CPG

Appendices B1-5

CPG Infrastructure Reports

Balmoral Developments (Outram) Ltd

Balmoral Subdivision Development
Infrastructure Services Report
Wastewater, Water and Stormwater

December 2011

Balmoral Developments (Outram) Ltd
Balmoral Subdivision Development Infrastructure Services Report
Water, Wastewater and Stormwater

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Balmoral Developments (Outram) Ltd

Balmoral Subdivision Development Infrastructure Services Report

Water, Wastewater and Stormwater

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1.0 DESCRIPTION OF THE ENVIRONMENT

1.1 Location and Site Description

Balmoral Developments Ltd is investigating the option of developing Lot 2 DP 20759 north east of the Outram Township into a 24 lot residential subdivision.

The proposed development site borders State Highway 87 and is adjacent to the upper end of the Taieri Plain Flood Protection Scheme stopbanking and flood management network as shown in Figure 1.1 below.

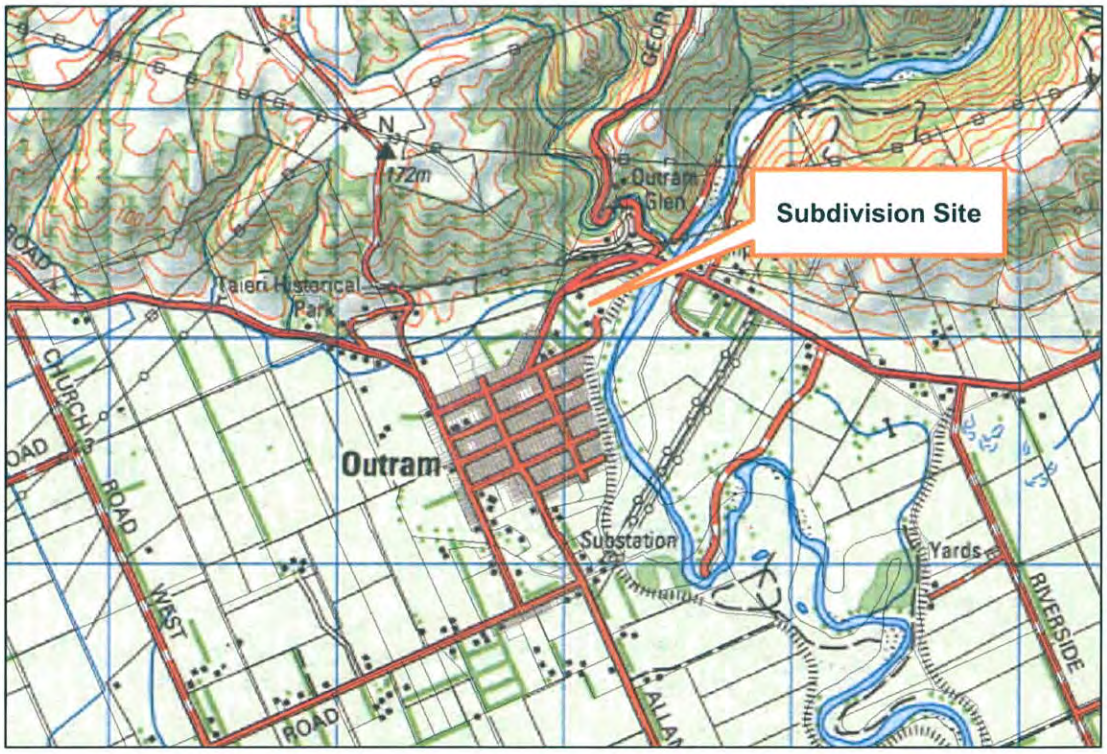

Figure 1.1: Location of Proposed Subdivision

The majority of the site is currently grassed with small outcrops of willows in places. There is a hedge running alongside the existing house access road and a small market garden north of the hedge. The site is bordered by trees and hedges along the northern, south western and eastern boundaries. The elevated Taieri River flood bank runs along the eastern boundary in adjacent land.

1.2 Current Land Use

The current land use of the site is a single historic farm house, a farm shed, a small market garden and the remainder of the site is currently in pasture for grazing.

1.3 Topography

The topography of the land is generally flat. There is however a slight crown to the land in that the western half of the site falls slightly to the west and the eastern half of the site falls slightly towards the south east corner. A difference of 2.73m in elevation was observed across the site.

Water was ponded in the low lying area adjacent to the Holyhead St entrance (Figure 1.2) and according to local residents this area is typically flooded after a heavy rainfall event.

Figure 1.2: View of Holyhead Street entrance and ponded area

1.4 Soils

1.4.1 Overview

Under the Otago Regional Council (ORC) Flood Protection Management Bylaw 2008 the site lies partly within an *Excavation Sensitive Area*. This bylaw prohibits excavation within 20m of the stopbank and the area of the subdivision affected by this rule is identified on the plan in Appendix 4.

The site is also located partly within the Regional Plan: Water for Otago *Groundwater Protection Zone A*. The ORC monitors groundwater levels at Outram, and the levels in the Outram monitoring bore show a rapid response to the Taieri River flows. That is, recharge in this area is predominantly from river recharge rather than rainfall percolating down through the soil profile as is seen in the Mosgiel area.

CPG visited the site on 10 May 2011 to review the site topography and subsoil characteristics. The findings of this investigation are described below.

1.4.2 Site Investigations

Six test pits were excavated across the site to review the subsoil characteristics. Soil profiles are provided in Table 1.1 and illustrated on the layout plan in Appendix 1. Test pit photographs are also provided in Appendix 1.

Table 1.1: **Soil Characteristics**

Test Pit No.	Level (m) Note: Reference point (100.00) taken at driveway entrance by SH87	Depth below ground level (mm)	Description
1	99.91	0-750	Topsoil
		750-1700	Silty loam (Light brown silty soil with finely grained sand)
		1700-2000	Silty loam with well graded coarse gravels (20-60mm)
2	100.52	0-425	Topsoil
		425-650	Sandy loam (Fine to medium grained sand layer)
		650-2900	Silty loam (Light brown silty soil with finely grained sand)
3	100.460	0-580	Topsoil
		580-2600	Silty loam (Light brown silty soil with finely grained sand) Ksat = 0.2m/day
4	100.09	0-550	Topsoil
		550-800	Silty loam (Light brown silty soil with finely grained sand) Ksat = 0.15m/day
		800-2500	Fine to medium grained sand layer
5	99.61	0-600	Topsoil
		600-1400	Silty loam (Light brown silty soil with finely grained sand)
		1400-2900	Clay "pug" layer (wet grey clay) Patches of silty sandy soil
6	97.79	0-700	Topsoil
		700-1700	Sandy loam (Fine to medium grained sand layer)
		1700-3200	Clay "pug" layer (wet grey clay) Patches of silty loam soil Note: Water drained into test pit from surrounding saturated soil and/or local drain

Key Observations

1. Some gravel and sand lenses were present.
2. Deep topsoil layer (range 550-750mm).
3. The silty sandy layer observed across over the site, but present at varying depths (550-2900mm below ground level).
4. Clay "pug" layer not uniform across the site.
5. Moderate permeability at the two locations tested – classed as Category 4 soil in accordance with the Australian/New Zealand Standard *On-site Domestic Wastewater Management* (AS/NZS 1547: 2000).

Given the soil variability discovered during the site inspection, it is recommended that for treated wastewater dispersal design, the Soil Category is confirmed for each property, noting that the lot sizes proposed are sufficiently sized to accommodate a larger dispersal fields if required.

