Rural Section 22268, Title reference CB27B/314, Owner Murphy Farms Limited

Stormwater Report

for: South Island Resource Recovery Limited

PROJECT KEA

Job No:	64308#C
Version:	1
Date of Issue:	25/11/2022

DOCUMENT APPROVAL AND REVISION HISTORY

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1 INTRODUCTION

Babbage Consultants Limited (Babbage) have been engaged by South Island Resource Recovery Limited (SIRRL) to prepare a stormwater report to support the resource consent application for the proposed development of a new waste-to-energy plant (known as Project Kea) at Morven-Glenavy Road in Glenavy, Waimate District, Canterbury.

This report presents information on:

- the existing site
- the proposed development
- planning controls
- the proposed stormwater management strategy for the site.

2 SITE DESCRIPTION

2.1 Site Location

The site is located approximately 2 km north of the town of Glenavy, and approximately 3 km north of the Waitaki River, at the corner of Carroll's Road and Morven-Glenavy Road. The site location is shown in Figure 1 below.

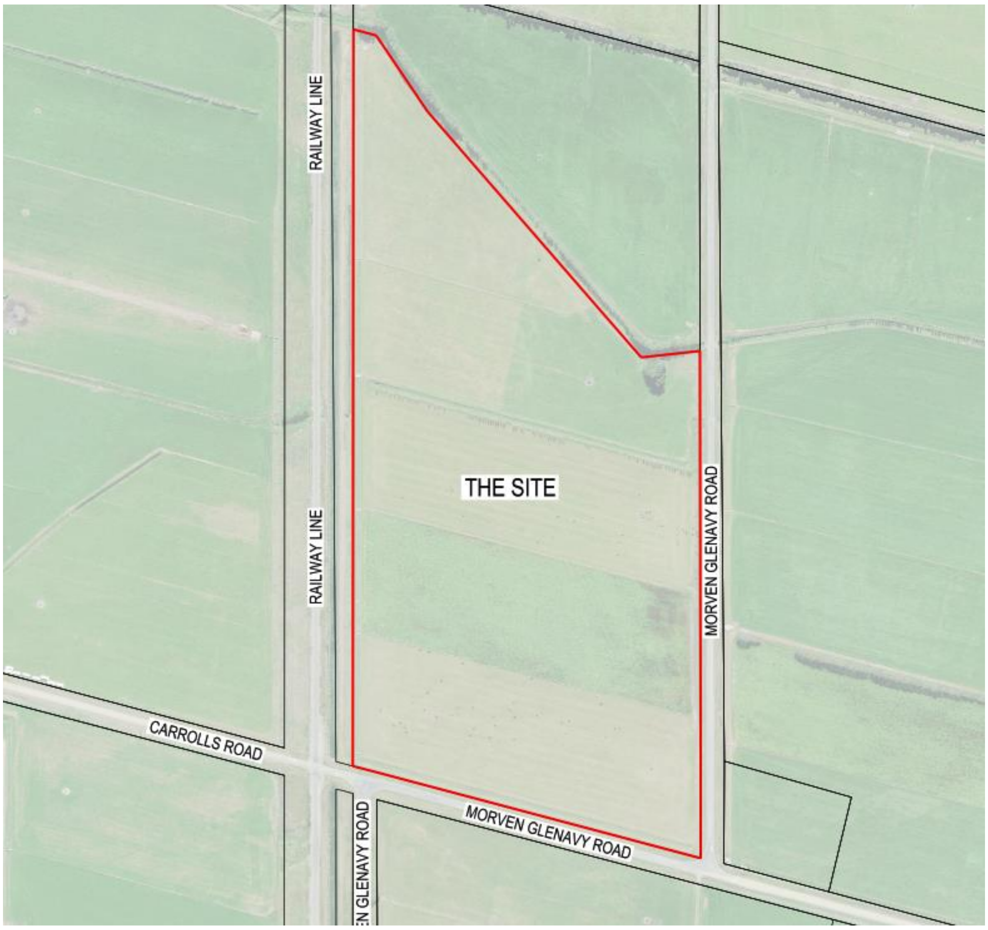


Figure 1. Site Location

The site is bounded by Morven-Glenavy Road to the east and south, an irrigation race and the South Island main trunk railway line to the west, and by Whitneys Creek to the north.

2.2 Property Details

The legal description of the site is Rural Section 22268, Title reference CB27B/314 with the owner being Murphy Farms Limited. The total area of the site is 14.85 hectares (ha).

2.3 Topography

The existing ground contours at the are shown on drawing C00 in **Appendix B**.

The existing ground surface on the site generally slopes down from west to east with a very minimal gradient of approximately 0.3% (1v to 300h). The railway line elevation varies between approximately

RL 29.0 m and RL 27.4 m (northern site boundary and southern site boundary respectively), while the site is generally between RL 27.0 m and RL 26.0 m (western and eastern boundary respectively). The railway line is also elevated above the land to the east. The existing ground surface on the site is generally 1.5 to 2.0 m below the top of the railway line.

2.4 Existing Water Surface Bodies and Open Channel

Whitneys Creek is located on the adjoining property adjacent to the northern boundary of the site. The existing MGI irrigation water race is located adjacent to the western boundary, between the railway and the site. These surface water bodies are shown on Figure 2 below and drawing C00 in **Appendix B**.

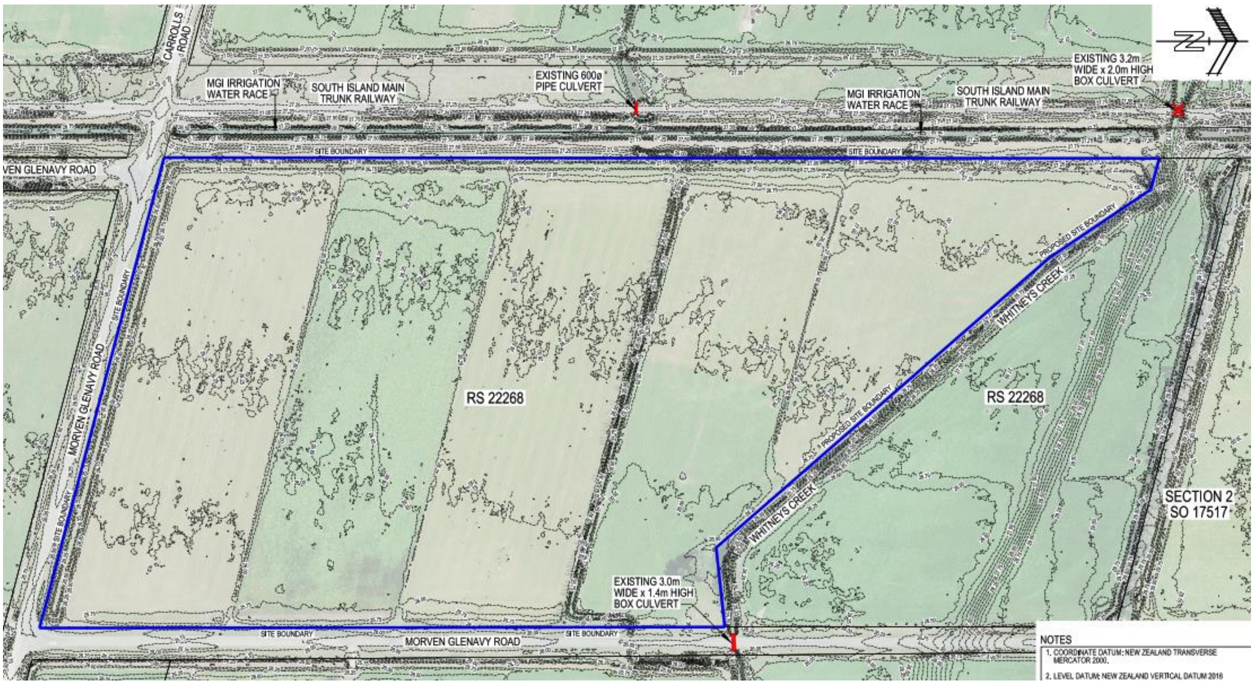


Figure 2. Existing Surface Water Bodies

There is an existing 600 mm stormwater culvert below the railway, near the centre of the western boundary of the site. This pipe discharges to an open channel that crosses the site and exits the eastern boundary via a culvert below Morven Glenavy Road, and then discharges to Whitneys Creek.

