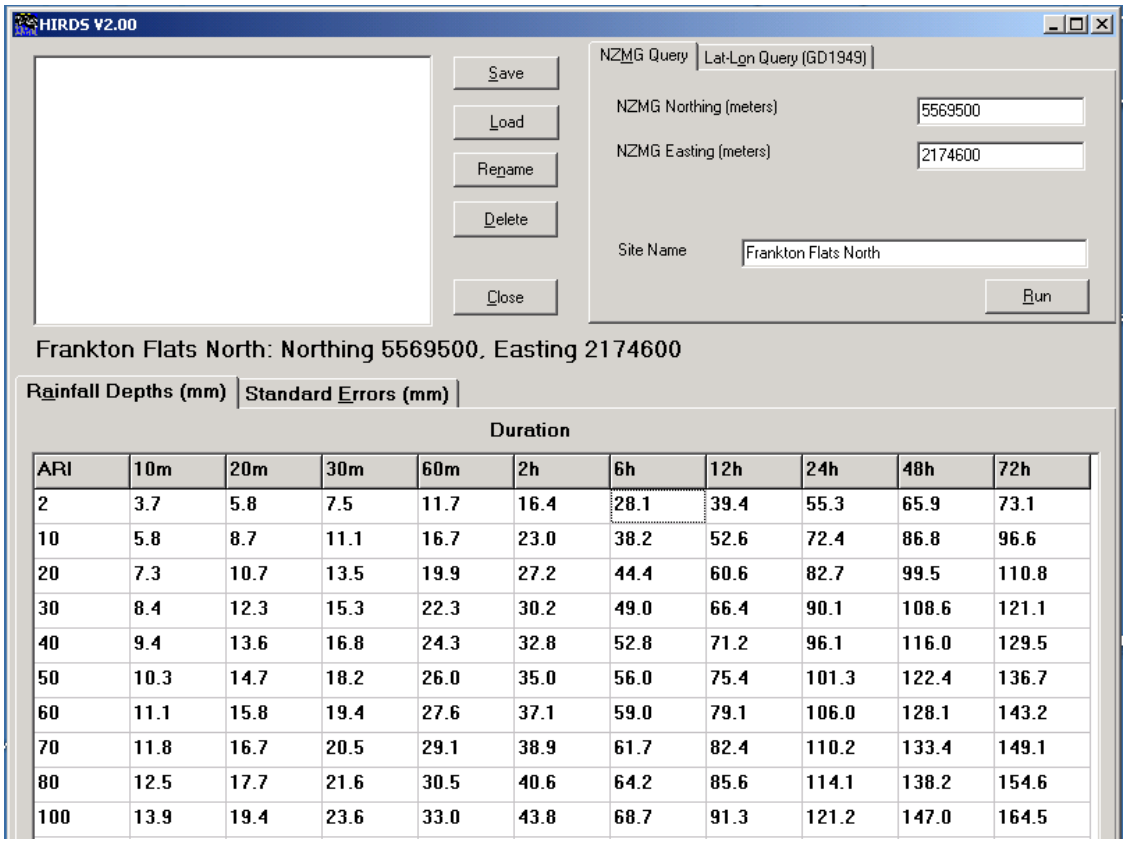
Minimum ARI required for primary protection in residential areas:	5 years*.
ARI used in the analysis:	25 years*.
ARI used for calculating capacities of secondary flowpaths:	100 years*.

Runoff Coefficient C

Hillside Catchment	18ha	0.4**
Flats (pre development)	11.8ha	0.3**
Flats (post development)	11.8ha	0.45**

Rainfall Intensity Curves – NIWA HIRDS** refer Figure 1 below.