1.4.3 Groundwater

As previously described, the site is located partly within the Regional Plan: Water for Otago *Groundwater Protection Zone A*. The extent of the groundwater protection zone on the site is illustrated on the located on the plan in Appendix 4. Groundwater is protected in this area due the potential risk of surface runoff infiltrating through the alluvial soils into the groundwater.

Groundwater was not encountered in any of the test pits excavated during the site assessment. Local information suggests groundwater is at depths of 5-8m below ground level. It is generally understood that the groundwater in the area flows to the southwest along the river alignment.

1.4.4 Surface Water

The Taieri Rivers runs adjacent to the site and is contained within stopbanks that are part of the local flood protection scheme.

As described above, the topography of the site currently dictates that any surface runoff in the western half of the site falls slightly to the west and is collected by the State Highway water tables and feeds in to the existing Outram stormwater control network. Rainfall falling on the eastern half of the site gradually flows towards the south east corner to the ponding area as shown in Photograph 1.1 above. The water then evaporates or percolates into the ground. During extreme events the water can build up and flow over Holyhead Street into the natural drainage path south of Holyhead Street.

1.5 Climate

1.5.1 Rainfall and Evapotranspiration

Table 1. below presents rainfall data provided by the NIWA Cliflo database. From the climate record, it can be seen that rainfall is relatively constant throughout the year. Potential evapotranspiration (PET) rates are highest in the summer, with the highest monthly average at 155 mm for the month of January.

The data for mean monthly rainfall was taken from the closest recorded meteorological station which is at the Dunedin Airport (NIWA Meteorological Station Network Number I50921 (1971 - 2009)), located approximately 9 km from the site.

Evapotranspiration is the transfer of water to the atmosphere by evaporation and plant transpiration. Potential evapotranspiration occurs when evapotranspiration is at its maximum, in conditions of unlimited moisture supply.

Table 1.2: Climate Statistics at Dunedin Airport (Momona)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean Total Rainfall (1961 – 1990) (mm)	70	50	64	47	61	51	47	45	44	60	51	72	662
Evapo-Transpiration (1971 – 1991) (mm)	126.2	94.6	70.6	41.8	24.8	13.6	16.7	31.5	55.8	82.4	107.6	122.1	787.6
Mean Temperature 1961 – 1990 (°C)	14.9	14.7	13.2	10.6	7.5	5.2	5	6.5	8.6	10.4	12.1	13.8	10.2
Mean Wind Speed (1971 -2011 – 25years of data) (m/s)	4.3	3.8	3.7	3.5	3.8	3.4	3.3	3.5	4.2	4.3	4.4	4.3	3.9

Notes:
Values have been rounded
Units = mm/month

Soil temperature data from Dunedin Airport is presented in Table 1.3 below:

Table 1.3: Soil Temperature

Parameter	Minimum	Average
Monthly Mean Temperature at 50mm	1.3	8.5
Monthly Mean Temp @ 300mm	3.9	11.0

1.5.2 Wind

The mean annual wind speed is 3.9m/s or 14km/hr. The mean monthly wind speed does not vary significantly from month to month with the maximum of 4.4m/s in November and a minimum of 3.3m/s in July.

2.0 WASTEWATER

2.1 Background

The proposed development is located on the edge of the Outram township. Currently all Outram residences dispose of their wastewater via on-site septic tanks and disposal fields as there is no reticulated wastewater system.

In discussions with Dunedin City Council staff there is currently no intention to build a reticulated sewerage system for Outram in the near future. As a result it is intended that the proposed Balmoral development follow a similar approach to the treatment and disposal of their wastewater.

2.2 Wastewater Flows

Each property (Lot) has been conservatively assessed in terms of a 4 bedroom dwelling and maximum 6 person occupancy. The design wastewater flow has been calculated as shown in Table 2.1 below.

Table 2.1: Design Flows

Maximum Occupants	Per Person Design Flow Allowance	Design Flow
6	180Litres/day	1080Litres/day

Note that wastewater flows can be reduced significantly if water conservation measures are adopted within households.

2.3 Wastewater Treatment

Given the site lies partly within a groundwater protection zone, conventional primary wastewater systems (septic tank only and soakage trenches) are not considered suitable. Additionally, discharge of sewage onto land within a groundwater protection zone is a discretionary activity under the Regional Plan: Water for Otago and therefore requires an approved resource consent application. It is expected that the ORC will likely require all wastewater to be treated to an advanced secondary standard prior to dispersal into the receiving environment.

Given the likely ORC requirements, and for sustainable long term performance of wastewater dispersal systems, advanced secondary treatment of the wastewater is therefore recommended. It is further recommended that recirculating packed bed reactor (PBR) technology, such as recirculating textile filters (e.g. Advantex™ and Texass™), be used.

It is intended that all lot owners be required to install wastewater treatment systems with secondary treatment prior to dispersing the treated effluent to land. Examples (brochures) of possible secondary wastewater treatment plants are provided in the Appendix 2.

2.4 Treated Effluent Dispersal

As noted above, test pits were dug on site to assess the soils. Two plate permeameter tests were also performed in two of the test pits on the silty layer immediately below the topsoil layer to assess the permeability of the soils that would be receiving the treated wastewater. Copies of the permeability test results are presented in Appendix 1.

The permeability test results indicate that the Ksat of the receiving layer to be between 0.15m/day and 0.21m/day. This equates to a Category 4 soil – clay loam, under the classification system set out in AS/NZS1547:2000 - On-site domestic wastewater management.

It is recommended that pressurised drip lines laid approximately 200mm below the ground surface be used in each of the lots for treated effluent dispersal. Dripper irrigation is considered the most suitable option in this environment for the following reasons:

- Slow rate irrigation in the topsoil promotes Nitrogen uptake by plants;
- Irrigation lines can be placed within garden areas;
- Promotes even distribution of effluent across the site.

Based on the adoption of a pressurised drip line system of dispersal and taking into consideration the requirements under AS/NZS1547:2000, the size of the recommended dispersal field area for each lot has been calculated as shown in Table 2.2 below.

Table 2.2: Dispersal Field Size

Effluent Dispersal System	Design Flow (L)	Loading Rate (mm/day)	Nominal Design Area (m^2)	Add Reserve Area (m^2)(1)	Total Effluent Dispersal Area (m^2)
Drip line	1080	3.6	300	90	390

(1) A reserve area (usually equivalent to 30% of the design dispersal area) that is suitable for effluent dispersal should be site aside for future expansion of the dispersal field.

It should be noted that the size of the treated wastewater effluent dispersal areas has influenced the size of the lots proposed in this development to ensure that wastewater systems will provide sustainable long term performance.

As the lots on the eastern side of the development will encroach onto the Groundwater Protection Zone A, it is fully expected that they will require resource consents for discharge of treated wastewater to land.

Furthermore as the same lots along the eastern boundary also encroach within 20m of the stopbank and being within an "excavation-sensitive area" they may also be restricted from any excavation under the Otago Regional Council (ORC) Flood Protection Management Bylaw 2008, Section 3.2 (g). In order to excavate for installation of a dispersal field authority would be required from the ORC. As a result they may elect to place their on-site wastewater treatment and disposal systems outside the 20m zone. ***The size and location of the proposed lots has taken this into consideration.***

2.5 Assessment of Environmental Effects

2.5.1 Assessment of Alternatives

The following options have been considered as alternatives to the proposed on-site wastewater treatment systems including:

1. **Primary Treatment of Effluent Only**
   Due to the proximity of protected groundwater zone primary treatment is not considered acceptable and thus a secondary treatment and dispersal to land is deemed the most appropriate option for this site.

