APPENDIX F

Water Balance Calculations

CROZIER CONSULTING ENGINEERS

Project Name: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Checked By: NCO
Date: 2023.05.24

Water Budget - Pre-Development
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Pre-development area available for infiltration (landscaped/lawn area considered to infiltrate)
Pre-development area not available for infiltration (total site area less landscaped area noted above)
Remaining Impervious area (e.g. parking asphalt area)

Note: site land use areas consistent with Pre-Development SWM hydrologic modeling & calculations

Catchment Designation	Site					Glenelg Phase 2 Lands	
	Pervious Area to CP Trail	Pervious Area to North Tile Drain	Pervious Area to South Residential	Pervious Area to Southeast Tile Drain	Pervious Area to East Tile Drain	Pervious Area from Glenelg Phase 2 Lands - External	Totals
Area (m^2)	43200	133300	30000	22900	30500	6800	266700
Pervious Area (m^2)	43200	133300	30000	22900	30500	6800	266700
Impervious Area (m^2)	0	0	0	0	0	0	0
Infiltration Factors							
Topography Infiltration Factor	0.25	0.25	0.25	0.25	0.25	0.25	
Soil Infiltration Factor	0.2	0.2	0.2	0.2	0.2	0.2	
Land Cover Infiltration Factor	0.1	0.1	0.1	0.1	0.1	0.1	
MOE Infiltration Factor	0.55	0.55	0.55	0.55	0.55	0.55	
Actual Infiltration Factor	0.55	0.55	0.55	0.55	0.55	0.55	
Run-off Coefficient	0.25	0.25	0.25	0.25	0.25	0.25	
Runoff from Impervious Surfaces *	0	0	0	0	0	0	
Inputs (per Unit Area)							
Precipitation (mm/yr)	1106	1106	1106	1106	1106	1106	1106
Run-On (mm/yr)	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0
Total Inputs (mm/yr)	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**
Outputs (per Unit Area)							
Precipitation Surplus (mm/yr)	573	573	573	573	573	573	573
Net Surplus (mm/yr)	573	573	573	573	573	573	573
Evapotranspiration (mm/yr) *	533	533	533	533	533	533	533
Infiltration (mm/yr)	315	315	315	315	315	315	315
Topsoil Amendment Infiltration(mmyr)	0	0	0	0	0	0	0
Bioretention Infiltration(mmyr)	0	0	0	0	0	0	0
Tree Pit Infiltration(mm/yr)	0	0	0	0	0	0	0
Total Infiltration (mm/yr)	315	315	315	315	315	315	315
Runoff Pervious Areas (mm/yr)	258	258	258	258	258	258	258
Runoff Impervious Areas (mm/yr)	0	0	0	0	0	0	0
Total Runoff (mm/yr)	258	258	258	258	258	258	258
Total Outputs (mm/yr)	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**
Difference (Inputs- Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)							
Precipitation (m^3/yr)	47788	147456	33186	25332	33739	7522	295024
Run-On (m^3/yr)	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	**47788**	**147456**	**33186**	**25332**	**33739**	**7522**	**295024**
Outputs (Volumes)							
Precipitation Surplus (m^3/yr)	24766	76420	17199	13128	17485	3898	152896
Net Surplus (m^3/yr)	24766	76420	17199	13128	17485	3898	152896
Evapotranspiration (m^3/yr) *	23022	71037	15987	12204	16254	3624	142127
Infiltration (m^3/yr)	13621	42031	9459	7221	9617	2144	84093
Topsoil Amendment Infiltration(mmyr)	0	0	0	0	0	0	0
Bioretention Infiltration(m^3/yr)	0	0	0	0	0	0	0
Tree Pit Infiltration(m^3/yr)	0	0	0	0	0	0	0
Total Infiltration (m^3/yr)	13621	42031	9459	7221	9617	2144	84093
Runoff Pervious Areas (m^3/yr)	11145	34389	7739	5908	7868	1754	68803
Runoff Impervious Areas (m^3/yr)	0	0	0	0	0	0	0
Total Runoff (m^3/yr)	11145	34389	7739	5908	7868	1754	68803
Total Outputs (m^3/yr)	**47788**	**147456**	**33186**	**25332**	**33739**	**7522**	**295024**
Difference (Inputs- Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**

NOTES:
* Evaporation from impervious areas was assumed to be 20% of precipitation.