Figure 1 – NIWA HIRDS Rainfall depths



ARI	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
2	3.7	5.8	7.5	11.7	16.4	28.1	39.4	55.3	65.9	73.1
10	5.8	8.7	11.1	16.7	23.0	38.2	52.6	72.4	86.8	96.6
20	7.3	10.7	13.5	19.9	27.2	44.4	60.6	82.7	99.5	110.8
30	8.4	12.3	15.3	22.3	30.2	49.0	66.4	90.1	108.6	121.1
40	9.4	13.6	16.8	24.3	32.8	52.8	71.2	96.1	116.0	129.5
50	10.3	14.7	18.2	26.0	35.0	56.0	75.4	101.3	122.4	136.7
60	11.1	15.8	19.4	27.6	37.1	59.0	79.1	106.0	128.1	143.2
70	11.8	16.7	20.5	29.1	38.9	61.7	82.4	110.2	133.4	149.1
80	12.5	17.7	21.6	30.5	40.6	64.2	85.6	114.1	138.2	154.6
100	13.9	19.4	23.6	33.0	43.8	68.7	91.3	121.2	147.0	164.5

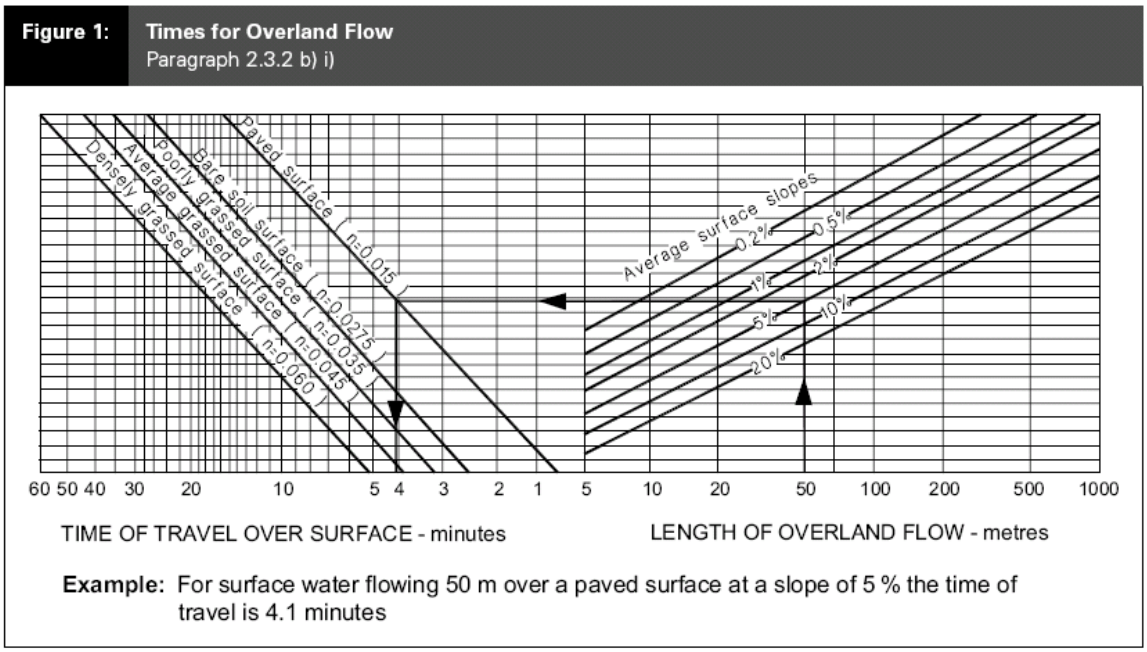
Table 1 – Rainfall Intensity

ARI	Duration 10 min	20min	30min	60min	120min
25yrs	47mm/hr	35 mm/hr	29 mm/hr	21 mm/hr	14 mm/hr
50yrs	62 mm/hr	44 mm/hr	36 mm/hr	26 mm/hr	18 mm/hr
100yrs	83 mm/hr	58 mm/hr	47 mm/hr	33 mm/hr	22 mm/hr

Time of concentration (Tc) minimum = 10 min**.

Time of entry Te = 10 min for low density residential areas.

Figure 2 - Te for overland flow (Hillside Catchment)



Estimation of surface water run-off to be calculated using the Rational Method**. This is appropriate for catchments of this size.

*Refer QLDC amendments to NZS4404:2004 dated September 2005.
**Refer Approved Document for Clause E1 of the NZBC: Surface Water which comprises Verification Method E1/VM1 and Acceptable Solution E1/AS1.

3.1.2 Estimated Pre and Post Development Runoff

It is necessary to analyse a series of storms to assess the likely effects that the increase in impervious area has on runoff.

