Annexure 4

Infrastructure Assessment Report, Davis Ogilvie & Partners

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INFRASTRUCTURE ASSESSMENT REPORT

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QUALITY ASSURANCE

Title:	Infrastructure Assessment Report Ravenswood, Woodend
Client:	Ravenswood Developments Ltd
File Name:	T:\projects\40s\40108 - Plan Change\Civil\Design\Infrastructure Report\200604.40108.ss.Infrastructure Report.docx
Version:	1
Date:	5 June 2020
Project No:	40108

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DISCLAIMER

This engineering report has been prepared at the specific instruction of Ravenswood Developments Ltd. It outlines the servicing for the commercial area in Ravenswood, Woodend.

Davis Ogilvie did not perform a complete assessment of all possible conditions or circumstances that may exist at the site or may be constructed. Conditions may exist which were undetectable given the extents of the investigation on site.

Davis Ogilvie's opinions are based upon information that existed at the time of the production of the document. Assessments made in this report are based on the conditions found onsite, where observed, and current engineering best practice. No warranty is included; either expressed or implied that all conditions will conform to the assessments contained in this report.

Davis Ogilvie has provided an opinion based on observations, site investigations, and analysis methodologies current at the time of reporting. The report cannot be used by any third party. The report cannot be used if there are changes in the referenced guidelines, analysis methodologies, laws or regulations.

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1.0 PURPOSE AND DESCRIPTION

This Infrastructure Assessment summarises the servicing provided to the Business Zone that forms the proposed Ravenswood Town Centre. This report supports an Assessment of Effects on the Environment associated with the Ravenswood Private Plan Change Request (PPCR).

Ravenswood is a residential and commercial development located north of Woodend, North Canterbury. The Business area comprises 25.2 ha located in the north-east of the overall development. Figure 1 illustrates the proposed Ravenswood Outline Development Plan.