2. **Connection to Outram's Municipal Sewerage System**
   There is no such facility available.

3. **Combined On-site Wastewater Systems for Entire Development**
   Based on the requirement to use one of the lots at the lowest point to collect and buffer stormwater flows it is considered that a combined wastewater treatment and disposal field could be compromised and would not make best use of the land available for development. The size of the lots proposed has taken a long term sustainable approach to the implementation of wastewater treatment and disposal.

No significant environmental effects have been identified and therefore alternative locations or treatment methodologies have not been investigated further. The proposed system is considered to be the best practicable option for the site.

2.5.2 Assessment of Environmental Effects

The Fourth Schedule of the Resource Management Act sets down matters that should be included in the assessment of effects on the environment. Matters relevant to the Balmoral Development site include:

- **Description of the Proposal**
  A description of the proposal is presented earlier in this document.
- **Significant Environmental Effects and Alternatives**
  There are a number of feasible options for treatment and dispersal of wastewater; the focus has been on achieving the most sustainable approach.
- **Assessment of Actual or Potential Effects**
  No potential environmental effects have been identified.
- **Community and Cultural Effects**
  No effects have been identified in relation to neighbouring properties or the community; no cultural effects have been identified.
- **Physical Effects**
  No physical effects on the locality or landscape, including visual effects (the system will be below ground) have been identified. The dispersal areas will be constructed to blend sympathetically with the surrounding landscape, and the dispersal systems will enhance vegetated areas by providing irrigation.

- **Ecosystems**
  No adverse effects on ecosystems, including plants and animals living in this habitat, have been identified in this assessment.
- **Natural Physical Resources**
  No adverse effects have been identified in this assignment regarding the natural and physical resources present in the vicinity of the development.
- **Risk Management**
  Under this assessment, no risks have been identified that will affect the neighbours or the wider community, and no hazardous installations are proposed.
- **Discharge**
  No adverse effects have been identified in the proposed discharge of treated effluent.
- **Mitigation Measures**
  Mitigation measures to protect against failure of the system or discharge of wastewater contaminants to the environment will include the following:
  - Requirement for regular servicing to ensure the systems continue to operate in a safe and effective manner.
  - A minimum of 24 hour emergency storage at peak flows within the treatment tank.
  - Low effluent loading.
  - No construction of wastewater systems within restricted excavation areas as described above.
- **Consultation**
  No consultation has been undertaken at this point, as it is considered that there are no potentially affected parties, due to the mitigation measures described above.
- **Monitoring**
  No monitoring is considered necessary.

2.6 Wastewater Infrastructure Summary

A summary of the wastewater concept for the proposed development is presented below.

(i) Each house is to have a wastewater treatment plant complete with secondary treatment.
(ii) Each house is to have a dispersal field with an area of at least 390m^2 with subsurface dripper irrigation.
(iii) Wastewater treatment and dispersal systems for each property should be designed and consented.

3.0 WATER SUPPLY

3.1 Water Supply System Design

The sizing and layout of the water supply network depends on the number of houses that are to be built on the site. The following aspects relating to the water supply have been investigated to determine the required water supply system:

- Population (i.e. number of dwellings and population figures)
- Water demands – both peak and fire fighting requirements
- Water storage
- Quality of the water
- Reticulation network

As the proposed development is located in the Dunedin City Council territorial area, the water supply system must be designed in accordance with the Dunedin Code of Subdivision and Development – August 2010.

3.2 Existing Water Supply System

The water supply to the Outram community is sourced from a bore located in the gravels next to the Taieri River (upstream of the subdivision). The raw water is pumped up to a treatment plant located next to a 2,273m^3 treated water reservoir A 150mm diameter pipeline transports the treated water from the reservoir to the Outram Township and surrounding settlements - see Figure 3.1 below.

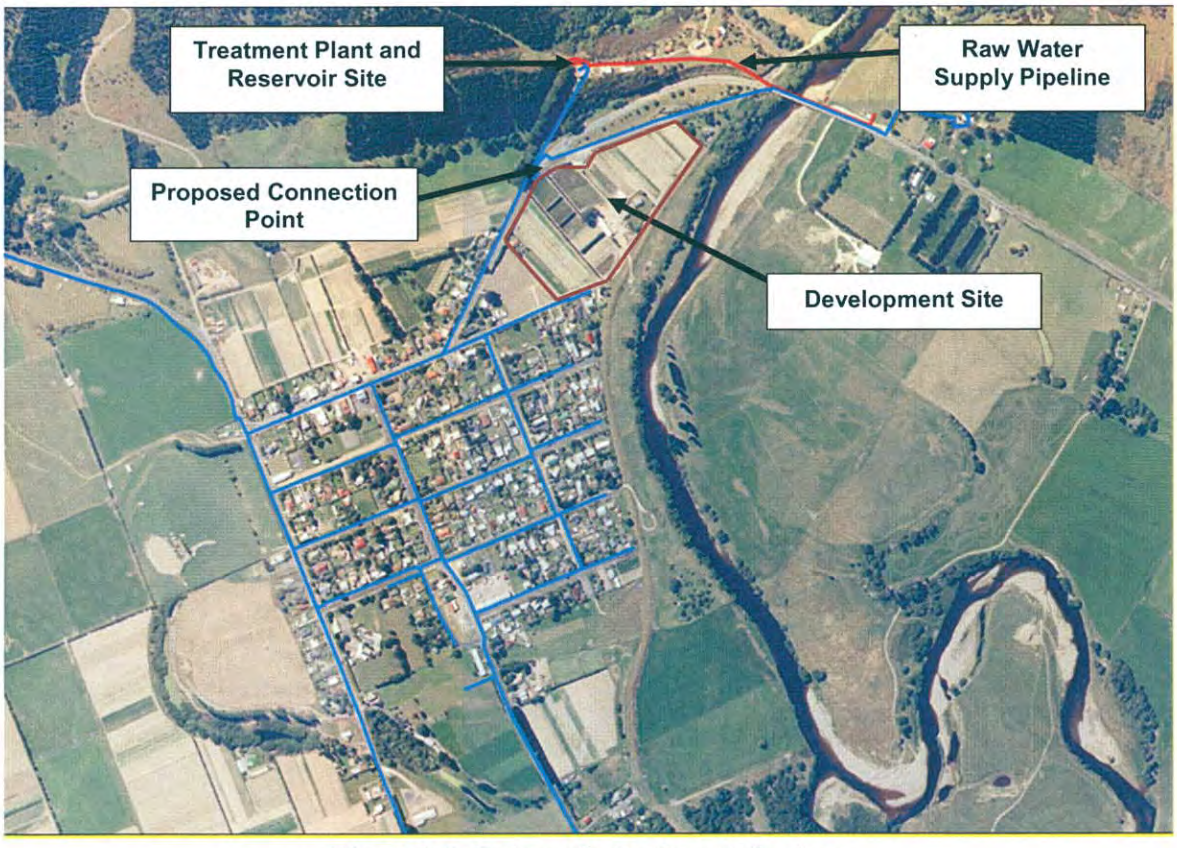

Figure 3.1: Outram Water Supply System

3.3 Peak Domestic Water Supply Demands

The existing Outram population connected to the Outram water supply is recorded as being 750 persons in the Ministry of Health Register of Drinking Water Supplies - 2011.

Based on the Dunedin City Council Code of Subdivision - August 2010 the minimum peak domestic water demand for the Outram supply including the 24 lots proposed for this development is calculated below.