E1/VM1 requires primary protection for storms with a 5 year ARI. The following stormwater analysis is based on a minimum storm ARI of 25 years, which is conservative. The calculations therefore consider storms with an ARI of 25 years, 50 years and 100 years.

From Figure 2 the time of overland flow for the entire catchment is 30 minutes. This sets the upper limit for time of concentration (Tc) to be used in the analysis.

The entire catchment area will contribute to the stormwater runoff catchment for a storm which has a duration of 30 minutes. Storms of duration greater than 30 minutes are, therefore, not critical for determining peak runoff and have not been considered.

It is also necessary to consider storms of shorter duration. Accordingly 10 minute and 20 minute duration storms have been considered. In this instance the results tabulated below show that the non-linear relationship between rainfall intensity and time of concentration produces higher flows for shorter duration storms even though the contributing catchment area is smaller.

Table 2 – Estimated Stormwater Runoff

Pre Development				Post Development				
Tc = 10 min				Tc = 10 min				
Catchment	Area (ha)	C	CA	Catchment	Area (ha)	C	CA	
Flats	11.8	0.3	3.54	Flats Dev	11.8	0.45	5.31	
Hillside	6	0.4	2.4	Hillside	6	0.4	2.4	
		SCA	5.94			SCA	7.71	
ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	Increase in Runoff (m^3/sec)
25	47		0.8	25	47		1.0	0.2
50	62		1.0	50	62		1.3	0.3
100	83		1.4	100	83		1.8	0.4
Tc = 20 min				Tc = 20 min				
Catchment	Area (ha)	C	CA	Catchment	Area (ha)	C	CA	
Flats	11.8	0.3	3.54	Flats Dev	11.8	0.45	5.31	
Hillside	12	0.4	4.8	Hillside	12	0.4	4.8	
		SCA	8.34			SCA	10.11	
ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	
25	35		0.8	25	35		1.0	0.2
50	44		1.0	50	44		1.2	0.2
100	58		1.3	100	58		1.6	0.3

Tc = 30 min				Tc = 30 min				
Catchment	Area (ha)	C	CA	Catchment	Area (ha)	C	CA	
Flats	11.8	0.3	3.54	Flats Dev	11.8	0.45	5.31	
Hillside	18	0.4	7.2	Hillside	18	0.4	7.2	
		SCA	10.74			SCA	12.51	
ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	
25	29		0.9	25	29		1.0	0.1
50	36		1.1	50	36		1.3	0.2
100	47		1.4	100	47		1.6	0.2
Tc = 60 min				Tc = 60 min				
Catchment	Area (ha)	C	CA	Catchment	Area (ha)	C	CA	
Flats	11.8	0.3	3.54	Flats Dev	11.8	0.45	5.31	
Hillside	18	0.4	7.2	Hillside	18	0.4	7.2	
		SCA	10.74			SCA	12.51	
ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	ARI (yrs)	i (mm/hr)		Runoff (m^3/sec)	
25	21		0.6	25	21		0.7	0.1
50	26		0.8	50	26		0.9	0.1
100	33		1.0	100	33		1.1	0.1

3.1.3 Water Quantity

The hydrological analysis shows the increase in impervious area within the development area increases stormwater runoff.

For a 25 year ARI storm the likely increase in stormwater runoff varies between 0.1m^3 / sec and 0.2m^3 / sec.

For a 100 year ARI storm the likely increase in stormwater runoff varies between 0.2m^3 / sec and 0.4m^3 / sec.

The purpose of the hydrological analysis is to give an appreciation of the likely increase in stormwater runoff. More accurate runoff estimates can be provided during the detailed design phase of the project, when roading layouts and exact development figures are known.

3.2 Water Quality

Stormwater can contain a number of contaminants which may adversely affect the receiving environment. Studies in New Zealand and abroad have identified urban development as a major contributor to the declining quality of aquatic environments. It is estimated that upwards of 40% of the contaminant content of this runoff can be attributed to run-off from roads.

At this site stormwater will be generated by run-off from the following:

- Roofs of residential buildings;
- Urban roadways;
- Footpaths; and
- Other hard-standing areas.