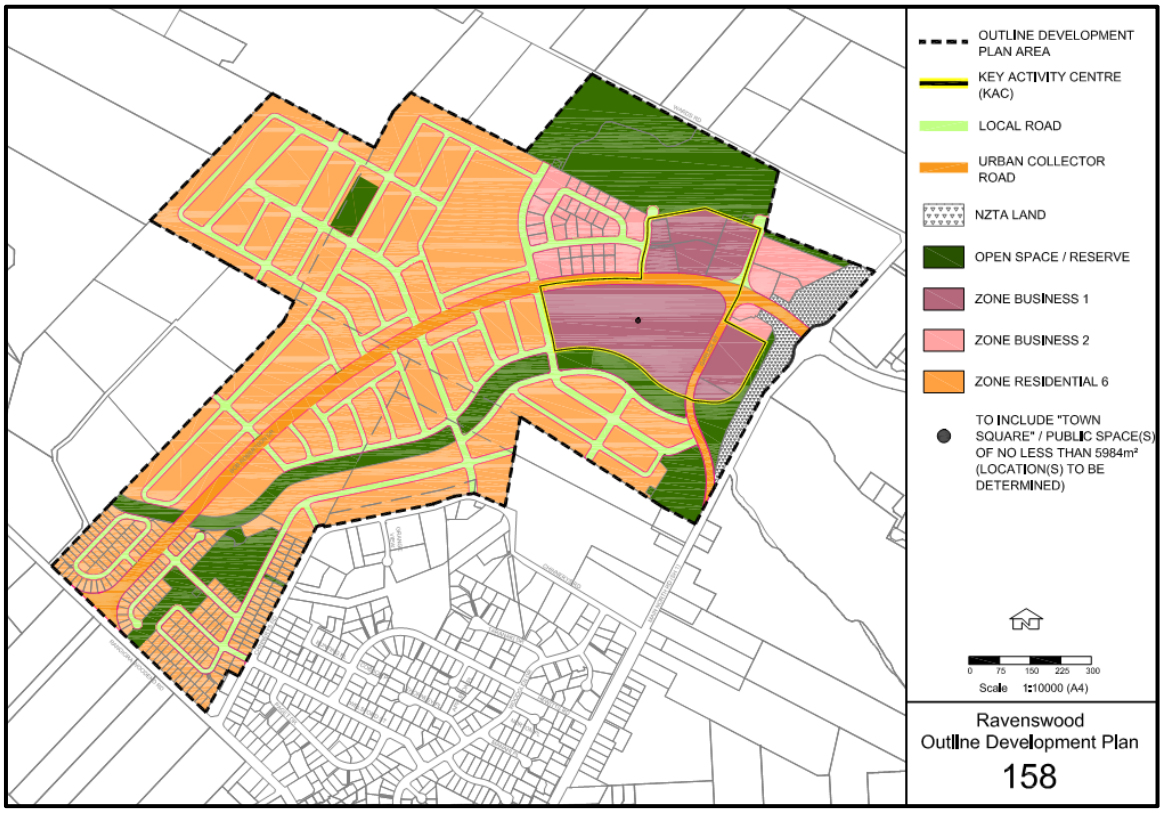

Figure 1: Proposed Ravenswood Outline Development Plan

Subdivision consent (RC165342) was granted from Waimakariri District Council (WDC) for the business area in 2017. Servicing design for the Ravenswood Business Zone was undertaken assuming a mixed commercial use. A light industrial area with both wet and dry industries was defined (Figure 2). A retail/commercial area was also defined. The area south of Road 1 (Lot 203), although presently zoned as Residential 6a, was designed for servicing on the basis of a retail/commercial land use.

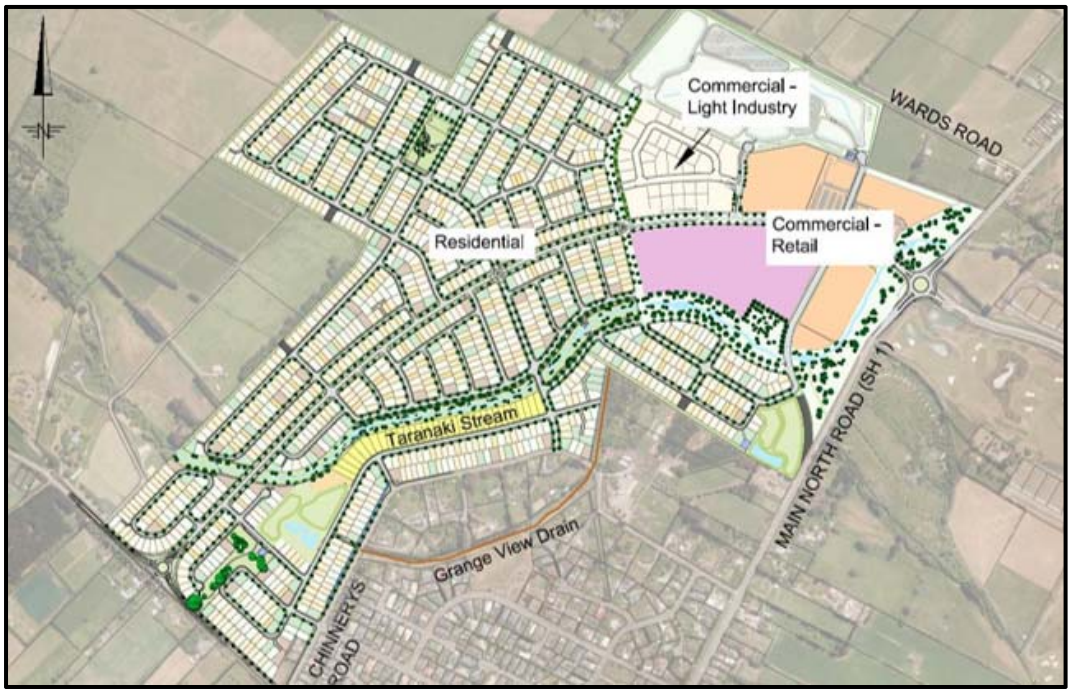

Figure 2: Ravenswood land uses (based on 2016 Ravenswood Masterplan)

2.0 EARTHWORKS

Bulk earthworks are complete across the majority of the business area. Lots are formed and earthworks are complete within the light industrial area. Minor works are required on the remaining lots, dependent on their development plans, for the provision of additional roading and associated services.