CROZIER CONSULTING ENGINEERS

Project Name: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Checked By: NCO
Date: 2023.05.24

Water Budget - Post-Development *Without Mitigation*
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Post-development area available for infiltration (landscaped/lawn area considered to infiltrate)
Post-development area not available for infiltration (total site area less landscaped area noted above)
Remaining Impervious area (e.g. parking asphalt area, building/rooftop area)

Note: site land use areas consistent with Post-Development SWM hydrologic modeling & calculations

Catchment Designation	Site			Glenelg Phase 2 Lands		
	Pervious Area	Impervious Block Area	Impervious Road Area	Pervious Area	Impervious Area	Totals
Area (m^2)	106349	90585	61966	6272	1528	266700
Pervious Area (m^2)	106349	0	0	6272	0	112621
Impervious Area (m^2)	0	90585	61966	0	1528	154079
Infiltration Factors						
Topography Infiltration Factor	0.25	0	0	0.25	0	
Soil Infiltration Factor	0.2	0	0	0.2	0	
Land Cover Infiltration Factor	0.1	0	0	0.1	0	
MOE Infiltration Factor	0.55	0	0	0.55	0	
Actual Infiltration Factor	0.55	0	0	0.55	0	
Run-off Coefficient	0.25	1	1	0.25	1	
Runoff from Impervious Surfaces *	0	0.8	0.8	0	0.8	
Inputs (per Unit Area)						
Precipitation (mm/yr)	1106	1106	1106	1106	1106	1106
Run-On (mm/yr)	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0
Total Inputs (mm/yr)	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**
Outputs (per Unit Area)						
Precipitation Surplus (mm/yr)	573	885	885	573	885	760
Net Surplus (mm/yr)	573	885	885	573	885	760
Evapotranspiration (mm/yr) *	533	221	221	533	221	346
Infiltration (mm/yr)	315	0	0	315	0	126
Topsoil Amendment Infiltration(mmyr)	0	0	0	0	0	0
Bioretention Infiltration(mmyr)	0	0	0	0	0	0
Tree Pit Infiltration(mm/yr)	0	0	0	0	0	0
Total Infiltration (mm/yr)	315	0	0	315	0	126
Runoff Pervious Areas (mm/yr)	258	0	0	258	0	103
Runoff Impervious Areas (mm/yr)	0	885	885	0	885	531
Total Runoff (mm/yr)	258	885	885	258	885	634
Total Outputs (mm/yr)	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**
Difference (Inputs- Outputs)	**0**	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)						
Precipitation (m^3/yr)	117643	100205	68547	6938	1690	295024
Run-On (m^3/yr)	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0
Total Inputs (m^3/yr)	**117643**	**100205**	**68547**	**6938**	**1690**	**295024**
Outputs (Volumes)						
Precipitation Surplus (m^3/yr)	60969	80164	54837	3596	1352	200918
Net Surplus (m^3/yr)	60969	80164	54837	3596	1352	200918
Evapotranspiration (m^3/yr) *	56674	20041	13709	3342	338	94105
Infiltration (m^3/yr)	33533	0	0	1978	0	35510
Topsoil Amendment Infiltration(m^3/yr)	0	0	0	0	0	0
Bioretention Infiltration(m^3/yr)	0	0	0	0	0	0
Tree Pit Infiltration(m^3/yr)	0	0	0	0	0	0
Total Infiltration (m^3/yr)	33533	0	0	1978	0	35510
Runoff Pervious Areas (m^3/yr)	27436	0	0	1618	0	29054
Runoff Impervious Areas (m^3/yr)	0	80164	54837	0	1352	136354
Total Runoff (m^3/yr)	27436	80164	54837	1618	1352	165408
Total Outputs (m^3/yr)	**117643**	**100205**	**68547**	**6938**	**1690**	**295024**
Difference (Inputs- Outputs)	**0**	**0**	**0**	**0**	**0**	**0**

Pre-Development Total Infiltration:
84093 m^3/yr

NOTES:
* Evaporation from impervious areas was assumed to be 20% of precipitation.

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Modelled By: KS
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Date: 2023.05.24

Water Budget - Post-Development *with Mitigation*
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Post-development area available for infiltration (lawn/landscaped area considered to infiltrate).