3 PROPOSED DEVELOPMENT

The proposed development consists of a waste to energy plant with buildings and associated roading, carparking, manoeuvring areas and landscaping areas on the site. It will include a railway siding along the western boundary with connection from the existing main trunk railway line. The earthworks design proposes to raise the existing site surface levels to enable the railway siding to connect to the railway and direct stormwater flows away from the railway and proposed buildings.

The layout of the proposed development is shown in **Appendix A**.

4 STORMWATER MANAGEMENT

4.1 Existing Stormwater

The entire site is currently grassed and generally falls eastwards towards Whitneys Creek and the Morven-Glenavy Road (see drawing C00 in **Appendix B**). Stormwater runoff from the northern area of the site discharges directly to Whitneys Creek and the southern eastern area to the water table drain along Morven-Glenavy Road, which falls southwards to meet the water table drain along Morven Glenavy Road along the southern boundary of the site.

There is an existing 600 mm stormwater culvert below the railway, near the centre of the western boundary of the site. This pipe discharges to an open channel that crosses the site and exits the eastern boundary via a culvert below Morven Glenavy Road, and then discharges to Whitneys Creek.

4.2 Proposed Stormwater - Quantity

The breakdown of the proposed impermeable and permeable surfaces is provided in Table 1 below.

Table 1: Proposed Impermeable and Permeable Surfaces

Item	**Quantity**
Impermeable Surfaces:	
- Buildings	39,000 m^2
- Pavements	51,500 m^2
- Drip irrigation field	2,000 m^2
Total impermeable surfaces	**92,500m^2**
Permeable Surfaces:	
- Grassed and landscaped areas	35,400 m^2
- Infiltration Basins	20,600 m^2
Total permeable surfaces	**56,000 m^2**

The layout for the proposed stormwater management for the site is shown on drawing C10 in **Appendix B**.

The total proposed impermeable surfaces make up approximately 62% of the site area. The increased stormwater flows from the proposed development are to be managed by three infiltration basins, which are designed to dispose of the full post-development 10% AEP stormwater flows to ground soakage. The infiltration basins have been designed in accordance with the Christchurch City Council's Waterways, Wetlands and Drainage Guide and the design calculations are provided in **Appendix C**.

The disposal of the 10% AEP stormwater flows to ground soakage ensures compliance with the Canterbury Land and Water Regional Plan because:

- there is no increase in the 20% AEP stormwater flows to existing water bodies (Whitney's Creek)
- there would be no 10% AEP stormwater flows that would enter any other property

The bases of the infiltration basins are likely to be within 1 m of the highest seasonal groundwater level, so do they do not comply with the Canterbury Land and Water Regional Plan. The presence of groundwater at or near the base of the basins could impact the infiltration performance of the basins. However, this should not adversely affect the infiltration as the hydraulic head from water building up within the basin is likely to ensure infiltration still occurs.

The proximity of the base of the infiltration basins could also impact the quality of the groundwater. However, the purpose of the infiltration basins is to provide treatment of the stormwater prior to discharge to ground, as described in the following section of this report, which would minimise any adverse effects on the groundwater quality.

4.3 Proposed Stormwater – Quality

4.3.1 Pre-treatment Stormwater Quality

There are two significant sources of contaminants from the proposed development: vehicle pavements and air discharge deposits. We have assessed the pre-treatment contaminant loads from the vehicle pavements generally in accordance with the Christchurch City Council's Waterways, Wetlands and Drainage Guide. The pre-treatment contaminant loads from the air discharge deposits have been obtained from the Air Quality Emissions Assessment (Technical Report 5). The assessment calculations for both contaminant sources are provided in **Appendix D**.

4.3.2 Proposed Stormwater Treatment and Post-Treatment Stormwater Quality

Pre-treatment is to be provided for stormwater runoff from the proposed vehicle pavements (on site access roads and railway siding) by the installation of Enviropod's within in each catchpit installed for the stormwater drainage for the vehicle pavements. The Enviropods will be fitted with 100 micron filters that will capture a large proportion of the suspended solids, heavy metals and hydrocarbons within the stormwater runoff from the vehicle pavements. We have used treatment efficiencies for the Enviropods of 75% for suspended solids and 56% for heavy metals and hydrocarbons based on the supplier's information.

We note the size of the air discharge deposits is less than 10 microns and as such the Enviropods will not be effective in removing these contaminants from the runoff from vehicle pavements. The infiltration basins are intended to provide the primary means of treatment for the air discharge deposits from all areas on the site including pavements, roofs and grassed areas.

The amount and size of suspended solids within the stormwater runoff from the building roofs is expected to be significantly less than from the vehicle pavements and largely associated with the air discharge deposits. Treatment for stormwater runoff from proposed vehicle pavements, building roofs and grassed areas will be provided by the three infiltration basins.

The infiltration basins have been designed in accordance with the Christchurch City Council's Waterways, Wetlands and Drainage Guide to treat the first flush stormwater flows from the proposed vehicle pavements, building roofs and grassed areas. The design calculations for the infiltration basins are attached in **Appendix C**.

The efficiency of the proposed stormwater treatment provided by the infiltration basins has been assessed generally in accordance with the Christchurch City Council's Waterways, Wetlands and Drainage Guide and other literature. We have used treatment efficiencies of 80% for suspended solids and 60% for heavy metals and hydrocarbons. This assessment has resulted in estimated containment concentrations that would discharge from the base of the proposed infiltration basins. The assessment calculations for the contaminant concentrations are provided in **Appendix D** and summarised in Table 2 below.

Table 2: Stormwater Contaminants

Vehicle Pavements, Building Roofs and Grassed Areas

Source	Contaminant	Pre-Treatment Contaminant Concentration		Post-Treatment Contaminant Concentration	
		g/m3	mg/m3	g/m3	mg/m3
Total Combined Surfaces	TSS	10.711	10711	1.3507	1350.7
	Zinc	0.0090	8.9888	0.0033	3.3467
	Copper	0.0019	1.8522	0.0007	0.6572
	Lead	0.0137	13.699	0.0027	2.7091
	TTPH	0.0013	1.3413	0.0003	0.3386
				1.3577	**1357.7**