The key remaining earthworks required include:

- Works associated with the connection roads to cross Taranaki Stream
- Bulk earthworks and remediation on Lot 203

2.1 Earthworks on Lot 203

To enable development of Lot 203, earthworks are required to fill the site to a finished level of 11.31 m – 11.91 m (refer to Engineering Design Earthworks Plans – Commercial Area 31143-C). Additionally, remediation of approximately 1.2 ha adjacent to the Taranaki Stream is required through the installation of a 1.8 m gravel raft with geogrid. A summary is provided in Table 1, indicating an imported fill requirement of approximately 90,000 m³.

Table 1: Earthwork Summary	
Activity	**Volume/Area**
Strip vegetation	-
Cut 300 mm topsoil and stockpile onsite	~23,000 m³
Cut unsuitable material and remove from site	~1,200 m³
Cut to fill to the design subgrade levels	~6,500 m³
Lay geogrid for raft areas	~12,200 m²
Fill raft areas with imported hard fill	~11,000 m³
Fill to design levels with imported fill	~79,800 m³
Re-spread topsoil and sow	-

Earthworks will be carried out in accordance with the requirements of NZS 4431:1989 (Code of Practice for Earthfill for Residential Development), WDC and Environment Canterbury (ECan). A detailed erosion and sediment control plan and report will be required to be submitted. Relevant consents currently held from WDC and ECan include:

- RC165111 Land Use Consent, lapse date Dec 2026
- CRC168247 to undertake earthworks, expires Feb 2042
- CRC168250 to take groundwater for dewatering, expires Feb 2042
- CRC168252 to discharge dewatering and construction-phase stormwater to land, expires Feb 2042

The excavation and shaping of the new section of the Taranaki Stream which is immediately south of Lot 203 has been completed. However, the filling of the existing Taranaki Stream, which crosses Lot 203, has been partially completed. Remediation may be required to ensure the filling is completed as shown in the capping detail shown on Construction Drawings 31143-C, Engineering Design – Details.

Earthworks requirements will alter dependent on the internal design of Lot 203. Should additional internal roads and intersections be formed; common services trenches, sewer and stormwater infrastructure will require excavation for installation.

2.2 Hazardous Activities and Industries

Several potentially contaminated areas across Ravenswood were inspected by ENGEO Ltd as part of their detailed environmental site investigation (DSI). An underground storage tank was identified within the extent of Lot 203, and it has been removed. Surrounding contaminated material was also removed from site and the remaining material has been verified as meeting the Tier 1 Residential land use criteria (refer to ENGEO Ltd Validation Report, Stages 9 & 10, 2017). (Note: Stage 1 of the commercial development was initially called Stages 9 & 10)

3.0 SEWER

3.1 Overview

The Ravenswood sewer gravity network is divided into four catchments, with four sewer pump stations required to transfer sewage from those catchments. The commercial area is serviced by Pump Station 2 (PS2) via two gravity connections (Figure 3).

Figure 3: Indicative sewer alignment

3.2 Pump Stations and External Rising Main

The pump station strategy is based on the overall site grading to the north-east to PS2. Therefore, the other pump stations will discharge to the PS2 gravity network. PS4 will pump to PS2 via a rising main. Provision for this has been made in the design of all pump stations and the overall sewer network.

Sewage from Ravenswood discharges to the Woodend Wastewater Treatment Plant, located south of Pegasus. A 3.5 km external rising main was constructed to service Ravenswood. Refer to the Overall Sanitary Sewer Design & External Rising Main Report[1] for details of the sewer pressure network.

[1] DO, 2017. Overall Sanitary Sewer Design and External Rising Main Report, Ravenswood. Davis Ogilvie & Partners Ltd. March 2017.

3.3 Internal Gravity Network

The Ravenswood internal gravity sewer network was designed and constructed in accordance with the WDC Engineering Code of Practise (ECoP). However, following discussion with WDC, the peaking factor for wet weather flow (PF_{WWF}) was reduced from 2.0 to 1.6. The peaking factor for dry weather flows (PF_{DWF}) remains 2.5 as per WDC ECoP Section 6.5.4. The overall peaking factor (OPF), typically 5.0, was revised to 4.0.