{750 + 24 lots x 3 persons/lot} x 250 l/person/day x 5 peaking factor = 1,027,500 l/day

This figure equates to an estimated peak flow of 11.9 l/sec.

The extra demand imposed by the subdivision is estimated to increase the peak flows by 9.6%.

This flow will be able to be conveyed easily down from the treated water reservoir by the existing 150mm dia. treated water main. The total township peak flow rate including the proposed development equates to a pipeline flow velocity of 0.67m/sec which is well within the flow capacity of the pipeline.

It is proposed to connect to the existing trunk main coming down the hill from the reservoir with a 150mm dia. PN16 Series 2 uPVC water main in compliance with the DCC standards as shown in the plan presented in Appendix 3. The new 150mm dia. reticulation will feed into the development to supply potable water to the lots and fire hydrants.

3.4 Fire Fighting Flows

As noted in the Dunedin City Council Code of Subdivision - August 2010 the water reticulation is also required to meet the flow and pressure requirements of SNZ PAS 4509 – NZ Fire Service Firefighting Water Supplies Code of Practice - 2008. Based on the requirements of Table 2 in the code and taking into consideration the types of dwellings proposed in this development the water supply must be able to provide a total flow of 25 l/sec from two hydrants at a minimum pressure of 100kPa.

It is proposed to locate the new 150mm dia. water main in the development with the appropriate number of hydrants to ensure that they meet the minimum spacing requirements as determined by the code. The hydrants will be located no further away than 135m from any building and no more than 270m apart. A plan showing the proposed water reticulation is presented in Appendix 3.

Based on the size of the trunk water main, the close proximity to the treated water reservoir and the size of proposed new pipeline at the development, the flows and pressures required by the Fire Fighting Code of Practice will be easily met.

3.5 Water Storage Requirements

Water storage is required to cover treatment plant failure and other supply interruption scenarios as well as providing a residual volume for fighting fires.

Based on the existing population including the proposed development the existing Outram treated water reservoir storage equates to 11 days storage at average daily flows.

i.e. 2,273m^3 / {750 + 24 x 3} x 0.25m^3/day = 11 days storage

This is more than enough to cope with any malfunction in the raw water supply system or water treatment plant.

In regards to the fire fighting reserve the NZ Fire Service Code of Practice requires 45m^3 of water storage for this type of development. This again is well below the amount of storage provided by the existing Outram treated water reservoir.

3.6 Drinking Water Quality Requirements

The Dunedin City Council Code of Subdivision - August 2010 requires that any new components connected to a water supply must be capable of providing potable water in compliance with the Health (Drinking Water) Amendment Act.

The quality of the water currently being supplied to Outram residents does not currently meet the New Zealand Drinking Water Standards. Under the Health (Drinking Water) Amendment Act the water supply authority (Dunedin City Council in this case) have a period of time to upgrade the supply to consumers. It is understood that the DCC currently have an upgrade of the treatment plant in their programme of impending works and will be adding UV disinfection to the existing plant in due course.

Given the impending upgrade of the existing treatment plant it is recommended that the proposed development connect to the existing water supply scheme as noted above. It is assumed that the treatment upgrade will most likely occur before a significant number of houses have been built and that it is therefore not necessary to provide any further water treatment to the new consumers in the interim.

3.7 Water Supply Infrastructure Summary

A summary of the water supply concept for the proposed development is presented below.

(i) Connect to the existing Outram water supply trunk main coming down the hill from the reservoir where it meets the main road leading into Outram.
(ii) Supply and install a 150mm dia. PN16 Series 2 uPVC water main into the development feeding the hydrants and smaller house water supplies as shown on the plan presented in the Appendix 3.
(iii) Supply and install enough fire hydrants on the new water main to meet the requirements of SNZ PAS 4509 – NZ Fire Service Firefighting Water Supplies Code of Practice - 2008.
(iv) Do not install any further water treatment devices. – This does not preclude individual lot owners to install their own Point of Use treatment systems.
(v) Do not provide any additional water storage.

4.0 STORMWATER

4.1 Introduction

This section of the report describes the stormwater runoff conditions that exist on the Balmoral development site and the stormwater management measures proposed for the development.

4.2 Stormwater Environment

4.2.1 External Catchments

The proposed development site lies in the former flood plain of the Taieri River outside the stopbank that now protects the site and Outram from flooding from the river. Mountford Street (SH 87), and the land above and north of SH87, on the western and north-western boundary of the site, drains to the west via a drain that lies close to the toe of the hills above Outram and is referred to as "West Drain" in Figure 4.1. A site layout plan showing the features of the vicinity of the site, the lot boundaries and the stormwater catchments is included in Appendix 4.

An urbanised area outside the south-western boundary of the site adjacent to Holyhead Street currently drains into the site and ponds on Lot 25 which also receives runoff from approximately 52% of the area within the site. The ponded stormwater infiltrates gradually from the pond to the groundwater table that is typically 5m to 8m below ground surface in the Outram area. All areas to the south and west of the site drain to in the "Contour Channel" that flows into Lake Waipori that is 15km southwest of Outram. During extreme events the pond that forms on Lot 25 overflows across Holyhead Street and the overflow joins the natural drainage path through Outram to the southwest. The overflow across Holyhead Street has a frequency of approximately once every 10years (10 year Average Return Interval (ARI)). The landward side of the stopbank on the east boundary of the site drains to Lot 25 but the eastern side of the stopbank drains to the Taieri River.

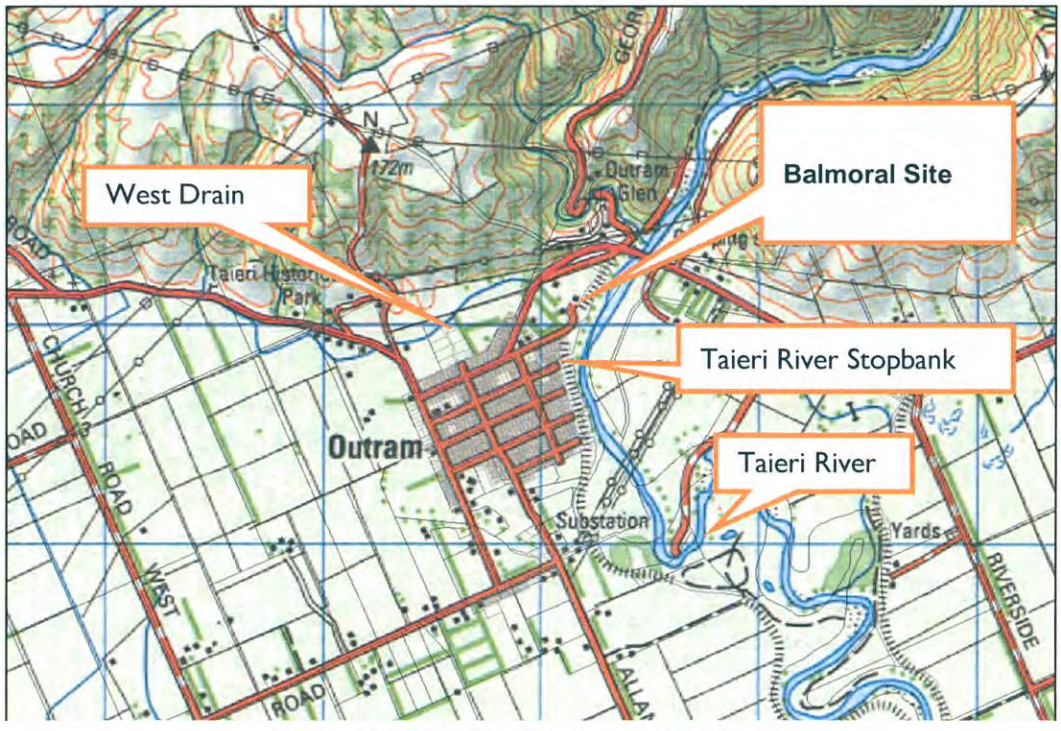

Figure 4.1: Existing Stormwater Features

The existing external catchments draining into the site are therefore limited to the face of the stopbank to the east and the small urban area on the northern side of Holyhead Street.