Air Discharge

Source	Contaminant	Pre-Treatment Contaminant Concentration		Post-Treatment Contaminant Concentration	
		g/m3	mg/m3	g/m3	mg/m3
Air Discharge	Calcium	0.02530	25.301	0.01012	10.120
	Oxygen	0.01649	16.491	0.00660	6.5966
	Chlorine	0.01247	12.474	0.00499	4.9897
	Silicon	0.00303	3.0305	0.00121	1.2122
	Potassium	0.00254	2.5371	0.00101	1.0149
	Sulphur	0.00176	1.7619	0.00070	0.7048
	Iron	0.00176	1.7619	0.00070	0.7048
	Sodium	0.00169	1.6914	0.00068	0.6766
	Water	0.00155	1.5505	0.00062	0.6202
	Carbon	0.00106	1.0571	0.00042	0.4229
	Aluminium	0.00078	0.7752	0.00031	0.3101
	Magnesium	0.00078	0.7752	0.00031	0.3101
	Zinc	0.00035	0.3524	0.00014	0.1410
	Titanium	0.00028	0.2819	0.00011	0.1128
	Lead	0.00014	0.1410	0.00006	0.0564
	Phosphorous	0.00014	0.1410	0.00006	0.0564
	Bromide	0.00014	0.1410	0.00006	0.0564
	Chromium	0.00007	0.0705	0.00003	0.0282
	Manganese	0.00007	0.0705	0.00003	0.0282
	Strontium	0.00007	0.0705	0.00003	0.0282
	Copper	0.00007	0.0705	0.00003	0.0282
	Barium	0.00007	0.0705	0.00003	0.0282
	Cadium	0.00003	0.0282	0.00001	0.0113
	Nickel	0.00001	0.0070	0.00000	0.0028
	Totals	**0.07065**	**70.6523**	**0.02826**	**28.261**

The effects of the post-treatment stormwater discharge on the groundwater and any surface water bodies are set out in the Surface and Groundwater Assessment (Technical Report 17).

5 CONCLUSIONS

6.1 The proposed development will increase the impermeable surfaces on the site to approximately 62% of the total site area.

6.2 The effects of increased stormwater quantity will be mitigated by infiltration basins, which will reduce off site stormwater flows to comply with the controls in the Canterbury Land and Water Regional Plan.

6.3 The effects of the stormwater flows on the quality of the groundwater and surface water will be mitigated by treatment by Enviropods and infiltration basins. An assessment of effects of the proposed stormwater discharge on ground water and surface water quality is set out in Technical Report 17 - Surface and Groundwater Assessment which concludes the quality of the discharge complies with the controls in the Canterbury Land and Water Regional Plan.

APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of South Island Resource Recovery Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

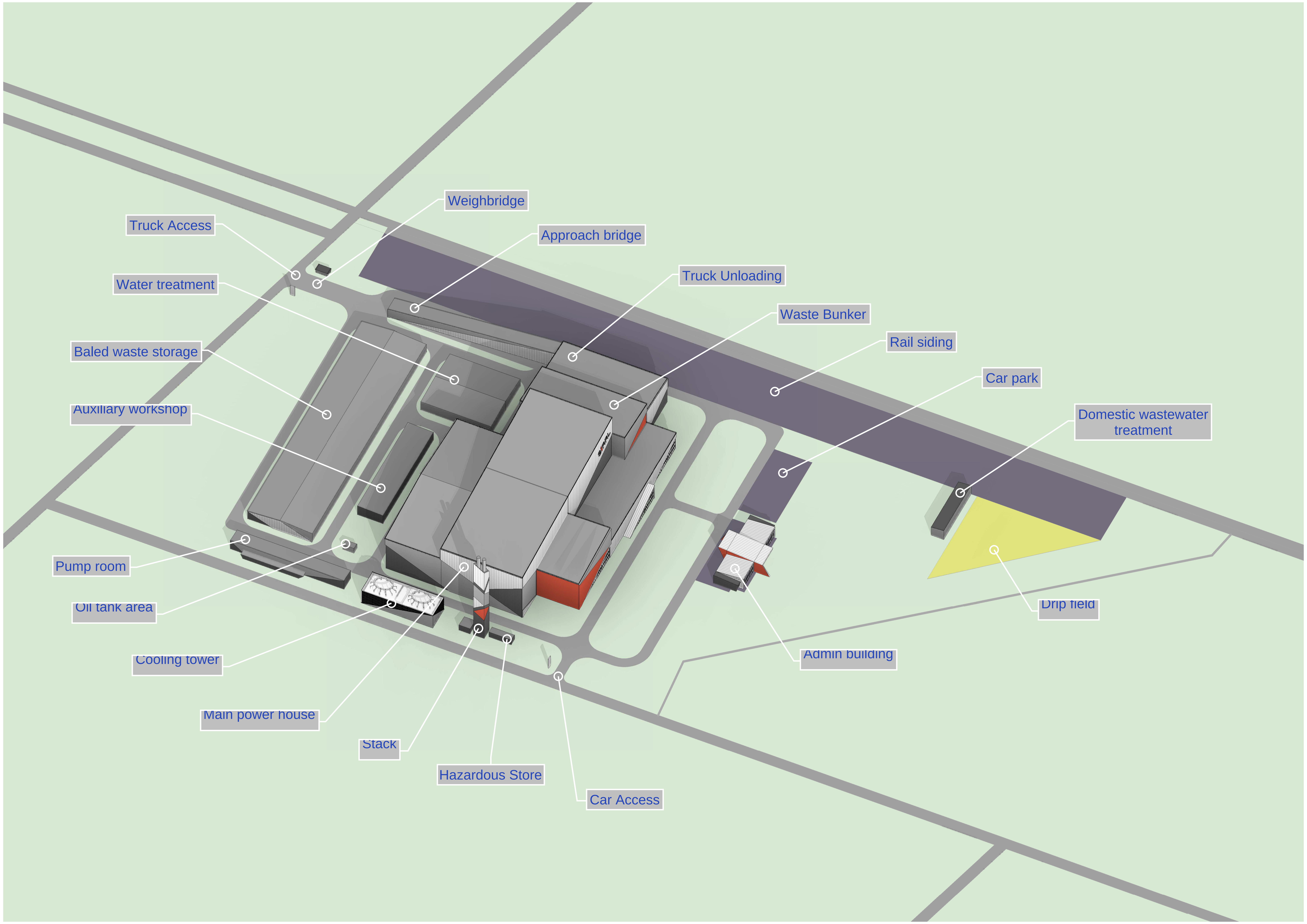
Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards, and should not be construed as legal opinions. Where opinions or judgements are to be relied on they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Babbage Consultants Limited.

Appendix A

Proposed Development Layout



PROJECT KEA
CONCEPT DESIGN
GLENAVY

SITE 3D VIEWS
SK19-00
14.09.2022

\\babaklfs01\Revit-Server\Projects\64300\64308#A Project Kea\5 Design Folder\5.1 Revit\Building\64308#A_Project Kea_V2022_CS.rvt