Post-development area not available for infiltration (total site area less landscaped area noted above)
Remaining impervious area (e.g. parking asphalt area, building/rooftop area)

Catchment Designation	Site - Post-Development																
	Draining to CP Trail (Outlet #1)				Draining to Southeast Tile Drain (Outlet #4)		Draining to East Tile Drain (Outlet #3)				Draining to North Tile Drain (Outlet #2)						
	Pervious Area Draining Uncontrolled to CP Trail	Impervious Area Draining Uncontrolled to CP Trail	Pervious Area Draining from TR-1 (Glenelg Phase 2 Lands)	Impervious Area Draining from TR-1 (Glenelg Phase 2 Lands)	Pervious Area Draining to Southeast Tile Drain	Impervious Area Draining to Southeast Tile Drain	Impervious Area Draining Uncontrolled to East Tile Drain	Pervious Area Draining Uncontrolled to East Tile Drain	Impervious Draining to Bioretention	Pervious Area Tributarty to Bioretention	Impervious Area Tributary to North Tile Drain	Pervious Area Tributarty to North Tile Drain	Impervious Draining to Tree Pits	Pervious Area Tributarty to Tree Pits	Impervious SWM Pond Block Tributary to North Tile Drain	Pervious SWM Pond Block Tributary to North Tile Drain	Totals
Area (m^2)	10198	0	6272	1528	20025	18436	2552	1310	1924	11816	31157	18512	90677	36683	7805	7805	266700
Pervious Area (m^2)	10198	0	6272	0	20025	0	0	1310	0	11816	0	18512	0	36683	0	7805	112621
Impervious Area (m^2)	0	0	0	1528	0	18436	2552	0	1924	0	31157	0	90677	0	7805	0	154079
Infiltration Factors																	
Topography Infiltration Factor	0.25	0	0.25	0	0.25	0	0	0.25	0	0.25	0	0.25	0	0.25	0	0.25	
Soil Infiltration Factor	0.2	0	0.2	0	0.2	0	0	0.2	0	0.2	0	0.2	0	0.2	0	0.2	
Land Cover Infiltration Factor	0.1	0	0.1	0	0.1	0	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	
MOE Infiltration Factor	0.55	0	0.55	0	0.55	0	0	0.55	0	0.55	0	0.55	0	0.55	0	0.55	
Actual Infiltration Factor	0.55	0	0.55	0	0.55	0	0	0.55	0	0.55	0	0.55	0	0.55	0	0.55	
Run-off Coefficient	0.25	1.00	0.25	1.00	0.25	1.00	1.00	0.25	1.00	0.25	1.00	0.25	1.00	0.25	1.00	0.25	
Runoff from Impervious Surfaces *	0	0.8	0	0.8	0	0.8	0.8	0	0.8	0	0.8	0	0.8	0	0.8	0	
Inputs (per Unit Area)																	
Precipitation (mm/yr)	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106
Run-On (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	1106
Outputs (per Unit Area)																	
Precipitation Surplus (mm/yr)	573	885	573	885	573	885	885	573	885	573	885	573	885	573	885	573	729
Net Surplus (mm/yr)	573	885	573	885	573	885	885	573	885	573	885	573	885	573	885	573	729
Evapotranspiration (mm/yr) *	533	221	533	221	533	221	221	533	221	533	221	533	221	533	221	533	377
Infiltration (mm/yr)	315	0	315	0	315	0	0	315	0	315	0	315	0	315	0	315	158
Topsoil Amendment Infiltration(mm/yr)	64	0	0	0	64	0	0	64	0	64	0	64	0	64	0	64	28
Bioretention Infiltration(mm/yr)	0	0	0	0	0	500	0	0	37	37	0	0	0	0	0	0	36
Tree Pit Infiltration(mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	99	99	0	0	12
Total Infiltration (mm/yr)	380	0	315	0	380	500	0	380	487	487	0	380	99	479	0	380	267
Runoff Pervious Areas (mm/yr)	193	0	258	0	193	0	0	193	0	86	0	193	0	94	0	193	88
Runoff Impervious Areas (mm/yr)	0	885	0	885	0	385	885	0	398	0	885	0	786	0	885	0	375
Total Runoff (mm/yr)	193	885	258	885	193	385	885	193	398	86	885	193	786	94	885	193	463
Total Outputs (mm/yr)	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**	**1106**
Difference (Inputs- Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			0
Inputs (Volumes)																	
Precipitation (m^3/yr)	11281	0	6938	1690	22152	20394	2823	1449	2128	13071	34466	20478	100307	40579	8634	8634	295024
Run-On (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	**11281**	**0**	**6938**	**1690**	**22152**	**20394**	**2823**	**1449**	**2128**	**13071**	**34466**	**20478**	**100307**	**40579**	**8634**	**8634**	**295024**
Outputs (Volumes)																	
Precipitation Surplus (m^3/yr)	5846	0	3596	1352	11480	16315	2258	751	1703	6774	27573	10613	80246	21030	6907	4475	200918
Net Surplus (m^3/yr)	5846	0	3596	1352	11480	16315	2258	751	1703	6774	27573	10613	80246	21030	6907	4475	200918
Evapotranspiration (m^3/yr) *	5435	0	3342	338	10672	4079	565	698	426	6297	6893	9865	20061	19549	1727	4159	94105
Infiltration (m^3/yr)	3216	0	1978	0	6314	0	0	413	0	3726	0	5837	0	11566	0	2461	35510
Topsoil Amendment Infiltration(m^3/yr)	658	0	0	0	1292	0	0	84	0	762	0	1194	0	2366	0	503	6859
Bioretention Infiltration(m^3/yr)	0	0	0	0	0	9218	0	0	71	437	0	0	0	0	0	0	9726
Tree Pit Infiltration(m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	8977	3632	0	0	12609
Total Infiltration (m^3/yr)	3873	0	1978	0	7606	9218	0	498	937	5752	0	7031	8977	17564	0	2964	66397
Runoff Pervious Areas (m^3/yr)	1973	0	1618	0	3875	0	0	253	0	1022	0	3582	0	3466	0	1510	17299
Runoff Impervious Areas (m^3/yr)	0	0	0	1352	0	7097	2258	0	766	0	27573	0	71268	0	6907	0	117222
Total Runoff (m^3/yr)	1973	0	1618	1352	3875	7097	2258	253	766	1022	27573	3582	71268	3466	6907	1510	134521
Total Outputs (m^3/yr)	**11281**	**0**	**6938**	**1690**	**22152**	**20394**	**2823**	**1449**	**2128**	**13071**	**34466**	**20478**	**100307**	**40579**	**8634**	**8634**	**295024**
Difference (Inputs- Outputs)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0