4.2.2 Site Catchment

Within the site, 52% of the site, referred to as the "East Catchment", drains to Lot 25 and the remaining 48%, referred to as the "West Catchment" drains to a culvert under SH87 on the western boundary of the site. Apart from some existing farm buildings and a historic house the catchment within the site is either grass or market garden. The soils over the site are generally silty sandy loams to a depth of up to 3m and therefore this soil layer is of relatively low permeability and consequently the natural infiltration to the underlying groundwater aquifer is slow. Permeability tests on the soils classified the soils as a "Clay loam". The cohesive and well graded nature of the soil means that the permeability is less than the "silty sandy loam" texture description would normally suggest.

Since the urban area adjacent to and on the northern side of Holyhead Street, the East catchment, a neighbouring property to the northeast of the site and the face of the stopbank all drain to the depression on Lot 25, the volume of water that collects there is significant and the volume of runoff would be increased to a limited extent by the increase in the impermeable area that would result from the proposed development.

A Stormwater Management Concept Layout plan is included in Appendix 4.

4.2.3 Groundwater Conditions

The depth to groundwater of 5m to 8m referred to above has been observed by Mr Brownlie, a local plumber, who has installed many of the septic tanks in the Outram Township. The test pits as part of the site investigations for assessing the options for wastewater disposal were up to 3m deep and as expected did not reach groundwater.

Information from the ORC for the "Outram Bore" records that under normal climatic conditions groundwater is typically 5m below ground at the site of the bore on the corner of Orme Street and Allanton Road. When there is significant rainfall that results in a flood down the Taieri River the groundwater table quickly responds. The response of the groundwater level to flood water levels in the Taieri River can be seen in Figure 4.2 below.

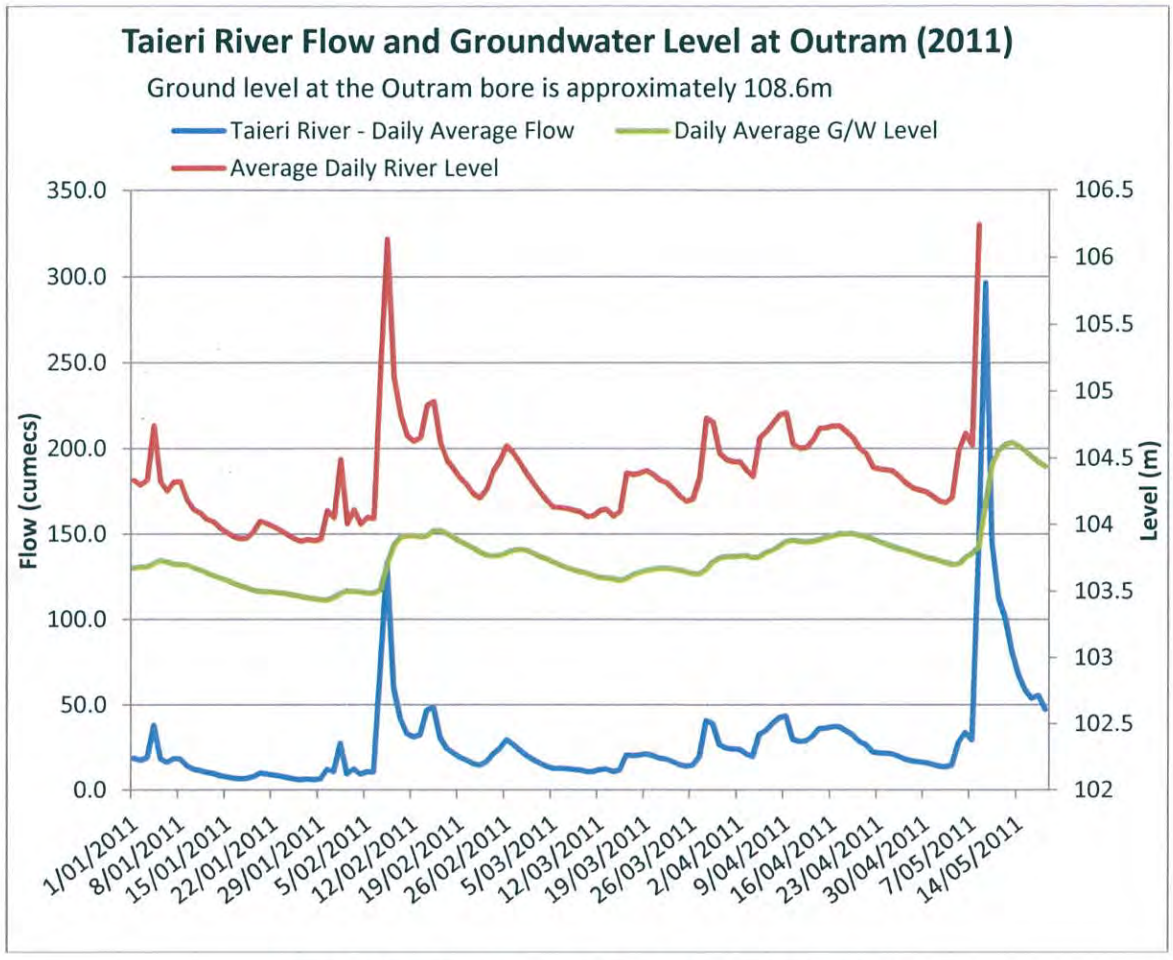

Figure 4.2: Taieri River Flow and Groundwater Data

4.2.4 Taieri River Flood Conditions

The flood hazard posed by the Taieri River is detailed in the report "Balmoral Developments (Outram) Ltd - Balmoral Subdivision Development - Flood Hazard Taieri River" prepared by David Hamilton and dated 5 December 2011. The conclusion with regard to the flood hazard at the site from this report is as follows:

"The capacity of the Taieri River floodway past the site is approximately 3,500 m^3/s before the spillway at the upstream end of the development site would commence operation. The 1% AEP (100 year return period flood event is currently assessed as 2,350 m^3/s and with climate change is expected to increase to about 2,725 m^3/s. The current protection standard is in excess of a 0.2% AEP (1 in 500 year return period) flood event."

Further, in relation to stormwater, the report notes that the peak flood flow in the river adjacent to the Balmoral site is due to the response to rainfall in the lower part of the Taieri River catchment generally down gradient from the Maniototo basin. The straight line distance from Outram to the lower Maniototo basin at Kokonga is 75km which means that the peak flow in the river at Outram is likely to occur at least 12hours after peak rainfall. The report notes that Traquair Stream that has a 100year Average Return Interval (ARI or 1% Annual Exceedence Probability (AEP)) flow of 94m^3/s and enters the Taieri River just upstream of the site, contributes less than 1% of the peak flood flow at Outram. This means that runoff from local

Outram catchments draining directly to the Taieri River would enter the river long before the upper catchment peak Taieri River flood flow arrives at Outram.