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64308#A

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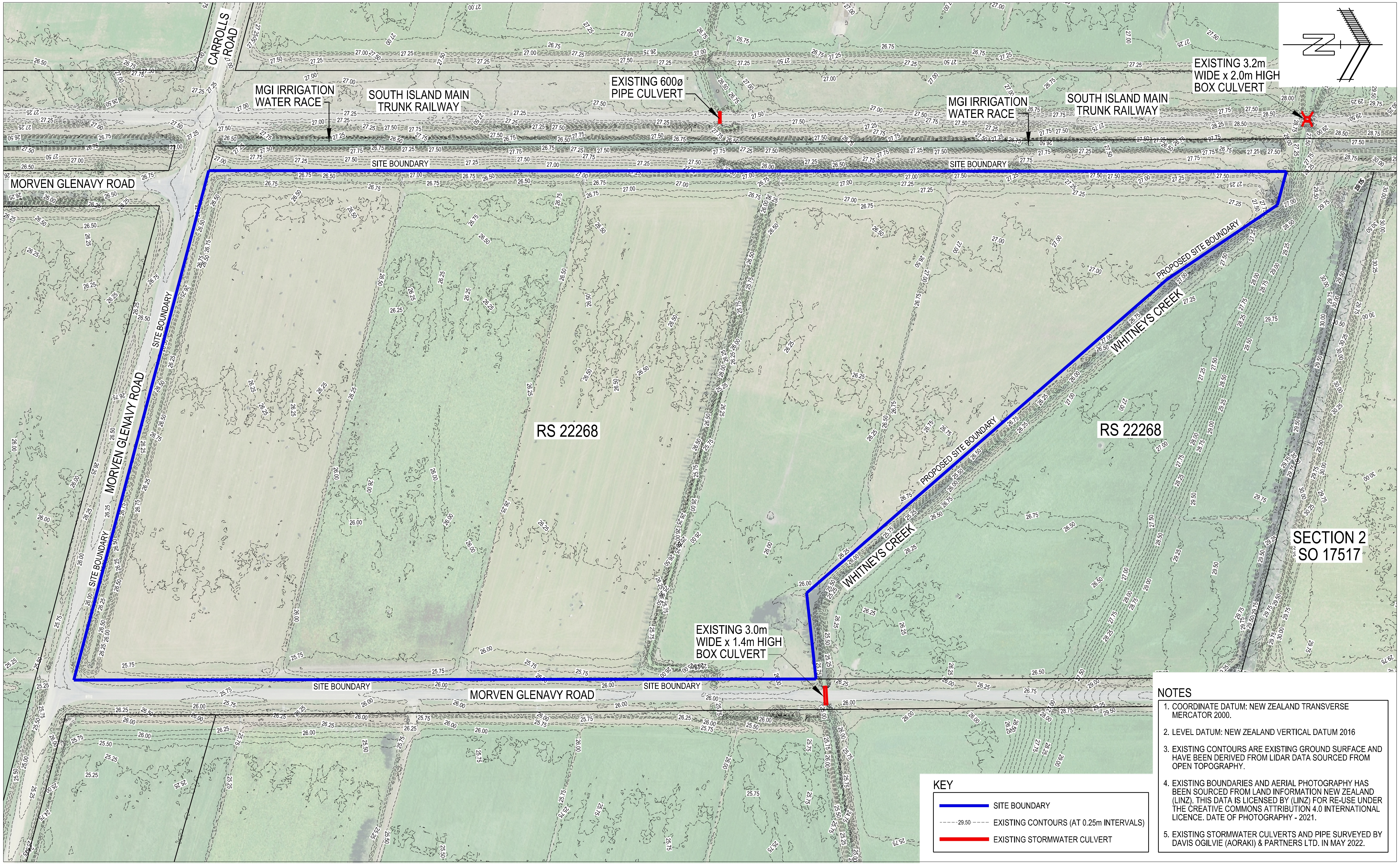
Appendix B

Stormwater Drawings



KEY

- SITE BOUNDARY
- 29.50 EXISTING CONTOURS (AT 0.25m INTERVALS)
- EXISTING STORMWATER CULVERT

NOTES

1. COORDINATE DATUM: NEW ZEALAND TRANSVERSE MERCATOR 2000.
2. LEVEL DATUM: NEW ZEALAND VERTICAL DATUM 2016
3. EXISTING CONTOURS ARE EXISTING GROUND SURFACE AND HAVE BEEN DERIVED FROM LIDAR DATA SOURCED FROM OPEN TOPOGRAPHY.
4. EXISTING BOUNDARIES AND AERIAL PHOTOGRAPHY HAS BEEN SOURCED FROM LAND INFORMATION NEW ZEALAND (LINZ). THIS DATA IS LICENSED BY (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE. DATE OF PHOTOGRAPHY - 2021.
5. EXISTING STORMWATER CULVERTS AND PIPE SURVEYED BY DAVIS OGILVIE (AORAKI) & PARTNERS LTD. IN MAY 2022.

Babbage

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DRAWING REVISIONS

REV	DATE	DRN BY	DES CHK	APPRVD	DESCRIPTION
A	2022.08.24	MJD		MJM	ISSUED FOR RESOURCE CONSENT
B	2022.09.14	MJD	MJM	MJM	ROAD NAME CORRECTED TO MORVEN GLENAVY ROAD (ALONG SITE SOUTHERN BOUNDARY)

	DATE	INITIAL
DESIGNED		
DRAWN	2022.08.19	MJD
DESIGN CHECK		
DRAWING CHECK	2022.08.19	MJM
APPROVED	2022.08.19	MJM

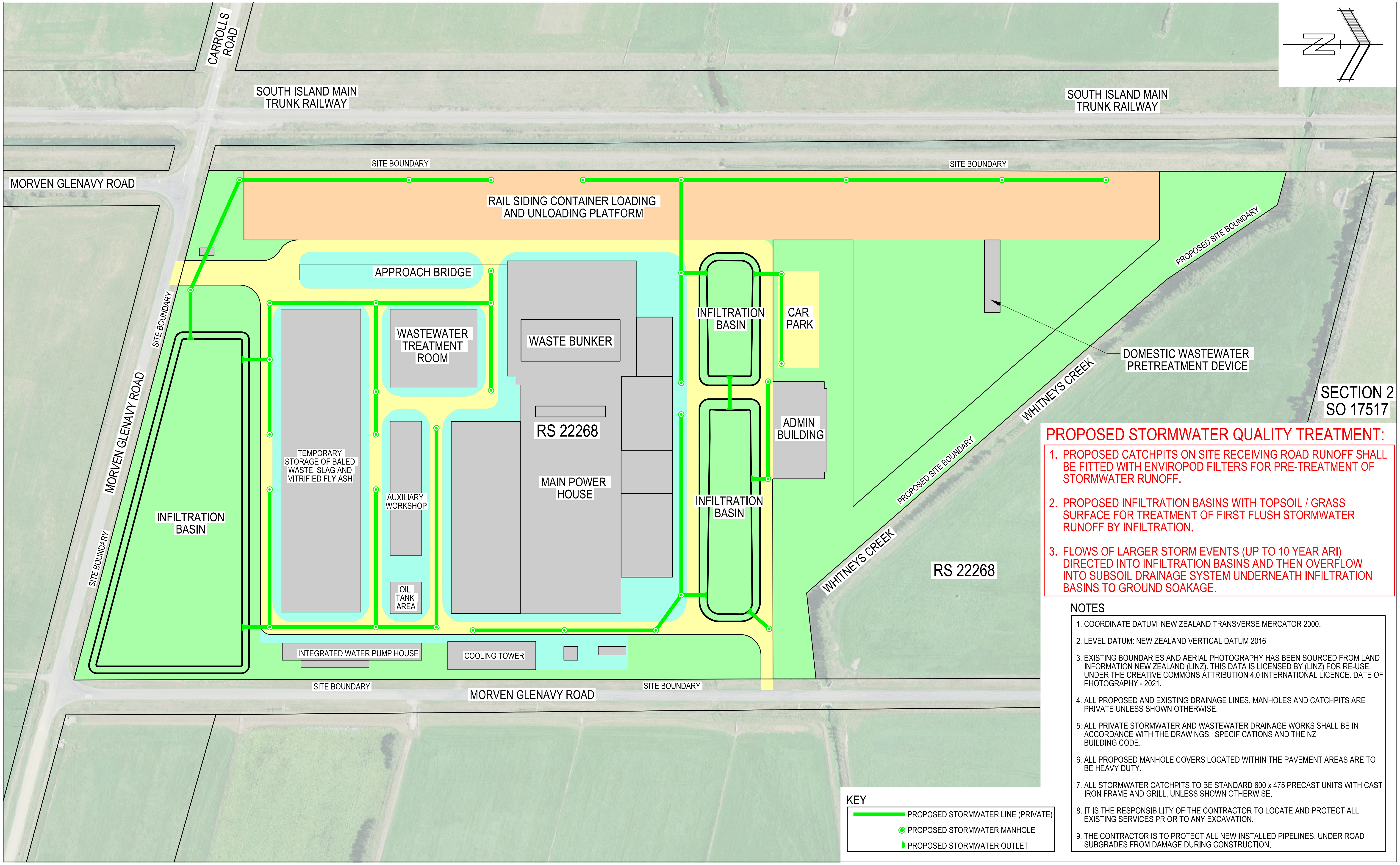
CLIENT / PROJECT
SOUTH ISLAND RESOURCE RECOVERY LTD.
PROJECT KEA

DRAWING TITLE
EXISTING SITE PLAN

FOR RESOURCE CONSENT

SCALE
1:1000 @ A1
1:2000 @ A3

JOB NO.	DRAWING NO.	REVISION
64380	C00	B



PROPOSED STORMWATER QUALITY TREATMENT:

1. PROPOSED CATCHPITS ON SITE RECEIVING ROAD RUNOFF SHALL BE FITTED WITH ENVIROPOD FILTERS FOR PRE-TREATMENT OF STORMWATER RUNOFF.
2. PROPOSED INFILTRATION BASINS WITH TOPSOIL / GRASS SURFACE FOR TREATMENT OF FIRST FLUSH STORMWATER RUNOFF BY INFILTRATION.
3. FLOWS OF LARGER STORM EVENTS (UP TO 10 YEAR ARI) DIRECTED INTO INFILTRATION BASINS AND THEN OVERFLOW INTO SUBSOIL DRAINAGE SYSTEM UNDERNEATH INFILTRATION BASINS TO GROUND SOAKAGE.

NOTES

1. COORDINATE DATUM: NEW ZEALAND TRANSVERSE MERCATOR 2000.
2. LEVEL DATUM: NEW ZEALAND VERTICAL DATUM 2016
3. EXISTING BOUNDARIES AND AERIAL PHOTOGRAPHY HAS BEEN SOURCED FROM LAND INFORMATION NEW ZEALAND (LINZ). THIS DATA IS LICENSED BY (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE. DATE OF PHOTOGRAPHY - 2021.
4. ALL PROPOSED AND EXISTING DRAINAGE LINES, MANHOLES AND CATCHPITS ARE PRIVATE UNLESS SHOWN OTHERWISE.
5. ALL PRIVATE STORMWATER AND WASTEWATER DRAINAGE WORKS SHALL BE IN ACCORDANCE WITH THE DRAWINGS, SPECIFICATIONS AND THE NZ BUILDING CODE.
6. ALL PROPOSED MANHOLE COVERS LOCATED WITHIN THE PAVEMENT AREAS ARE TO BE HEAVY DUTY.
7. ALL STORMWATER CATCHPITS TO BE STANDARD 600 x 475 PRECAST UNITS WITH CAST IRON FRAME AND GRILL, UNLESS SHOWN OTHERWISE.
8. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO LOCATE AND PROTECT ALL EXISTING SERVICES PRIOR TO ANY EXCAVATION.
9. THE CONTRACTOR IS TO PROTECT ALL NEW INSTALLED PIPELINES, UNDER ROAD SUBGRADES FROM DAMAGE DURING CONSTRUCTION.

KEY

- PROPOSED STORMWATER LINE (PRIVATE)
- PROPOSED STORMWATER MANHOLE
- PROPOSED STORMWATER OUTLET

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DRAWING REVISIONS

REV	DATE	DRN BY	DES CHK	APPRVD	DESCRIPTION
A	2022.08.24	JC	MJM	MJM	ISSUED FOR RESOURCE CONSENT
B	2022.09.14	MJD	MJM	MJM	ROAD NAME CORRECTED TO MORVEN GLENAVY ROAD (ALONG SITE SOUTHERN BOUNDARY)

	DATE	INITIAL
DESIGNED	2022.08.16	JC
DRAWN	2022.08.16	JC
DESIGN CHECK	2022.08.23	MJM
DRAWING CHECK	2022.08.23	MJD
APPROVED	2022.08.23	MJM

CLIENT / PROJECT

SOUTH ISLAND RESOURCE RECOVERY LTD.

PROJECT KEA

DRAWING TITLE

INDICATIVE DRAINAGE LAYOUT PLAN

FOR RESOURCE CONSENT

SCALE

1:1000 @ A1
1:2000 @ A3

JOB NO.	DRAWING NO.	REVISION
64380	C10	B

Appendix C

Stormwater Pond Design Calculations

JOB NAME:	**Project KEA**	**DATE:**	17.08.2022
JOB NO:	64308#C	**DES BY:**	MB
SUBJECT:	Stormwater Soakage Basin Sizing	**CHKD BY:**	JC

CATCHMENT AREA A (North half of the site)

Waterways, Wetlands and Drainage Guide (WWDG) - Part B Design

[6 Stormwater Treatment Systems]

Christchurch City Council ◄◄◄ input values in these cells

1) Determine First Flush Volume V_{ff}

$V_{ff} = 10 \times C_{ff} \times A_{total} \times d_{ff}$ — 930.69 m^3

C_{ff} = composite First Flush coefficient

A_{total} = full catchment area — 4.9699 Ha

d_{ff} = First Flush rainfall depth (mm) — 25 mm

$C_{ff} = im\% \times C_{eff} \times C_D$ (or C_{ff} as per Table 6-10) — 0.75

Table 6-10: Zone average impervious area percentages and composite first flush coefficients.

District Zone	Effective impervious area (im %)	Impervious % Contribution C_{eff}	Discharge Coefficients C_D	Composite FF Coefficients C_{ff}
L1	50%	90%	0.9	0.41
L2	55%	90%	0.9	0.53
L3, L4, L5	70%	100%	0.9	0.63
LH	45%	95%	0.9	0.38
Business	90%	100%	0.9	0.81

Schools : Seek advice from CCC
Rural and Park: Not considered to contribute to first flush

2) First Flush Basin Water Surface Area A_{ff}

$A_{ff} = V_{ff}/y_{ff} + (2xh) \times \sqrt{(V_{ff} \times y_{ff})}$ — 6,299.12 m^2

y_{ff} = soakage basin First Flush depth (m) [≤ 1.0m] — 0.15 m

$8 \times \sqrt{(V_{ff} \times y_{ff})}$ = an approximation for 1:4 side batters — 94.52 m^2

$(2xh) \times \sqrt{(V_{ff} \times y_{ff})}$ = an approximation for 1:h side batters

A_b = Area basin base

1v:?h h = 4

L1 =	34.80 m	Base Sides
L2 =	173.78 m	

A_s = Area basin surface = Assuming A_{ff}

L3 =	36.00 m	A_{ff} Sides
L4 =	174.98 m	

Check: V_{ff} = 930.69 m^3 **Resulting V_{ff}=** 925.99 m^3

3) <u>Storm Average Runoff Flow Rate</u> **Q_{avg}**

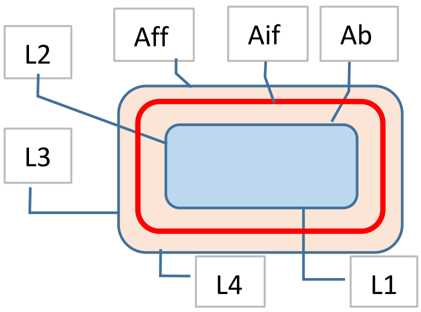
Q_{avg} **= 2.78 x C x i x A** (m^3/s) =

AEP 2% (50y) **			
T_c	T_c (sec)	i (mm/h) *	Q_{avg} (m^3/s)
10m	600	45.96	0.5715
20m	1200	31.47	0.3913
30m	1800	25.58	0.3181
1h	3600	18.23	0.2266
2h	7200	13.13	0.1633
6h	21600	7.69	0.0956
12h	43200	5.33	0.0663
24h	86400	3.55	0.0442
48h	172800	2.25	0.0280
72h	259200	1.68	0.0208
C =	0.9		

* Rainfall depth from NIWA HIRDS website (incl. 2.1 deg C Climate Change)

** Selwyn - CoP 5.12.10 requires 'total detention' of 2% AEP critical duration storm event. Waimate district council requirements to be confirmed.