The modifications were made to the peaking factor due to the assumption that new reticulation will not experience significant stormwater or groundwater inflow, and that the scale of the overall development will ensure flows are balanced. Note a peaking factor of 5.0 was used for the network capacity checks to ensure enough capacity in the future should the network deteriorate.

The reduced peaking factor means that flows for retail/commercial lots were calculated using a value of **0.8 L/s/ha** for PWWF.

There is uncertainty regarding the land use of the light industrial areas, with respect to wet or dry industry. A 50/50 split of wet/dry industries was assumed. Therefore flows for the light industrial lots were calculated using a value of **1.0 L/s/ha** for PWWF.

Table 2 summarises the catchments and flows expected within the commercial area (Figure 4).

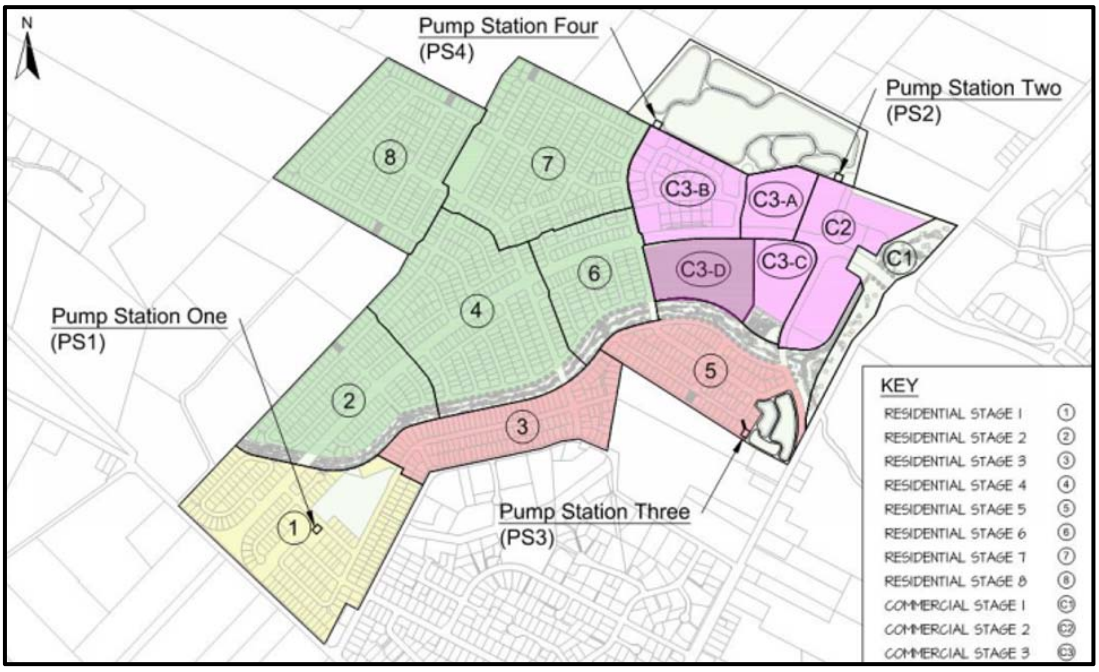

Figure 4: Ravenswood sewer network internal pump stations and catchments
(C2, C3 A-D discharge directly to PS2)

Table 2: Sewer Catchments			
Stage	**Area (ha)**	**PWWF (L/s)**	**Land Use**
C2	5.7	4.5	Retail/commercial
C3-A	2.5	2.0	Retail/commercial
C3-B	4.6	4.6	Light Industrial
C3-C	2.6	2.1	Retail/commercial
C3-D	4.6	3.7	Retail/commercial
Total		*16.9 L/s*	
Note: Catchment areas are lots only			

3.4 Laterals and As-Built Network

Lots within the light industrial area are serviced by a single 150 mm diameter uPVC lateral, with larger lots (100, 101 and 113) having an additional lateral. Lots in the remaining commercial area are serviced by 150 mm or 225 mm diameter uPVC laterals.