4.3 Regulatory Requirements

4.3.1 Otago Regional Council

Otago Regional Plan Water

The discharge of stormwater to water from a reticulated stormwater system to water, or onto or into land in circumstances where it may enter water is a ***permitted*** activity under the ORP: Water. Under Rule 12.4.1. The following items must be considered as part of the stormwater discharge decision:

(a) *Where the system is lawfully installed, or extended, after 28 February 1998:*
- *(i) The discharge is not to any wetland identified in Schedule 9; and*
- *(ii) Provision is made for the interception and removal of any contaminant which would give rise to the effects identified in Condition (d) of this rule; and*

(b) *The discharge does not contain any human sewage; and*

(c) *The discharge does not cause flooding of any other person's property, erosion, land instability, sedimentation or property damage; and*

(d) *The stormwater discharged, after reasonable mixing, does not give rise to all or any of the following effects in the receiving water;*

- *(i) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or*
- *(ii) Any conspicuous change in the colour or visual clarity; or*
- *(iii) Any emission of objectionable odour; or*
- *(iv) The rendering of fresh water unsuitable for consumption by farm animals; or*
- *(v) Any significant adverse effects on aquatic life.*

Flood Protection Management Bylaw 2008

The ORC Flood Protection Bylaw sets out the requirements for protection of the Taieri River Stopbank that exists on the east boundary of the site. An important consideration is a 20m wide zone along the toe of the stopbank where excavation may be prohibited for the construction of drains within 20m of the "excavation-sensitive areas" without the prior authority of the ORC. This prohibition on excavation extends over significant areas of Lots 15 and 16 and Lots 22 to 25.

4.3.2 Dunedin City Council

Dunedin City Council sets minimum standards and requirements for residential subdivision in the Dunedin Code of Subdivision and Development 2010 (DCSD). The code requires that the design and construction of stormwater systems be undertaken in accordance with the requirements of Part 4 of NZS 4404:2004 except as amended and extended by the Dunedin City Council document.

Section 4.3.2.5.1 of the amended code requires that primary stormwater infrastructure be designed for a 10year ARI storm. Primary protection in areas where secondary flow paths are not available or for secondary flow paths through private property then a 100year ARI design storm is applicable.

Under Section 4.3.2.5.2 a freeboard of 0.5m is required in addition to computed flood level for habitable floor levels and 0.3m freeboard is required for commercial and industrial buildings.

4.3.3 Building Act

Any proposed alteration to flood levels in a stream in the vicinity of buildings is subject to the requirements of the Building Act (1991). The Building Act requires that a 50 year ARI flood event does not enter habitable building areas and that a 10 year ARI does not cause nuisance or damage to property. The flood protection requirement for habitable building areas in the Building Act is surpassed by the requirements for freeboard required by the DCSD set out in Section 4.3.2.

4.4 Existing Stormwater Infrastructure

The existing infrastructure includes road side open water table drainage on the northern side of Holyhead Street that drains to Lot 25, an open water table drain along the toe of the outer batter and shoulders of the SH87 road formation. The toe of batter and water table drainage along SH87 is intercepted and drained at two locations on the southeast side of the road to the West Drain on the northwest side of the SH87 road formation. There is a mixed piped and open channel stormwater drainage system through Outram that starts on the south side of Holyhead Street adjacent to Lot 25. The disposal of stormwater in Outram is a mix of infiltration to ground and conveyance to a stormwater detention area west of the township.

The level of flood protection from floods in the Taieri River provided by the stopbank on the eastern boundary of the site is not included in the scope of this report.

With the exception of the depression on Lot 25 there is no significant stormwater infrastructure on site that would be retained in use in the future development of the site.

4.5 Proposed Stormwater Management Concept

4.5.1 Potential Development Stormwater Effects

Stormwater would be generated from additional roofs of residential buildings, roads, footpaths and hard-standing areas as a result of the development and therefore the proposed development without the proposed mitigation infrastructure would increase the peak runoff rate and runoff volume.

An analysis of the site assuming that the impermeable area per lot would be 200m^2 for a dwelling and attendant buildings, 100m^2 for paved areas including driveways and outdoor living areas, sealed carriageways for the roads and footpaths would result in the impermeable area being 18% of the total area of the site. The area per lot varies from 2,000m^2 to 3560m^2.

The effect of the increase in impermeable area as a result of the development will be mitigated by providing a stormwater management concept that includes features such as swales, detention ponds and a small pump station and rising main.

4.5.2 Stormwater Management Concept

As noted in Section 4.2.2 the topography of the site creates two catchments; the East Catchment that drains to the depression in Lot 25 and the West Catchment that drains to the West Drain. In addition to the East Catchment that drains to the depression in Lot 25 three external catchments also drain to the depression and these are:

i. The stopbank on the eastern boundary referred to as the "Stopbank" catchment.
ii. The existing property on the northeast boundary referred to as the "Neighbour" catchment.
iii. Part of the urban area adjacent to the southwest boundary of the site referred to as the "External Urban" catchment.

The post development stormwater management concept includes the components for the East and West catchments described in Table 4.1. Refer to the Appendix 4 for the layout of the stormwater management concept.

Table 4.1 Post Development Stormwater Management Concept

Catchment	Stormwater Management Concept
East Catchment The East catchment is divided into "East 1" and "East 2" sub-catchments.	**Stormwater Flow Collection** i. For the East Catchment the discharge of stormwater would be without on lot detention storage from all lots to the depression on Lot 25 referred to further as the East Area Detention Pond (EDP). ii. The EDP would receive runoff from the East Catchment within the site plus the Stopbank, External Urban Area and Neighbour sub-catchments including a sealed ROW to lot's 2 and 5 iii. The existing drainage along the toe of the Taieri River stopbank would remain essentially unchanged. **Stormwater Disposal Options** iv. Two stormwater disposal discharge options were considered for the EDP: **a. West Drain Discharge Option** - natural infiltration to the ground as occurs now and a pump station for discharge to the West Drain at nominally 15 litres per second (l/s) ; or, **b. Taieri River Discharge Option** – as for option a. above but the pump from the EDP would discharge directly to the Taieri River at 15l/s. **West Drain Discharge Option** v. The EDP would detain the increased runoff from the developed site including runoff from the Stopbank and Neighbour catchments on the northern side of Holyhead Street. vi. For flood events up to the 10year ARI storm rainfall the pump station in the EDP would defer pumping runoff in the pond to the West Drain until 12hours after the peak water level is reached. This is intended to avoid any adverse effects on the West Drain beyond the site while also minimising damage to grass and vegetation in the EDP. vii. For a 100year ARI design rainfall event the pump would provide a constant discharge to the West Drain such that the total flow from the EDP catchment and the West Catchment Area to the West Drain is no greater than under the pre-development scenario. For the design 100year ARI event the total post-development peak flow to the West Drain will be 195 l/s which is less than the pre-development peak flow (197 l/s). viii. Adopting the pre-development peak flow as the maximum flow, the design pump capacity is 15l/s being the approximate difference between the pre-development flow of 197l/s and post development