Based on available information it is expected that stormwater from the above named developed surfaces could contain the following contaminants:

- Suspended solids;
- Oxygen demanding substances;
- Pathogens; and
- Dissolved contaminants.

The dissolved stormwater contaminants of concern at this site can cause an aquatic risk to the ecology of the receiving environment. The parameters of concern are as follows:

(1) Hydrocarbons and Oils

These are associated with vehicle use, although there is potential for spillages of hydrocarbon products to occur. They may be in solution or absorbed into sediments. Routine stormwater discharges are likely to have low concentrations ranging between 1 and 5g/m^3 total hydrocarbons over each storm event.

(2) Toxic Metals

A variety of persistent trace-metal compounds are carried in stormwater in both solid and dissolved forms. The most commonly measured metals of concern are zinc, copper, and chromium (mostly associated with vehicles and roads).

(3) Nutrients

Fertiliser application and animal waste associated with the current agricultural use of the site have the potential to generate high levels of nutrients such as phosphorus and nitrogen within stormwater runoff. High nutrient levels are not anticipated within the post-development stormwater runoff as agricultural activities, such as grazing in particular, will cease.

3.2.1 Expected Contaminant Levels

Ranges of contaminant levels area provided by both the Auckland Regional Council (TP 10 and 53) and NIWA (Williamson 1993). This data can be used to predict the likely contaminant loading levels associated with changes in land use.

Contaminant levels anticipated for this development have been estimated from TP10 and are included in Table 3 below.

Table 3 – Estimated Contaminant Loading Ranges for Land Use Types (kg/ha/year)

Land Use	Total Susp. Solids	Total Phosph.	Total Nitrogen	BOD	Lead (median)	Zinc	Copper
Road	281-723	0.59-1.5	1.3-1.5	20-33	0.49-1.10	0.18-0.45	0.03-0.09
Res (low density)	60-340	0.46-0.64	3.4-4.7	12-20	0.03-0.09	0.07-0.20	0.09-0.27
Pasture	103-583	0.01-0.25	1.2-7.1	NA	0.004-0.015	0.02-0.17	0.02-0.04
Grass	80-588	0.01-0.25	1.2-7.1	NA	0.03-0.10	0.02-0.17	0.02-0.04

3.2.2 Construction-Stage Stormwater

Construction stage stormwater has the greatest potential to cause discharge of sediment laden runoff to the receiving environment. We would suggest that the applicant provide details of the proposed stormwater management plan as part of the engineering design phase of the project.

3.3 Stormwater Management Objectives

The following draft overall objectives should be recognised while assessing stormwater management options for the development area:

- Primary protection for 25 year ARI storms;
- Secondary protection (overland flowpaths) for 100 year ARI storms;
- Regulatory Compliance;
- Avoidance of significant increases in downstream peak flows resulting from the increase in developed surface areas;
- Sustainable management of the effects of the proposed development;
- Minimisation of pollution of receiving waterways through the reduction of stormwater contaminants from roadways;
- Erosion protection in the stormwater discharge zone;
- Keeping construction and maintenance costs to a reasonable level.

3.4 Stormwater Management Approaches

This Section of the report introduces options available for the *Quail Rise Estate Extension Plan Change* stormwater management, in particular traditional design (big pipe), Low Impact Design (LID) or Sustainable Urban Drainage (SUD) approaches.

3.4.1 Traditional Approaches (Big Pipe)

The traditional approach to stormwater management has been to direct all runoff from residential allotments and roadways to a pipe network which discharges to the nearest receiving water body, with minimal effort made to replicate the pre-development hydrological regime.

The big pipe approach has one advantage over LID and SUD approaches: lower construction and maintenance costs.

3.4.2 LID / SUD Approaches

Some LID options are presented below. These have been sourced from the *Low Impact Design Manual* for the Auckland Region TP124 (Shaver et al. 2000), the *On-Site Stormwater Management Guideline* (NZWERF, 2004) and *Waterways, Wetlands and Drainage Guide* (CCC, 2003).

- Clustering and alternative allotment configuration. Fewer, smaller allotments, with more open space. This approach is less economic for the Developer.