Proposed Infiltration via Mitigation

Pre-Development Total Infiltration:
315 mm/yr

Note:
mm Precipitation available between Apr-Oct (non-winter months). Therefore

Pre-Development Total Infiltration:
84093 m3/yr

Runoff draining to CP Tile Drain decreased by **56% (6,201m^3/yr)** in Post-Development Conditions
Runoff draining to Southeast Tile Drain increased by **86% (5,064m^3/yr)** in Post-Development Conditions
Runoff draining to East Tile Drain decreased by **45% (3,569m^3/yr)** in Post-Development Conditions
Runoff draining to North Tile Drain increased by **232% (79,917m^3/yr)** in Post-Development Conditions

NOTES:
* Evaporation from impervious areas was assumed to be 20% of precipitation.

Project: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Checked By: NCO
Date: 2023.05.24

Water Budget Summary
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Characteristic	Site				
	Pre-Development	Post-Development	Post-Development *with Mitigation*	Change (Pre to Post)	Change (Pre to Post) *with Mititgation*
Inputs (Volumes)					
Precipitation (m^3/yr)	295024	295024	295024	0%	0%
Run-On (m^3/yr)	0	0	0	0%	0%
Other inputs (m^3/yr)	0	0	0	0%	0%
Total Inputs (m^3/yr)	**295024**	**295024**	**295024**	**0**	**0**
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	152896	200918	200918	31%	31%
Net Surplus (m^3/yr)	152896	200918	200918	31%	31%
Evapotranspiration (m^3/yr)	142127	94105	94105	-34%	-34%
Infiltration (m^3/yr)	84093	35510	35510	-58%	-58%
Topsoil Amendment Infiltration (m^3/yr)	0	0	6859	-	**6859 m3/yr**
Bioretention Infiltration (m^3/yr)	0	0	9726	-	**9726 m3/yr**
Tree Pit Infiltration(m^3/yr)	0	0	12609	-	**12609 m3/yr**
Total Infiltration (m^3/yr)	**84093**	**35510**	**66397**	-58%	-21%
Runoff Pervious Areas (m^3/yr)	68803	29054	17299	-58%	-75%
Runoff Impervious Areas (m^3/yr)	0	136354	117222	-	-
Total Runoff (m^3/yr)	68803	165408	134521	140%	96%
Total Outputs (m^3/yr)	**295024**	**295024**	**295024**	0%	0%