	peak flow for the 100year ARI storm event of180l/s. The reduction in the post development peak flow from the West Catchment is achieved by specifying slightly more detention storage for the lots in the West Catchment than strictly required to achieve stormwater neutrality. **Taieri River Discharge Option** ix. For all rainfall events the pump would begin to operate as soon as the EDP meets its minimum operating level equivalent to a designated pond empty water level. x. The 15l/s flow would have no adverse effect on the flow regime in the Taieri River at the site or downstream. (The 100yr ARI peak river flow is estimated to be 2,725,000l/s.) xi. Installation of the rising main from the pump station to the river would require installation of a pipe through area where excavation is prohibited without ORC approval including over the stopbank formation. The pipe would be shallow and the pipe outlet would be designed and located so that there is no erosion or other adverse effects on the river flood berm and banks. **Pump Station** xii. The pump station for both the West Drain and Taieri River discharge options would be located outside the Excavation Prohibited area and where the drainage of the pond floor can be achieved with a minimum of earthworks. An indicative location is shown in Drawing 704132: Sheet SW01 in Appendix 4. **East Area Detention Pond** xiii. To contain the 100year ARI event the existing pond that would become the EDP would be increased in size. Excavation to increase the size of the existing pond would be outside the area along the toe of the stopbank where excavation is prohibited. The EDP would be a grassed and landscaped area available for recreation (except during flood events).
West Catchment The West catchment is divided into "West 1" and "West 2" sub-catchments.	xiv. **Collector System** A piped collector system would be provided as the primary drainage system with a minimum capacity to carry the 10year ARI storm event. xv. **Lot Detention Storage** Detention storage on each lot would be required to offset the effects of the increased post development flows. Preliminary calculations indicate that the detention volumes for the 100year ARI event would be 6.5m^3 per lot (m^3/lot) (6500 litres/lot) for the West 1 catchment and 4.2m^3/lot (4,200 litres/lot) for the West 2 catchment. The difference is due to the shorter time of concentration for the West 1 catchment over the West 2 catchment. xvi. **Permissible Discharge** The detention storages on each lot would be designed to provide the permissible discharge for the 10year and 100year ARI storm events respectively. (The permissible discharge for the 100year ARI event is greater than for the 10year ARI event.) The discharge from the lot would be via a sump that would allow a permissible discharge to leave the lot to the stormwater system. Each sump

	would discharge to an open channel or piped stormwater collector or secondary overland flow path. xvii. **Secondary Flow Paths** Flows in excess of the 10year ARI event would flow overland using constructed surface swales and roadways (Lot 26) including Rights of Way (ROW) to the off-site drainage network under SH87. xviii. **Access Way Drainage** For Lot 26 and a reciprocal ROW that would serve Lots 3, 4, 7, 8 and 9 would be provided with a sealed surface and water table drains.

4.5.3 Preferred East Catchment Stormwater Disposal Option

As described in Table 4.1 there are two possible stormwater disposal options for stormwater from the East Catchment Detention Pond (EDP) with disposal being either to the West Drain or to the Taieri River.

A third "Status Quo" option was rejected without detailed consideration. The Status Quo option was to provide for lot detention storage in the East Catchment and let the extreme event secondary flows continue to flow down gradient through the existing Outram stormwater system. This would perpetuate the existing long duration ponding problem on Lot 25 and therefore it was seen as desirable to install a pump to reduce future issues with the existing and future pond.

Assuming that an acceptable design for the rising main can be agreed to with the ORC to mitigate any risk to the Taieri River stopbank then the Taieri River disposal option has the following advantages:

i. The potential for any adverse effect on the capacity of the West Drain is avoided.
ii. There is no significant effect on the Taieri River flood regime that would be the result of pumping 15l/s to the river. The discharge to the river would initiate of the order of half a day before the flood peak from the Taieri River would arrive at the site.
iii. The proposal offers a solution that would be of benefit to the Outram. During extreme storm events water would be confined to the site instead of flowing down gradient and surcharging the Outram stormwater system.
iv. The EDP would be emptied at a greater rate and therefore the risk of damage to grass and plantings around the proposed detention pond would be significantly less that for the West Drain disposal option.

The preferred stormwater disposal option for the East Catchment is therefore to pump stormwater runoff from the EDP over the stopbank to the Taieri River.

4.5.4 Effects Assessment Methodology

The pre-development and post development peak flow from the East and West catchments were calculated using hydrological modelling software (HEC-HMS) to account for the storage proposed in Lot 25 and in the West 1 and West 2 catchments to offset the increased imperviousness as a result of development.

The peak flood flows were estimated using the United States Soil Conservation Service rainfall loss / runoff method and the SCS unit hydrograph method. Both the loss and unit hydrograph methods are included in the US Army Corp of Engineers HEC-HMS hydrological software suite.

The SCS method calculations for the predevelopment scenario were checked against the modified Rational Method where good agreement was found for the 10year ARI event.

Catchment Data

The silty sandy soil texture and relatively low permeability of the topsoil and sub-soil layers meant that the Soil group D and a grassed catchment condition was chosen to provide a Curve Number (CN) value of 75. The CN equal to 75 was adopted for the loss calculations for the pre- and post-development scenarios consistent with grazing and market garden use now and low density urban use for the post-development land use. A summary of the catchment data is shown in Table 4.2 below.

Table 4.2: Site Catchment Analysis

Catchment	Catchment Area (m^2)	% of Site Area	Post Development % Impervious
West Catchment area	30,390	48%	18%
East Catchment area	33,372	52%	14%
Total Site Area	**63,762**		

The hydrological calculations assume a total site catchment area of 63,762m^2 (6.4 hectares (ha)) determined using Johnston Whitney "Schematic Proposal" (Paterson Pitts Partners Ltd drawing - Job Ref:30-688, Sheet 4 of 4, June 2011).

Rainfall Data

HIRDS Version 3 data for a climate change scenario for a 0.7 to 1.1 °C increase in temperature out to 2040 was adopted to generate the design rainfall depth – duration - ARI data for the model computations. The 2040 storm rainfall profiles for the 10year and 100year ARI events were adopted for both the pre and post development catchment conditions.

The land within the site is relatively flat and therefore times of concentration are accordingly relatively long. The time of concentration for East and West catchments was estimated to be between 49 and 53 minutes in the predevelopment condition and 39 to 44 minutes in the post development condition. The peak rainfall in the model was set to occur at 50% of the storm duration. Use of the SCS design storm rainfall distribution method in this case means that a 100 year ARI short duration peak rainfall coincides with the respective 24 hour duration 100 year ARI rainfall depth. The coincidence of a 100 year ARI 12 hour duration and a 100 year ARI 30 minute duration peak rainfall depth was considered the most appropriate extreme event case for the relatively small sub-catchments that include storage elements.

Model Elements

The HEC-HMS modelling software enables the rainfall runoff process to be modelled for a "sub-basin" being a total catchment represented by a number of sub-catchments joined by a network of channels and storages. The pre-development condition was modelled as two catchments being the East and West catchments plus the relevant external catchments being the "External Urban" (northern side of Holyhead Street), the "Stopbank" and "Neighbour" catchments that drain to the East catchment.

The post-development condition was based on the pre-development model except that the West catchment was broken down into two sub-catchments West 1 and West 2 and a storage element was added to model detention storage in each sub-catchment with the increase in imperviousness in the West 1 and West 2 sub-catchments. The East catchment was represented as the East 1 and East 2 sub-catchments and the imperviousness was increased to

represent the post – development condition. The imperviousness was not increased for the Stopbank, External Urban and Neighbour catchments.

4.5.5 Hydrological Analysis Results

The preliminary design estimates of peak flow for the pre and post development scenario and storage requirements for the West catchment are set out in Tables 4.3 and 4.4 below.