4) <u>Basin Floor Infiltration Flow Rate</u> **Q_{if}**



Q_{if} = A_{if} x f (m^3/s) — 0.0164 m^3/s

A_{if} = first flush basin inflitration area (m^2) — 6,214.89 m^2 ***

*** **At 2/3 y_{ff} - A_{if}** will vary with basin water level but a good result can be obtained by adopting a mean value for **A_{if}** as the area at 2/3 **y_{ff}**.

L_{if}1 = 35.60 m

L_{if}2 = 174.58 m

f = infiltration rate (m/s)

9.523809524 mm/h	0.0000026 m/s	****
	20 mm/h	

Equivalent safety factor = 2.1 *****

**** A soil infiltration rate not exceeding 75 mm/h is considered appropriate to achieve effective treatment of contaminants. However, a value of 20 mm/hour should be used for design purposes in sizing basins to allow for a reduction in infiltration rate over time

***** Based on GD07, B.4.0, $F_{(u)}$=1.4, $F_{(c)}$=1.5

5) Underdrain Flow Rate $\mathbf{Q_{ud}}$

Conservatively assume that all basin floor infiltration is intercepted by under-drains:

$\mathbf{Q_{ud} = Q_{if}}$ (m^3/s) | 0.0164 m^3/s

6) Storm Total Volume $\mathbf{V_s}$

$\mathbf{V_S = Q_{avg} \times T}$ (m^3) Storm Total Volume

7) Basin Live Storage Volume $\mathbf{V_{LS}}$

V_{ff} First Flush Volume

V_{If} Infiltration Volume

V_{LS} Live Storage Volume

V_B Basin Full Volume (which equals V_s - V_{if})

	$V_S = Q_{avg} \times T$		$V_{If} = Q_{ud} \times T$	$V_{LS} = V_s - V_{ff} - V_{If}$	$V_B = V_{ff} + V_{LS}$	
T_c	**V_S (m3)**	**V_{ff} (m3)**	**V_{If} (m3)**	**V_{LS} (m3)**	**V_B (m3)**	
10m	342.89	930.69	9.86	-597.66	333.03	
20m	469.58	930.69	19.73	-480.84	449.85	
30m	572.61	930.69	29.59	-387.67	543.02	
1h	815.85	930.69	59.19	-174.03	756.66	
2h	1175.63	930.69	118.38	126.56	1,057.25	
6h	2064.45	930.69	355.14	778.63	1,709.32	
12h	2864.09	930.69	710.27	1223.12	2,153.81	
24h	3818.78	930.69	1420.55	1467.54	**2,398.23**	*****
48h	4840.37	930.69	2841.09	1068.58	1,999.27	
72h	5399.81	930.69	4261.64	207.47	1,138.16	

***** Critical storm duration - RC conditions specify up to 24hour duration

7a) Check: $V_B \geq$ Volume of 10% AEP, 18hrs storm:

Storage volume required to be no less than runoff from a 10% AEP, 18 hour storm

AEP 10% (10y)				$\mathbf{V_{min}}$ **(m^3)**	**Check: $V_B > V_{min}$**
T_c	T_c (sec)	i (mm/h) *	$\mathbf{Q_{avg}}$ (m^3/s)		
18h	64800	4.44	0.0552	3580.11	**Increase storage**
C =	0.9				

Summary - Basin parameters:

$\mathbf{V_B = V_{ff} + V_{LS}}$ (m3) Basin full volume | 2,398.23 m^3

$\mathbf{V_{ff}}$ = First flush volume | 930.69 m^3

$\mathbf{V_{LS}}$ = Basin Live Storage Volume | 1,467.54 m^3

$\mathbf{V_S}$ = Storm total runoff volume | 3,818.78 m^3

$\mathbf{V_{If}}$ = Infiltration volume | 1,420.55 m^3

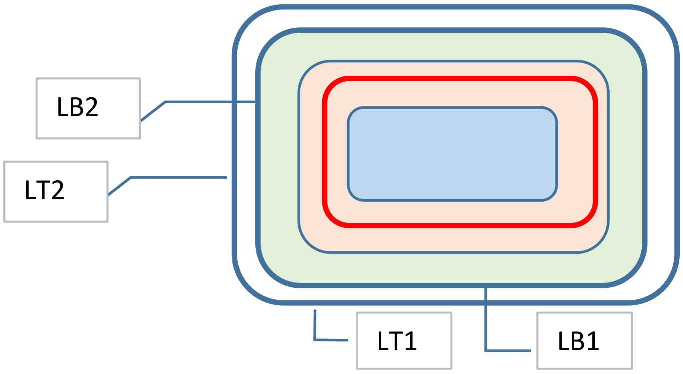
$\mathbf{V_{If} = Q_{ud} \times T_c}$ (m^3)

$\mathbf{Q_{ud}}$ = underdrain flow rate (m3/s) | 0.0164 m^3/s

8) Basin Total Surface Area A_B

(Approximation for 1:h side batters)

1v:?h　　h = 4



$A_B = V_B/y_t + (2 \times h)\sqrt{(V_B \times y_t)}$ (m^2)

y_t = Full Basin Depth

y_t = 0.40 m　　A_B = 6,243.37 m^2

Check:

Resulting V_t = 2,553.47 m^3 ≥ 2,398.23 m^3 = V_B

OK

Total Basin Dimensions:

Assumed freeboard = 0.15 m

y_t + freeboard = 0.55 m

V_B' + freeboard = 3,583.77 m3

L1 =	34.80 m	Base Sides
L2 =	173.78 m	
LT1 =	39.20 m	Top Sides
LT2 =	178.18 m	

JOB NAME:	**Project KEA**	**DATE:**	17.08.2022	Babbage
JOB NO:	64308#C	**DES BY:**	MB	
SUBJECT:	Stormwater Soakage Basin Sizing	**CHKD BY:**	JC	

CATCHMENT AREA B (South half of the site)

Waterways, Wetlands and Drainage Guide (WWDG) - Part B Design

[6 Stormwater Treatment Systems]

Christchurch City Council

◄◄◄ input values in these cells

1) Determine First Flush Volume $\mathbf{V_{ff}}$

$V_{ff} = 10 \times C_{ff} \times A_{total} \times d_{ff}$ — 1,150.21 m^3

C_{ff} = composite First Flush coefficient

A_{total} = full catchment area — 7.0414 Ha

d_{ff} = First Flush rainfall depth (mm) — 25 mm

$C_{ff} = im\% \times C_{eff} \times C_D$ (or C_{ff} as per Table 6-10) — 0.65

Table 6-10: Zone average impervious area percentages and composite first flush coefficients.