NOTES:
* Total Infiltration into groundwater system (29194m3/yr) is to be maintained via the proposed LIDs.

Months contributing to Water Balance (winter months not considered due to freezing effects) - April, May, June, July, August, September, October = 7 months

Project: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Date: 2023.05.24

Design Storm Determination - Bioretention in Park Block
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Days with Precipitation (From Climate Data)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
>= 0.2 mm	14.6	13	12.8	11.9	13.1	15.3	16.9	98
>= 5 mm	4.7	5.6	5.2	4.5	5.2	6.2	6.1	38
>= 10 mm	2.1	2.9	3.2	2.2	3	3.5	2.9	20
>= 25 mm	0.32	0.64	0.86	0.81	0.81	0.86	0.33	5

Available Precipitation

Storm Event (mm)	**Total Days Per Year**	**Incremental Precipitation (mm/yr)**	**Cummulative Precipitation (mm/yr)**
0.2	98	19.5	19.5
5	38	187.5	207.0
10	20	198.0	405.0
25	5	115.8	520.8
Total	**160**	**520.8**	

Bioretention Infiltration Target: 37 mm/yr

Runoff Coefficient: 0.30

Design Precipitation: 124 mm/yr (Design Infiltration / Contributing RC)

Therefore Min. Design Storm: 2.91 mm

Volume of Storage Required: 39.95 m^3

Project: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Date: 2023.05.24

Mitigation Sizing - Bioretention in Park Block
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Contributing Drainage Area:	13740	m^2
Runoff Coefficient:	0.30	
Design Storm:	3	mm
Design Runoff/Infiltration Volume:	39.9	m^3

Maximum Depth of Cell

$$d_{cmax} = i*(t_s-d_p/i)/V_r$$

Where:
$d_{c\,max}$ = Maximum cell depth (mm)
i = Infiltration rate for native soils (mm/hr)
V_r = Void space ratio for filter bed and gravel storage layer (assume 0.4)
t_s = Time to drain
d_p = Maximum surface ponding depth (mm)

Assumptions

i^1 =	6	mm/hr
V_r =	0.4	
t_s =	48	hr
d_p =	0	mm
$d_{c\,max}$ =	0.7	m

Length of Bioretention:	35	m
Width of Bioretention:	3	m
Number of LIDs:	2	
Storage Depth:	0.500	m
Drawdown Time:	33.333	hr
Total Volume Retained:	42	m^3

Based on Borehole MW22-313 S

Depth to Groundwater:	1.985	m
Storage Depth:	0.500	m
Clearance from Groundwater:	1.485	m

Therefore, the proposed system will drain within 48 hours and will provide a retention volume that exceeds the volume for mitigation.

Project: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Date: 2023.05.24

Design Storm Determination - Bioretention in School Block
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Days with Precipitation (From Climate Data)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
>= 0.2 mm	14.6	13	12.8	11.9	13.1	15.3	16.9	98
>= 5 mm	4.7	5.6	5.2	4.5	5.2	6.2	6.1	38
>= 10 mm	2.1	2.9	3.2	2.2	3	3.5	2.9	20
>= 25 mm	0.32	0.64	0.86	0.81	0.81	0.86	0.33	5

Available Precipitation

Storm Event (mm)	**Total Days Per Year**	**Incremental Precipitation (mm/yr)**	**Cummulative Precipitation (mm/yr)**
0.2	98	19.5	19.5
5	38	187.5	207.0
10	20	198.0	405.0
25	5	115.8	520.8
Total	**160**	**520.8**	

Bioretention Infiltration Target: 500 mm/yr

Runoff Coefficient: 0.90

Design Precipitation: 556 mm/yr (Design Infiltration / Contributing RC)