The intended development of Lot 203 is not yet defined, therefore nine laterals have been provided for future sewer connections, from both Road 1 and Road 2.

Table 3: Sewer Laterals to Lot 203			
Location	**Pipe Size**	**Discharge Point**	**Catchment Area**
Road 1	150 mm	PS2 via Road 3	4.6 ha (C3-D)
Road 1	150 mm		
Road 1	150 mm		
Road 1	225 mm	PS2 via Road 2	2.6 ha (C3-C)
Road 1	150 mm		
Road 2	225 mm		
Road 2	225 mm		
Road 2	225 mm		
Road 2	150 mm		

There is no allowance for sewer connections from Road 7 bordering the residential zone.

The layout of the gravity sewer reticulation is shown on As Built Drawings 31143-C, Engineering Design Sewer Asbuilt Plans, and 31143-C, Engineering Design Sewer Long Section Asbuilts (Appendix 1).

4.0 STORMWATER

4.1 Overview

The commercial Ravenswood development has two separate piped primary stormwater networks that operate in isolation from each other. These networks discharge to two points (N2 and N3) in the North Stormwater Management Area (SMA) (Figure 5). Following treatment, stormwater is discharged to the Taranaki Stream, with some infiltration to ground. ECan Consent CRC168257 is held to discharge developed phase stormwater to land and to water.

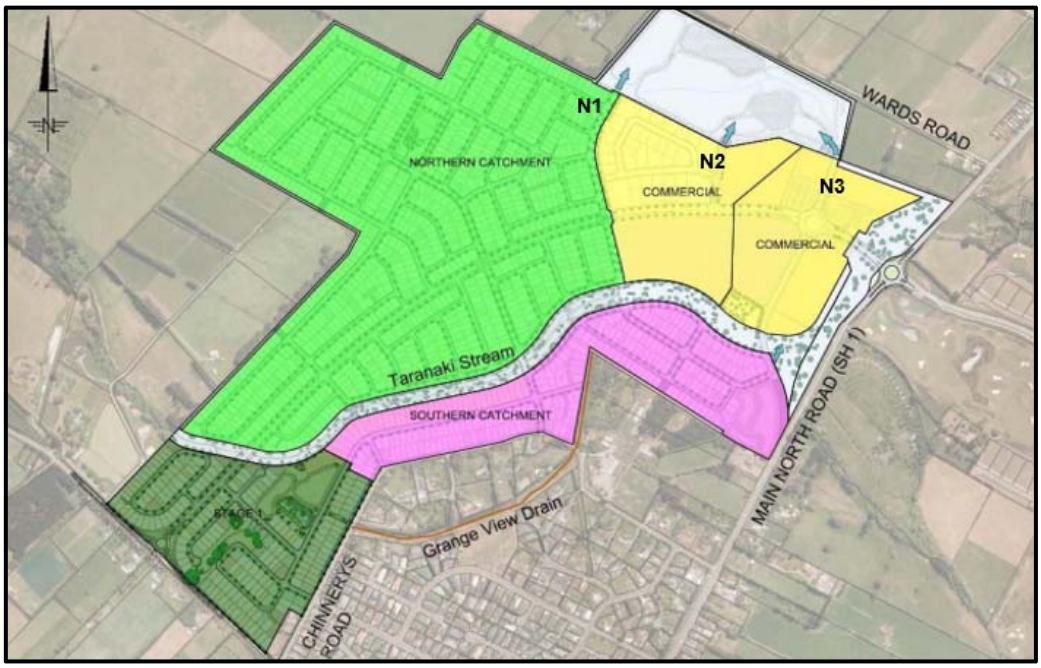

Figure 5: Stormwater catchments and discharge locations

The overall Ravenswood stormwater design was reviewed in 2019 to confirm its capacity with increased residential site density (refer to DO Memo, September 2019[2]). The residential runoff coefficient was increased (C = 0.63) to reflect a 61 % impervious catchment. The commercial catchment runoff coefficient is 0.83, indicating a 90 % impervious catchment. The stormwater network and treatment system as designed, consented and constructed can adequately manage these flows.