- Reduction in setbacks. Reduction in the front setback reduces the length of driveway required. Correspondingly, the total amount of impervious area within the development is reduced. This approach presents compliance issues with QLDC District Plan rules.

- Reduction in developed surfaces. This approach applies mainly to transport related aspects of residential developments such as reduced carriageway widths, use of grassed swales as opposed to kerb & channel, and alternative turning head design. This approach presents compliance issues with the QLDC code of subdivision.

- Vegetated filter strips and swales. Stormwater from roadways is directed through a densely vegetated strip, and then into a road-side swale. Swales are generally used for conveyance of stormwater however they do have contaminant removal properties such as sediment removal efficiency of 20 – 40% (Waterways, Wetlands and Drainage Guide, CCC 2003). Stormwater velocity is reduced so this approach is beneficial in reducing peak flows.

- Infiltration Trench. Infiltration trenches can be constructed in place of swales if natural soils are sufficiently free draining. This is applicable to sites with limited available open space. Infiltration trenches also have the ability to store stormwater. This is beneficial in reducing peak flows.

- Infiltration Basin. The suitability of this option is reliant upon free draining natural soils, adequate depth to groundwater, and sufficient open space to construct.

- Soakage chambers. These allow direct discharge of stormwater to groundwater or free drainage soils. Soakage chambers are expensive and are reliant upon clean, pre-treated stormwater.

- Permeable paving. This option allows stormwater to permeate directly into pavement layers, and is applicable for low traffic areas with low ground water levels and free draining non-cohesive soils. Construction and maintenance costs for this option are high.

- Detention Ponds. These are used to reduce peak discharges to pre-development levels. They allow for settlement of suspended solids by vegetation. They require sufficient open space to construct.

3.5 Management Options

Many options are available to avoid, remedy or mitigate the adverse effects associated with residential development on receiving environments.

For the *Quail Rise Estate Extension Plan Change* project the recommended stormwater management strategy is to provide an integrated treatment train approach to water management, which is premised on providing control at the catchment wide level, the allotment level, and the extent feasible in conveyance followed by end of pipe controls. This combination of controls provides a satisfactory means of meeting the criteria for water quality, volume of discharge, erosion and flood control.

Table 4 – Recommendations

	Recommendations	**Remarks**
Collection	Combinations of LID/SUD measures, kerb & channel, swales, open channels and pipes.	(1) Where allotment density allows direct roadway runoff to grass swales (primary treatment) – also for secondary overland flow during flood events. (2) Where natural soils allow incorporate infiltration measures. (3) Kerb & Channel & pipework to provide primary protection.
Treatment	Combinations of swales, detention ponds and end of pipe structures (gross pollution traps and filters).	(1) Pipework to discharge to detention / infiltration ponds. (2) End of pipe structures and fore bay bunds to provide pre-treatment of stormwater before infiltration to ground water / discharge to the Shotover River and other minor watercourses in the vicinity of the development area.
Disposal	Use attenuation prior to discharging to watercourses.	(1) Sufficient space is available to construct detention ponds. (2) Where natural soils allow construct an infiltration pond. (3) Where possible post development discharge not to exceed pre-development levels.

Subject to more detailed design, when roading layouts and exact development figures are known, detention ponds within a residential development would require approximately 6.5% - 7.5% of the development area. On that basis the land required for the *Quail Rise Estate Extension Plan Change* development would be in the vicinity of 0.7ha – 0.8ha.

3.6 Construction Estimates

Table 5 – Construction Estimates

Item	Description	Qty	Unit	Rate	Sum
1	Cut-off trenches	500	m	$10	$5K
2	Sumps	15	No.	$1500	$22K
3	225mm dia pipe	600	m	$100	$60K
4	300mm dia pipe	400	m	$130	$52K
5	375mm dia pipe	200	m	$160	$32K
6	100mm dia lot conn.	200	m	$50	$10K
7	Ys for 100mm dia off	40	No.	$200	$8K
8	Manholes	12	No.	$3700	$44K
9	Hynds Up-Flo filters			Allow	$20K
10	Swales	1000	m	$10	$10K
11	Infiltration trenches	500	m	$50	$25K
12	Ponds			Allow	$12k
13	Connection to Shotover River	700	m	200	140K
	Total				**$440K**

3.7 Consents

The preferred option requires discharge of stormwater to land or water. This activity has restricted discretionary status pursuant to Section 12.4.2 of the *Regional Plan: Water for Otago*. On that basis it will be a requirement to obtain resource consent from the Otago Regional Council to discharge stormwater either to land or to the Shotover River.