Therefore Min. Design Storm: 13.80 mm

Volume of Storage Required: 189.63 m^3

Project: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Date: 2023.05.24

Mitigation Sizing - Bioretention in School Block
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Contributing Drainage Area:	18436	m^2
Runoff Coefficient:	1.00	
Design Storm:	14	mm
Design Runoff/Infiltration Volume:	189.6	m^3

Maximum Depth of Cell

$$d_{cmax} = i*(t_s-d_p/i)/V_r$$

Where:
$d_{c\,max}$ = Maximum cell depth (mm)
i = Infiltration rate for native soils (mm/hr)
V_r = Void space ratio for filter bed and gravel storage layer (assume 0.4)
t_s = Time to drain
d_p = Maximum surface ponding depth (mm)

Assumptions

i^1 =	6	mm/hr
V_r =	0.4	
t_s =	48	hr
d_p =	0	mm
$d_{c\,max}$ =	0.7	m

Length of Bioretention:	42	m
Width of Bioretention:	4	m
Number of LIDs:	4	
Storage Depth:	0.720	m
Drawdown Time:	48	hr
Total Volume Retained:	193.54	m^3

Based on Borehole MW22-314

Depth to Groundwater:	4.38	m
Storage Depth:	0.720	m
Clearance from Groundwater:	3.660	m

Therefore, the proposed system will drain within 48 hours and will provide a retention volume that exceeds the volume for mitigation.

Project: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Date: 2023.05.24

Design Storm Determination - Tree Pits
Project Name: Glenelg Expansion Lands
Water Balance/Water Budget Assessment

Days with Precipitation (From Climate Data)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
>= 0.2 mm	14.6	13	12.8	11.9	13.1	15.3	16.9	98
>= 5 mm	4.7	5.6	5.2	4.5	5.2	6.2	6.1	38
>= 10 mm	2.1	2.9	3.2	2.2	3	3.5	2.9	20
>= 25 mm	0.32	0.64	0.86	0.81	0.81	0.86	0.33	5

Available Precipitation

Storm Event (mm)	**Total Days Per Year**	**Incremental Precipitation (mm/yr)**	**Cummulative Precipitation (mm/yr)**
0.2	98	19.5	19.5
5	38	187.5	207.0
10	20	198.0	405.0
25	5	115.8	520.8
Total	**160**	**520.8**	

Tree Pit Infiltration Target: 99 mm/yr

Runoff Coefficient: 0.71

Design Precipitation: 139 mm/yr (Design Infiltration / Contributing RC)

Therefore Min. Design Storm: 3.28 mm

Volume of Storage Required: 417.7 m^3

Project: Glenelg Expansion Lands
Project No: 1060-6220
Modelled By: KS
Date: 2023.05.24

Stormwater Tree Pit
Project Name: Glenelg Expansion Lands

Water Balance/Water Budget Assessment

Location	Drainage Area (Ha)	Required Storage Volume (m^3)	Native Soil Infiltration Rate* (mm/hr)	Safety Factor	Native Soil Infiltration Rate with Safety Factor (mm/hr)	Void Space of Sand Layer	Void Space Ratio of Gravel Layer	Depth of Sand Layer (m)	Depth of Gravel Layer (m)	Actual Length of Bioretention Cell (m)	Actual Width of the Biretention Cell (m)	Provided Surface Area (m^2)	Drawdown Time (hrs)	Total Retention Storage Provided per LID (m^3)	# of LIDs	Total Retention Storage Provided (m^3)
Tree Pits - North Tile Drain	12.736	418	12	1.5	8.00	0.20	0.40	0.10	0.67	2	2	4	36.00	1.152	364	419.33

Notes:
*Soil infiltration rate estimated as minimum 12mm/hr for infiltration LID's as per MOE 2003 Design Guidelines.
**Tree Species used shall be salt resistant species (i.e. Honey Locust, American Elm Cultivars, Kentucky Coffee-tree, Hackberry, & Bur Oak).
***Use of a Type 4 Bio Retention Mix is recommended for this feature, as per TS 5.10.

Soil Volumes

Area ID	Soil Depth (m)	Provided LID Area (m^2)	Provided Volume (m^3)	Allow. Vol per Tree (m^3)*	Allowable Number of Trees in LID
Tree Pit#0A	1.50	3.00	4.5	30	1.0