4.2 Primary Stormwater Network – 20% AEP Event

Stormwater reticulation has been designed in accordance with the WDC ECoP, the Christchurch City Council Waterways, Wetlands and Drainage Guide (WWDG) and engineering best practice. The following parameters, amongst others, were used to model the stormwater flows for the relevant design storms:

- Primary reticulation design storm – 20% AEP

[2] DO, 2019. Increased Impervious Memo for WDC dated 6 September 2019

- Secondary flow path design storm – 2% AEP
- Industrial/Commercial - Runoff coefficient C = 0.83
- Te = 10 minutes
- Rainfall – HIRDS V4 RCP8.5 to 2100

The western section of Road 1 also includes swales on both sides of the road. The swales drain to sumps for entry into the piped network.

4.3 Secondary Stormwater Network – 2% AEP Event

The secondary stormwater network was designed to accommodate the 2% AEP event with flows conveyed via secondary flow paths, primarily in the road carriageway. Additionally, gravelled swales from the cul-de-sac heads to the first flush ponds provide conveyance of secondary flows.

4.4 As Built Network and Laterals

The primary stormwater network layout is summarised in Figure 6. Detail of the stormwater network is shown on As Built Drawings 31143-C, Engineering Stormwater Asbuilt Plans and 31143-C, Engineering Design Stormwater Long Section Asbuilts (Appendix 1).

Figure 6: Indicative Primary Stormwater Network Layout

Discharge point N2 receives runoff from 12.0 ha of light industrial and retail/commercial land. Discharge point N3 receives runoff from 13.2 ha of retail/commercial land (Table 4).

Table 4: North SMA Catchments				
Discharge Point	**Catchment Area (ha)**	**Land Use**	**Percent Impervious Area**	**First Flush Rainfall Depth (mm)**
N1	66.3[1]	Residential	61 %	25
N2	5.9	Light Industrial	90 %	25
	6.6[2]	Retail/Commercial		
N3	13.7[2]	Retail/Commercial	90 %	25

Note: Detention and wetland areas are excluded from first flush calculations [1] Inclusive of 1.7 ha of first flush pond area with 0.81 C_{ff} applied. [2]Inclusive of 0.5 ha of first flush pond area.

Laterals

Lots within the light industrial area are typically serviced by a 150 mm or 225 mm diameter lateral. For the remaining lots in the commercial area, servicing is via 300 mm or 375 mm diameter laterals.

The intended development of Lot 203 is not yet defined, therefore six laterals were provided for future stormwater connections (Table 5).

Table 5: Stormwater Laterals to Lot 203				
Location	**Pipe Size**	**Type**	**Discharge Point**	**Catchment Area (ha)**
Road 1	450 mm	RCRRJ	N2	4.6
Road 1	600 mm	RCRRJ		
Road 1	525 mm	RCRRJ	N3	3.2
Road 2	600 mm	RCRRJ		
Road 2	525 mm	RCRRJ		
Road 2	300 mm	uPVC		

As lots are developed, any subdivision or construction of roading would require the design and installation of additional kerb and channel, sumps and pipes.

There is no allowance for stormwater connections to commercial lots from Road 7 bordering the residential zone.

4.5 Stormwater Attenuation

Hydraulic modelling for the Ravenswood development was undertaken to determine the appropriate detention volumes necessary to ensure runoff rates are reduced to pre-development conditions.

A storm duration of 6 hours was identified as critical for the Ravenswood site catchment, while a duration of 24 hours was identified as critical for the downstream catchment. The attenuation and outlet structure within the North SMA has adequate capacity to detain flows and match pre-post development flow rates for the critical storm duration to protect downstream infrastructure and properties.

4.6 Stormwater Treatment

Stormwater treatment is provided within the North SMA (Figure 7). A treatment train combining three treatment steps is utilised, including:

1. First flush basins – dry basins to remove sediments and solids
2. Treatment wetlands – shallow vegetated areas for enhanced removal of contaminants
3. Extended detention basin – ponding in larger rain events

Discharges from the N2 and N3 networks enter separate first flush basins, then combine in a treatment wetland for additional treatment. Detention is the final step in the treatment train prior to discharge through an outlet structure.