In additional to the above it will be a requirement to obtain engineering approval from the QLDC in relation to the design plans, specification for construction and calculations.

3.8 Headworks Fees

Headworks fees would be assessed by Council, and levied as part of a development contribution, in accordance with the Local Government Act 2002. At this time, Council's Development Contributions and Financial Contributions Policy (2008/09) demonstrates funding requirements, for stormwater, of $711 per dwelling equivalent in Queenstown. This equates to a total headworks fee of $28K for 40 proposed residential units. However, it is anticipated that headworks fees would be negotiated with Council during the resource consent application phase of the project.

4.0 WATER RETICULATION

4.1 Demand and Flows

4.1.1 Minimum Flow

Minimum flow shall be:

- 40 l/min for each residential unit*.
- As specified in SNZ PAS 4509*.

4.1.2 Minimum Water Demand

The minimum peak domestic demand shall be based on:

- Daily consumption of 700 l/person/day*.
- Peak factor of 4.0 (Queenstown) and 6.6 (rest of district)*.
- Number of people per residential unit of 3.0*.

*Refer QLDC amendments to NZS4404:2004 dated September 2005.

Table 6 – Domestic Demand

No. of residential allotments	40
No. of residential units (say)	40
No. of people.	120
Estimated demand per person.	700 l/day*
Average daily demand.	84 m^3/day
Peak factor for peak day / average day.	2.35**
Peak daily flow rate.	8.2 m^3/hr
Peak factor for peak hourly flow rate / average daily flow rate.	4*
Peak hourly domestic demand required from reservoir.	3.9 l/sec.

4.2 Existing Infrastructure

The proposed development adjoins the Quail Rise subdivision. Water supply for Quail Rise is provided by the existing reservoir on the south-eastern flank of Ferry Hill.

4.3 Supply Options

4.3.1 Option 1 – Extend the Existing Quail Rise Reservoir

This option involves:

- Improvements to the existing pump station;
- Construction of additional storage at the Quail Rise reservoir to provide capacity for the *Quail Rise Estate Extension Plan Change* development area;
- Construction of a new falling main from the reservoir to the *Quail Rise Estate Extension Plan Change* development area.

One noteworthy point to consider is this: if modifications are made to the Quail Rise reservoir, it could trigger the requirement for the domestic demand to be re-assessed within the existing supply area also. This may lead to the requirement for the reservoir to be

extended to supply the existing Quail Rise allotments (approximately 180) in accordance with the new demand figures as specified in Section 4.1.

For that reason, this is not the preferred option.

4.3.2 Option 2 – Connection to the Proposed Plan Change 19 Reticulation

This option involves a connection to, and an extension of, the proposed reticulation which is to service the Plan Change 19 development area.

After consultation with the Council's engineers and consideration of the option specified above, Option 2 is preferred, as it is likely to:

- Have the lowest capital cost,
- Require the least amount of land,
- Have the lowest ongoing cost to the QLDC;
- Provide the most systematic, area wide solution for water supply.

4.4 Construction Estimates

We would estimate costs to construct the internal pipe network to be around $3,500 per allotment. This would have project cost of around $140K. This excludes any reservoir upgrading works or headworks fees.

4.5 Consents

The preferred option does not involve any bore or intake. On that basis there appear to be no Regional Plan implications.