Table 4.3: Pre and Post Development Scenario Flow Estimates

Peak Estimated Stormwater Runoff Flow (l/s)										
Pre-Development						Post-Development				
East Catchment			West Catchment			East Catchment			West Catchment		
Sub-catchments	10 yr ARI	100 yr ARI	Sub-catchments	10 yr ARI	100 yr ARI	Sub-catchments	10 yr ARI	100 yr ARI	Sub-catchments	10 yr ARI	100 yr ARI
Catchment	76	218	Catchment	69	197	East 1	42	106	West 1	25	88
Road	10	30				East 2	42	120	West 2	37	128
Neighbour	11	32				East 3		36			
External Urban	17	48				External Urban	30	69			
						Neighbour	18	43			
Stopbank	11	39				Stopbank	11	39			
Combined Runoff Flow	**112 (to EDP)**	**319 (to EDP)**		**69**	**197**	**Combined Runoff Flow**	**142 (to EDP)**	**365 (to EDP)**		**62**	**195**
Stormwater Disposal flow at the sub-Catchment Disposal Point	**See Note 1 below**			**69**	**197**	**Option - EDP runoff pumped to West Drain**	**0**	**15**		**62**	**195**
	See Note 2 below					**Option – EDP runoff pumped to Taieri River**	**15**	**15**		**62**	**180**

Note 1 Stormwater discharge infiltrates to ground over days and weeks and during extreme events there is some flow to the Outram surface and piped stormwater system.

Note 2 The West Catchments 10yr ARI disposal discharge – For the West Drain disposal option the discharge from the EDP would be deferred for 12hours after the peak runoff has passed from the West Catchment and therefore the peak discharge from the West catchment is the same for both disposal options.

Table 4.4: Detention Storage Estimates

Required Total Storage Volume per Lot (m_3) for the 10yr and 100yr ARI Events			
West 1		West 2	
10 yr ARI	100 yr ARI	10 yr ARI	100 yr ARI
4.2	6.5	2.6	4.1

4.5.6 Conclusions

The following conclusions are drawn from the hydrological calculations in the context of the proposed post development stormwater management concept.

i. The detention storage requirements for the West catchment are modest and could be accommodated using swales, garden plots or tankage all with permissible discharge controls. The options for providing for the permissible discharge would be a matter for the lot owner and final design. If cost effective, a practical option would be to increase the detention storage volume on a lot and discharge at the 10year ARI permissible design flow to the primary collector system and simplify the permissible discharge control requirement.

ii. The storage requirement for the EDP on Lot 25 for a 100year ARI event is 4,000m^3 in order to prevent an overflow to the area of Outram south of Holyhead Street. The storage requirement over the area of Lot 25 represents a uniform water depth of 970mm. A detailed plan as to how 4,000m^3 of storage would be accommodated within Lot 25 has not been prepared however from a visual examination of the site it appears that the depth of storage up to the existing road extension off Holyhead Street will be adequate with excavation likely to be required to enlarge the pond beyond the Prohibited Excavation zone. Refer to the photograph in Figure 4.3.

iii. The stormwater detained in the EDP would be pumped over the adjacent stopbank to the Taieri River.

iv. Based on the West 1 and West 2 total detention storage volumes required per lot from Table 4.4 for the 100year ARI event the peak discharge calculated to the West Drain is 180l/s which is 17l/s less than the 100yr ARI pre-development peak flow of 197l/s. The capacity of the culverts under SH87 to take the pre-development flow from the site has not been confirmed.

v. The enlarged EDP with a pump station discharging to the Taieri River reduces the existing potential risk of adverse flooding to the Outram south of Holyhead Street.

Figure 4.3: Balmoral Site at Lot 25 – Location of proposed Detention Pond – Existing Access from Holyhead Street is visible upper centre of photograph.

4.5.7 Consent Requirements

The inclusion of a pump in the EDP means that provision would need to be made for a discharge of stormwater to the Taieri River. Since the discharge of stormwater from a reticulated stormwater system to water, or onto or into land in circumstances where it may enter water is a permitted activity under the ORC Water Plan provided the requirements of Section 12.4.1 of the Plan are satisfied a resource consent is not required.

Approval would be required from the ORC for construction of the works in the Excavation Prohibited area and over the stopbank before implementing the preferred East Catchment stormwater disposal option.

4.6 Stormwater Effects Assessment

4.6.1 Runoff Flow and Volume

For the West Catchment the peak runoff flow in the post-development scenario would be equal to or less than the pre-development flow at the point of discharge from the site.

The stormwater disposal discharge from the East Catchment EDP to groundwater would be similar to the pre-development scenario but there would be an additional pumped discharge from the East Catchment to the Taieri River. The pumped discharge would have no significant adverse effect on flood conditions in the Taieri River and would reduce extreme storm event flows to the Outram stormwater network and therefore would be of benefit to Outram.

The change in the volume of runoff due to the increase in the impermeable area is proposed as part of the development is minor.

4.6.2 Runoff Water Quality

It is expected that stormwater from this site could contain the following changes in the discharge of contaminant from the pre-development condition:

- Suspended Solids - possible increase.
- Oxygen Demanding Substances - possible increase.
- Pathogens - likely reduction.
- Dissolved Contaminants - an increase due to vehicles (lead, zinc, copper).

The effects of the changes in contaminant discharges would however be minor. The lot area is relatively large and therefore the area of grass and garden vegetation and the flat topography of the site would mean that erosion is minimal and the other contaminants would be largely absorbed. Features that would absorb contaminants include grass, lawns and gardens, on site detention basins and road sumps.

The West Drain drainage path leaving the site is ephemeral therefore there is no significant effect on natural waterways. The volume of contaminants from SH87 would be relatively large compared to that from the proposed development and therefore any marginal effects due the proposed development would be minor.

4.6.3 Alternative Stormwater Management Options

The proposed stormwater management option was developed taking into consideration other options as presented in Table 4.5 below.

Table 4.5 Alternative Stormwater Management Option Assessment

No.	Alternative Stormwater Concept	Conclusion
1	Conventional development with on-site communal detention storage would be developed to maintain post development neutrality. Discharge to the Outram stormwater network south of Holyhead Street.	The location of the detention storage on Lot 25 would require upgrading of the Outram stormwater system to accommodate the development. Upgrading the Outram system to take the modest increase in flow would be too expensive.
2	As for 1 above but with Disposal to West Drain.	The cost of the pump and the reliance on the pump represented additional cost and a greater risk of overflows to the area south of Holyhead Street. Additional flow would load the West Drain to a greater extent than for the adopted stormwater management concept.
3	Utilise the existing West Drain drainage network with detention storage but discharge the East catchment to water to ground using an infiltration pit beneath the pond in Lot 25.	Very unlikely to work due to high groundwater levels during flood conditions in the Taieri River. Represents a significant risk of a piping failure under the stopbank even if the infiltration pit were located outside the excavation prohibited zone. Risk of groundwater contamination.
4	Re-use of roof and other impervious area runoff for non-potable use to maintain stormwater neutrality.	The volume of storage required for residential water supply would be greater than the detention storage required for lot areas of 2000m^2 or greater. The greater storage volume would be greater due to the expected water demand. Taking a water supply available from the existing Outram water supply network would be beneficial for fire fighting and residential use. The duplication of the water supply system for re-use and mains supply from Outram would add additional cost.

4.6.4 Environmental Effects

The proposed stormwater management concept represents very little change to the current stormwater drainage flows and volumes and disposal locations except in the case of an extreme event where there would be a small reduction in flows to the existing Outram stormwater system.

Stormwater flows would not adversely affect the receiving groundwater after infiltration from the EDP and other detention facilities proposed for the West Catchment and conceivably if ponds or garden features were adopted in the East Catchment if lot owners voluntarily practiced water conservation.

4.6.5 Construction Erosion and Sedimentation Plan

Development of the site would require and Erosion and Sedimentation Management Plan (ESMP).

The site is relatively flat and therefore the construction of access ways and the installation of services will not require extensive earthworks. Construction of the EDP will require earthworks and therefore will require specific attention in the ESMP.