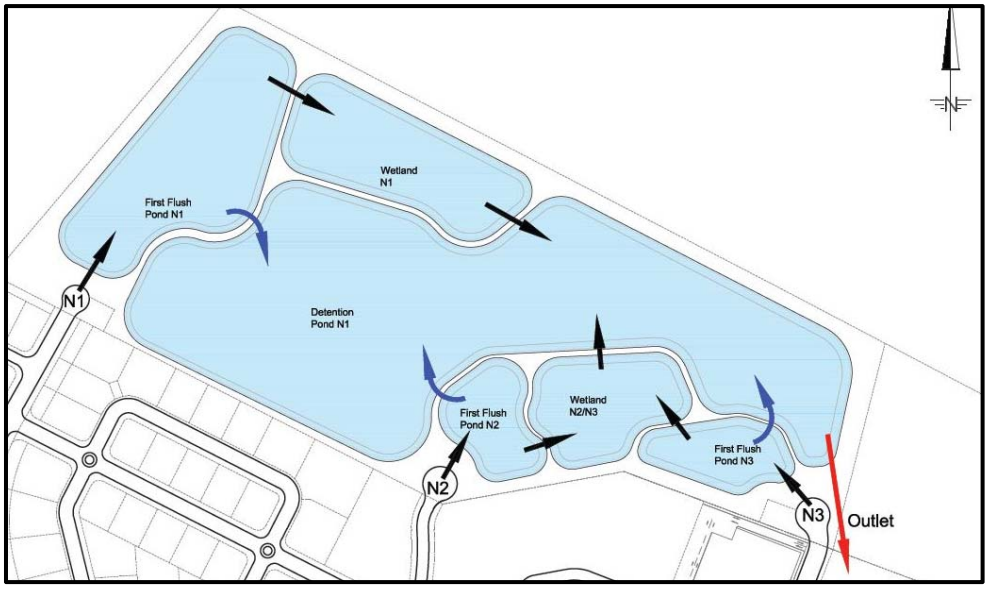

Figure 7: Ravenswood North Stormwater Management Area (SMA)

First flush basin design assumptions (CCC WWDG[3]) applied to the full commercial area (25.2 ha) include:

[3] CCC, 2012. Waterways, Wetlands and Drainage Guide. Christchurch City Council, revised May 2012.

- 90 % effective impervious area (im%)
- composite first flush coefficient (C_{ff}) of 0.81
- 25 mm first flush depth

The commercial catchment (N2 and N3) first flush basins discharge to the wetland over 3 days.

Water quality was assessed for the commercial area assuming 'light industry' and 'large-format retail' land uses. Typical contaminants expected from the light industrial and retail/commercial areas include:

- Total Suspended Solids (TSS)
- Metals (zinc, copper, lead)
- Hydrocarbons/oils and grease

Based on the treatment train described above, and typical commercial land use activities, the treated stormwater is considered an appropriate quality for discharge to ground and surface water, refer to the Revised Stormwater Management Report, August 2016[4] and CRC168257.

4.7 Hazardous Activities

Sites undertaking potentially hazardous activities may require additional treatment, prior to discharge into the Ravenswood network. There is no allowance for treatment of contaminants generated by HAIL sites within the Ravenswood stormwater network.

Where HAIL activities are occurring which would lead to the generation of stormwater runoff, additional treatment is required to reduce runoff contaminant concentrations to typical urban runoff levels (as described in Revised Stormwater Management Report, August 2016[5]).

[4] DO, 2016. Revised Stormwater Management Report. Ravenswood, Woodend, North Canterbury. Ravenswood Developments Ltd. Ref: 31143. Davis Ogilvie & Partners Ltd. August 2016.
[5] DO, 2016. Revised Stormwater Management Report. Ravenswood, Woodend, North Canterbury. Ravenswood Developments Ltd. Ref: 31143. Davis Ogilvie & Partners Ltd. August 2016.