District Zone	Effective impervious area (im %)	Impervious % Contribution C_{eff}	Discharge Coefficients C_D	Composite FF Coefficients C_{ff}
L1	50%	90%	0.9	0.41
L2	55%	90%	0.9	0.53
L3, L4, L5	70%	100%	0.9	0.63
LH	45%	95%	0.9	0.38
Business	90%	100%	0.9	0.81

Schools : Seek advice from CCC
Rural and Park: Not considered to contribute to first flush

2) First Flush Basin Water Surface Area $\mathbf{A_{ff}}$

$A_{ff} = V_{ff}/y_{ff} + (2xh) \times \sqrt{(V_{ff} \times y_{ff})}$ — 7,773.17 m^2

y_{ff} = soakage basin First Flush depth (m) [≤ 1.0m] — 0.15 m

$8 \times \sqrt{(V_{ff} \times y_{ff})}$ = an approximation for 1:4 side batters — 105.08 m^2

$(2xh) \times \sqrt{(V_{ff} \times y_{ff})}$ = an approximation for 1:h side batters

A_b = Area basin base

1v:?h h = 4

L1 = 68.80 m
L2 = 109.85 m
Base Sides

A_s = Area basin surface = Assuming $\mathbf{A_{ff}}$

L3 = 70.00 m
L4 = 111.05 m
A_{ff} Sides

Check: V_{ff} = 1,150.21 m^3 **Resulting V_{ff}** = 1,149.79 m^3

3) <u>Storm Average Runoff Flow Rate</u> **Q_{avg}**

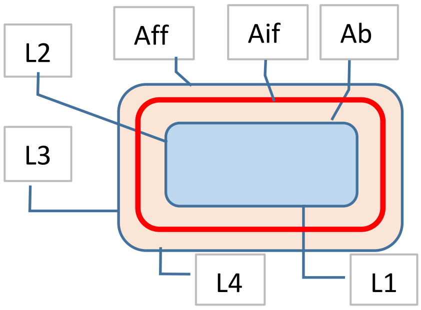
Q_{avg} **= 2.78 x C x i x A** (m^3/s) =

AEP 2% (50y) **			
T_c	T_c (sec)	i (mm/h) *	**Q_{avg}** (m^3/s)
10m	600	45.96	0.8097
20m	1200	31.47	0.5544
30m	1800	25.58	0.4507
1h	3600	18.23	0.3211
2h	7200	13.13	0.2313
6h	21600	7.69	0.1354
12h	43200	5.33	0.0939
24h	86400	3.55	0.0626
48h	172800	2.25	0.0397
72h	259200	1.68	0.0295
C =	0.9		

* Rainfall depth from NIWA HIRDS website (incl. 2.1 deg C Climate Change)

** Selwyn - CoP 5.12.10 requires 'total detention' of 2% AEP critical duration storm event. Waimate district council requirements to be confirmed.

4) <u>Basin Floor Infiltration Flow Rate</u> **Q_{if}**



Q_{if} = A_{if} x f (m^3/s) — 0.0204 m^3/s

A_{if} = first flush basin inflitration area (m^2) — 7,700.91 m^2 ***

*** **At 2/3 y_{ff} - A_{if}** will vary with basin water level but a good result can be obtained by adopting a mean value for **A_{if}** as the area at 2/3 **y_{ff}**.

L_{if}1 = 69.60 m **L_{if}2** = 110.65 m

f = infiltration rate (m/s)	9.523809524 mm/h	0.0000026 m/s ****
		20 mm/h
Equivalent safety factor =		2.1 *****

**** A soil infiltration rate not exceeding 75 mm/h is considered appropriate to achieve effective treatment of contaminants. However, a value of 20 mm/hour should be used for design purposes in sizing basins to allow for a reduction in infiltration rate over time

***** Based on GD07, B.4.0, $F_{(u)}$=1.4, $F_{(c)}$=1.5

5) Underdrain Flow Rate $\mathbf{Q_{ud}}$

Conservatively assume that all basin floor infiltration is intercepted by under-drains:

$Q_{ud} = Q_{if}$ (m^3/s) | 0.0204 m^3/s

6) Storm Total Volume $\mathbf{V_s}$

$V_S = Q_{avg} \times T$ (m^3) Storm Total Volume

7) Basin Live Storage Volume $\mathbf{V_{LS}}$

V_{ff} First Flush Volume

V_{If} Infiltration Volume

V_{LS} Live Storage Volume

V_B Basin Full Volume (which equals V_s - V_{if})

	$V_S = Q_{avg} \times T$		$V_{If} = Q_{ud} \times T$	$V_{LS} = V_s - V_{ff} - V_{If}$	$V_B = V_{ff} + V_{LS}$	
T_c	**V_S (m3)**	**V_{ff} (m3)**	**V_{If} (m3)**	**V_{LS} (m3)**	**V_B (m3)**	
10m	485.81	1,150.21	12.22	-676.62	473.59	
20m	665.30	1,150.21	24.45	-509.36	640.85	
30m	811.29	1,150.21	36.67	-375.60	774.61	
1h	1155.90	1,150.21	73.34	-67.65	1,082.56	
2h	1665.65	1,150.21	146.68	368.75	1,518.96	
6h	2924.94	1,150.21	440.05	1334.67	2,484.88	
12h	4057.86	1,150.21	880.10	2027.55	3,177.76	
24h	5410.48	1,150.21	1760.21	2500.06	**3,650.28**	*****
48h	6857.87	1,150.21	3520.41	2187.25	3,337.46	
72h	7650.49	1,150.21	5280.62	1219.66	2,369.87	

***** Critical storm duration - RC conditions specify up to 24hour duration

7a) Check: $V_B \geq$ Volume of 10% AEP, 18hrs storm:

Storage volume required to be no less than runoff from a 10% AEP, 18 hour storm

AEP 10% (10y)				V_{min} (m^3)	**Check: $V_B > V_{min}$**
T_c	T_c (sec)	i (mm/h) *	Q_{avg} (m^3/s)		
18h	64800	4.44	0.0783	5072.33	**Increase storage**
C =	0.9				

Summary - Basin parameters:

$V_B = V_{ff} + V_{LS}$ (m3) Basin full volume: 3,650.28 m^3

V_{ff} = First flush volume: 1,150.21 m^3

V_{LS} = Basin Live Storage Volume: 2,500.06 m^3

V_S = Storm total runoff volume: 5,410.48 m^3

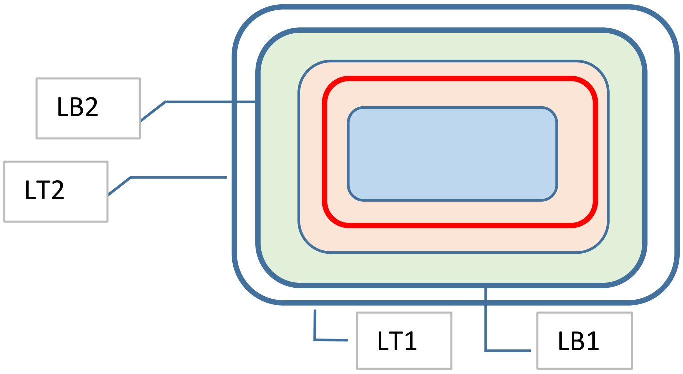
V_{If} = Infiltration volume: 1,760.21 m^3

$V_{If} = Q_{ud} \times T_c$ (m^3)

Q_{ud} = underdrain flow rate (m3/s): 0.0204 m^3/s

8) Basin Total Surface Area $\mathbf{A_B}$

(Approximation for 1:h side batters)



1v:?h h = 4

$A_B = V_B/y_t + (2 \times h)\sqrt{(V_B \times y_t)}$ (m^2)

y_t = Full Basin Depth

y_t = 0.50 m

A_B = 7,642.33 m^2

Check:

Resulting V_t = 3,959.32 m^3 ≥ 3,650.28 m^3 $=V_B$

OK

Total Basin Dimensions:

Assumed freeboard = 0.15 m

y_t + freeboard = 0.65 m

V_B' + freeboard = 5,222.98 m3

L1 = 68.80 m
L2 = 109.85 m
→ Base Sides

LT1 = 74.00 m
LT2 = 115.05 m
→ Top Sides

Appendix D

Stormwater Contaminant Calculations

Stormwater Contaminant Assessment

25-Nov-22
BW/MJM

Vehicle Pavements, Building Roofs and Grassed Areas

		Pre-Treatment Contaminants							Post-Treatment Contaminants			
Source	Contaminant	Contaminant Load	Area	Initial Contaminant Load	Rainfall Depth	Rainfall Volume	Pre-Treatment Contaminant Concentration		Enviropod Efficiency	Infiltration Basin Efficiency	Post-Treatment Contaminant Concentration	
		g/m2/yr	m2	g/yr	mm/yr	m3/yr	g/m3	mg/m3	%	%	g/m3	mg/m3
Roof	TSS	5.000	42200	211000	895	37769	5.5866	5586.6	N/A	80%	1.1173	1117.3
	Zinc	0.020	42200	844.00	895	37769	0.0223	22.346	N/A	60%	0.0089	8.9385
	Copper	0.002	42200	67.520	895	37769	0.0018	1.7877	N/A	60%	0.0007	0.7151
	Lead	0.000	42200	0.0000	895	37769	0.0000	0.0000	N/A	60%	0.0000	0.0000
	TTPH	0.000	42200	0.0000	895	37769	0.0000	0.0000	N/A	60%	0.0000	0.0000
Roads	TSS	20.000	16100	322000	895	14410	22.346	22346	75%	80%	1.1173	1117.3
	Zinc	0.004	16100	67.467	895	14410	0.0047	4.6821	56%	60%	0.0008	0.8194
	Copper	0.001	16100	22.693	895	14410	0.0016	1.5749	56%	60%	0.0003	0.2756
	Lead	0.047	16100	751.33	895	14410	0.0521	52.142	56%	60%	0.0091	9.1248
	TTPH	0.003	16100	53.667	895	14410	0.0037	3.7244	56%	60%	0.0007	0.6518
Railway Sliding	TSS	15.00	21200	318000	895	18974	16.760	16760	75%	80%	0.8380	837.99
	Zinc	0.003	21200	66.629	895	18974	0.0035	3.5116	56%	60%	0.0006	0.6145
	Copper	0.001	21200	22.411	895	18974	0.0012	1.1812	56%	60%	0.0002	0.2067
	Lead	0.035	21200	742.00	895	18974	0.0391	39.106	56%	60%	0.0068	6.8436
	TTPH	0.003	21200	53.000	895	18974	0.0028	2.7933	56%	60%	0.0005	0.4888
Grassed	TSS	8.000	56000	448000	895	50120	8.9385	8938.5	N/A	80%	1.7877	1787.7
	Zinc	0.002	56000	112.00	895	50120	0.0022	2.2346	N/A	60%	0.0009	0.8939
	Copper	0.002	56000	112.00	895	50120	0.0022	2.2346	N/A	60%	0.0009	0.8939
	Lead	0.003	56000	168.00	895	50120	0.0034	3.3520	N/A	60%	0.0013	1.3408
	TTPH	0.001	56000	56.000	895	50120	0.0011	1.1173	N/A	60%	0.0004	0.4469
Total Combined Surfaces	**TSS**			1299000	895	121273	10.711	10711			1.3507	1350.7
	Zinc			1090.1	895	121273	0.0090	8.9888			0.0033	3.3467
	Copper			224.62	895	121273	0.0019	1.8522			0.0007	0.6572
	Lead			1661.3	895	121273	0.0137	13.699			0.0027	2.7091
	TTPH			162.67	895	121273	0.0013	1.3413			0.0003	0.3386
										Totals	**1.3577**	**1357.7**

Notes:
1. Contaminant load estimated at 75% of road contaminant load
2. Contaminant load adopted from TP10, Table 4-4
3. All other contaminant loads adopted from CLM

Air Discharge

			Pre-Treatment Contaminants							Post-Treatment Contaminants			
Source	Contaminant	Percentage	Contaminant Load	Area	Initial Contaminant Load	Rainfall Depth	Rainfall Volume	Pre-Treatment Contaminant Concentration		Enviropod Efficiency	Infiltration Basin Efficiency	Post-Treatment Contaminant Concentration	
		%	g/m2/yr	m2	g/yr	mm/yr	m3/yr	g/m3	mg/m3	%	%	g/m3	mg/m3
Air Discharge	Calcium	35.9%	0.022644	148500	3362.681	895	132908	0.02530	25.301	0%	60%	0.01012	10.120
	Oxygen	23.4%	0.014760	148500	2191.831	895	132908	0.01649	16.491	0%	60%	0.00660	6.5966
	Chlorine	17.7%	0.011164	148500	1657.924	895	132908	0.01247	12.474	0%	60%	0.00499	4.9897
	Silicon	4.3%	0.002712	148500	402.772	895	132908	0.00303	3.0305	0%	60%	0.00121	1.2122
	Potassium	3.6%	0.002271	148500	337.205	895	132908	0.00254	2.5371	0%	60%	0.00101	1.0149
	Sulphur	2.5%	0.001577	148500	234.170	895	132908	0.00176	1.7619	0%	60%	0.00070	0.7048
	Iron	2.5%	0.001577	148500	234.170	895	132908	0.00176	1.7619	0%	60%	0.00070	0.7048
	Sodium	2.4%	0.001514	148500	224.803	895	132908	0.00169	1.6914	0%	60%	0.00068	0.6766
	Water	2.2%	0.001388	148500	206.070	895	132908	0.00155	1.5505	0%	60%	0.00062	0.6202
	Carbon	1.5%	0.000946	148500	140.502	895	132908	0.00106	1.0571	0%	60%	0.00042	0.4229
	Aluminium	1.1%	0.000694	148500	103.035	895	132908	0.00078	0.7752	0%	60%	0.00031	0.3101
	Magnesium	1.1%	0.000694	148500	103.035	895	132908	0.00078	0.7752	0%	60%	0.00031	0.3101
	Zinc	0.5%	0.000315	148500	46.834	895	132908	0.00035	0.3524	0%	60%	0.00014	0.1410
	Titanium	0.4%	0.000252	148500	37.467	895	132908	0.00028	0.2819	0%	60%	0.00011	0.1128
	Lead	0.2%	0.000126	148500	18.734	895	132908	0.00014	0.1410	0%	60%	0.00006	0.0564
	Phosphorous	0.2%	0.000126	148500	18.734	895	132908	0.00014	0.1410	0%	60%	0.00006	0.0564
	Bromide	0.2%	0.000126	148500	18.734	895	132908	0.00014	0.1410	0%	60%	0.00006	0.0564
	Chromium	0.1%	0.000063	148500	9.367	895	132908	0.00007	0.0705	0%	60%	0.00003	0.0282
	Manganese	0.1%	0.000063	148500	9.367	895	132908	0.00007	0.0705	0%	60%	0.00003	0.0282
	Strontium	0.1%	0.000063	148500	9.367	895	132908	0.00007	0.0705	0%	60%	0.00003	0.0282
	Copper	0.1%	0.000063	148500	9.367	895	132908	0.00007	0.0705	0%	60%	0.00003	0.0282
	Barium	0.1%	0.000063	148500	9.367	895	132908	0.00007	0.0705	0%	60%	0.00003	0.0282
	Cadium	0.04%	0.000025	148500	3.747	895	132908	0.00003	0.0282	0%	60%	0.00001	0.0113
	Nickel	0.01%	0.000006	148500	0.937	895	132908	0.00001	0.0070	0%	60%	0.00000	0.0028
	Total		**0.063076**		**9366.8**		**Total**	**0.07065**	**70.6523**		**Total**	**0.02826**	**28.261**