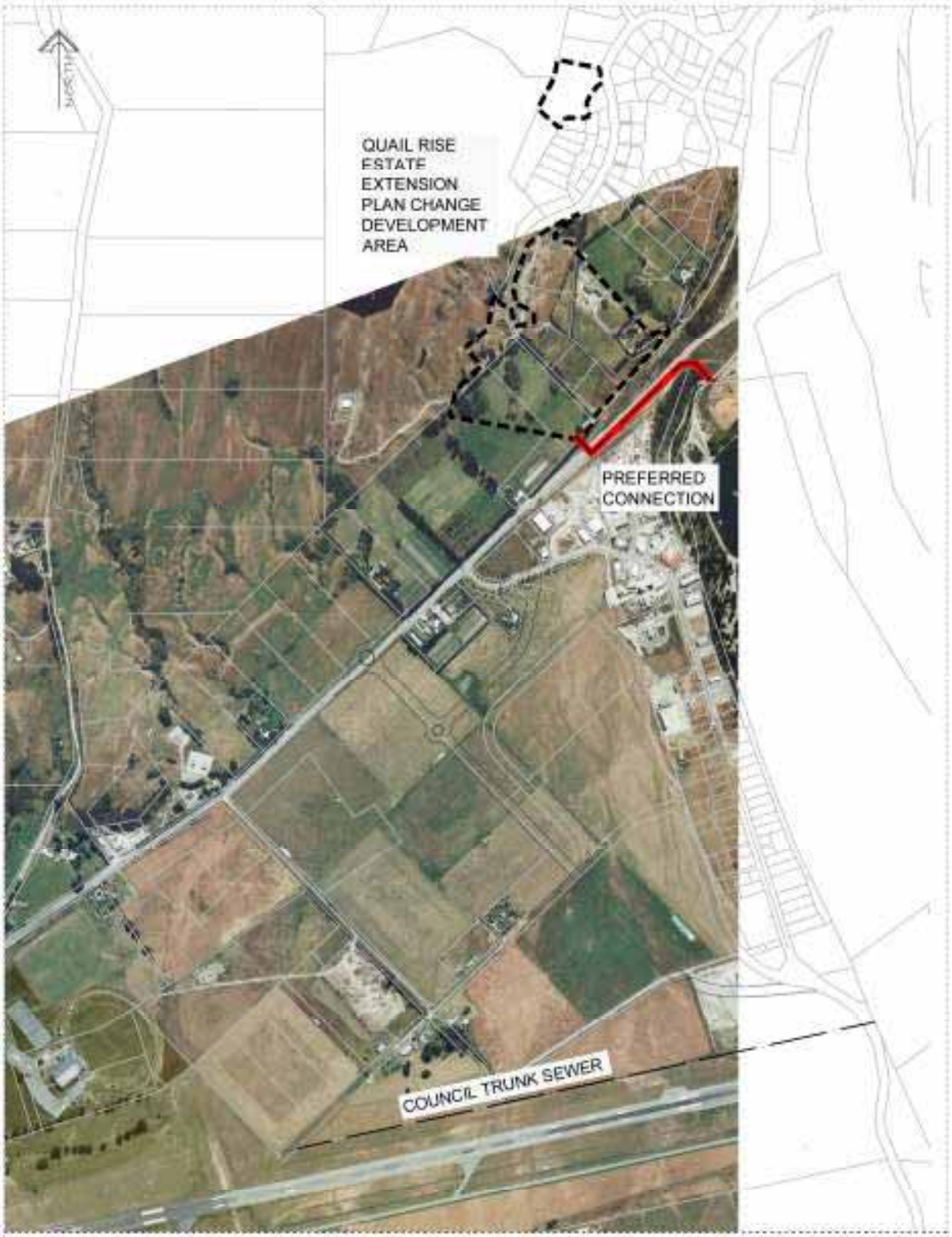
It will be a requirement to obtain engineering approval from the QLDC in relation to the design, specification and construction of the internal pipe network

4.6 Headworks Fees

Headworks fees would be assessed by Council, and levied as part of a development contribution, in accordance with the Local Government Act 2002. At this time, Council's Development Contributions and Financial Contributions Policy (2008/09) demonstrates funding requirements, for water supply, of $3,762 per dwelling equivalent in Queenstown. This equates to a total headworks fee of $150K for 40 proposed residential units. However, it is anticipated that headworks fees would be negotiated with Council during the resource consent application phase of the project.

5.0 APPENDICES

5.1 Appendix 1 – Waste-Water Concept Plan



APPENDIX 1
QUAIL RISE ESTATE EXTENSION PLAN CHANGE
WASTEWATER CONCEPT PLAN

5.2 Appendix 2 – Stormwater Catchment Plan