5.0 HIGH PRESSURE WATER

5.1 Overview

Initially, the Ravenswood development is serviced from a single point of supply from Pegasus. However, the overall design is to connect the Woodend water network to the Pegasus water network. The resilience and firefighting capacity of the commercial water network will increase once the Chinnerys Road pump station is permanently connected along Road 1. The layout of the high pressure water network is shown on As Built Drawings 31143-C, Engineering Design Water Asbuilt Plans (Appendix 1).

The high pressure water network for the Commercial Stages has been designed in accordance with Part 7: Water Supply of the WDC ECoP and SNZ PAS 4509:2008 – New Zealand Fire Service, Firefighting Water Supplies Code of Practice.

5.2 Internal Water

The design flow rate is based on a peak flow rate of **1.00 l/s/ha**, with the assumption that this can be supplied by the network. A mains pressure of 350kPa at the point of supply on Pegasus Boulevard was assumed, giving a residual pressure greater than the minimum required 250 kPa for peak demand flows.

A new DN 280 PE100 PN 12.5 trunk main connects into the existing 225 mm diameter uPVC water main located at the intersection of Pegasus Boulevard and Mapleham Drive, located within the Pegasus Development. The trunk main then changes to a DN 300 uPVC PN 12 water main along the length of Road 1, with feeder mains and sub-mains off it.

5.3 As Built Network and Laterals

Lots within the light industrial area are serviced by a single 20 mm OD connection from the sub mains.

For the remaining lots in the commercial area, the developer has provided a 15 mm connection into the lot. However, larger laterals are provided within the berms, and sites have the potential to connect to the larger laterals. The intended development of Lot 203 is not yet defined, therefore a number of laterals are provided for future water connections to Lot 203:

- 2 x DN 150 uPVC laterals provided from Road 2
- 3 x DN 150 uPVC laterals provided from Road 1

As lots are developed, any subdivision or construction of roading would require the design and installation of additional mains, hydrants and connections.

There is no allowance for water connections to commercial lots from Road 7 bordering the residential zone.

5.4 Fire Fighting

Fire hydrants have been spaced at a maximum of 135 m from any proposed lot in accordance with SNZ PAS 4509:2008. The high pressure water network has been designed to be able to deliver firefighting water supply equivalent to the **FW4 classification**. The network has capacity to deliver 50 l/s within 135 m, and a second 50 l/s within a distance of 270 m.

The firefighting demand of individual lots must be checked at the time of building consent against the number of available hydrants. If any future buildings exceed the FW4 criteria, then options including sprinkler systems, compartmentalisation into smaller fire cells, or additional water storage could be employed to achieve the firefighting water supply requirements of SNZ PAS 4509:2008.

6.0 TELECOMMUNICATIONS AND POWER

Power reticulation design for each stage is undertaken by Mainpower and are installed in common services trenches. Mainpower can confirm the suitability and requirements to connect to Lot 203. Refer to the Mainpower Plan in Appendix 2.

Telecommunication reticulation design and supply has been provided by Enable. Services are installed in common services trenches and supplied through a cabinet located on Road 1. Connections are in place to all lots excluding Lot 203. In order to service Lot 203 there are road crossings and duct capacity at various locations. Enable has confirmed that the existing cabinet can supply an additional 30 lots before a further cabinet extension is required. Refer to the Enable Installation Plan in Appendix 3.

7.0 CONCLUSIONS

The Business Zone that forms the proposed Ravenswood Town Centre is presently serviced by stormwater, water and sewer suitable for a commercial land use. This report summarises the assumptions employed in the design of these services, prior to their installation in 2018, and concludes that no changes are required to existing stormwater, sewer or water infrastructure for the commercial use of this area.

Earthworks are required to be undertaken prior to development of Lot 203. The extent of earthworks includes remediation of approximately 1.2 ha adjacent to the Taranaki Stream through the installation of a 1.8 m gravel raft with geogrid. Overall, there is an imported fill requirement of approximately 90,000 m³. Telecommunications and power is supplied to the commercial area by Enable and Mainpower, respectively.