MEMORANDUM

To [redacted]
From
Date
Subject
Our ref 24010249_M01V01.docx

1 INTRODUCTION

The current water quality assessment aims to understand the existing (or base case scenario) pollutant loading generated within Aireys Inlet and Anglesea townships. In the absence of existing catchment water quality monitoring data, MUSIC modelling was adopted to estimate sediment, nutrient and gross pollutant loads generated within the Aireys Inlet and Anglesea areas and the treatment effectiveness of existing Water Sensitive Urban Design (WSUD) assets within the two areas.

2 METHODOLOGY

2.1 Data Sources

- Council drainage network layout
- WSUD Audit 2009 Summary Report and Data Sheets
- LiDAR (2022 data)
- SILO point database (daily rainfall and Potential Evapotranspiration (PET) data)
- eWater pluviograph data

2.2 Catchment Delineation and FI Estimation

Catchment areas for MUSIC modelling were derived from LiDAR data and the Council drainage network. The main areas of interest for Aireys Inlet were catchments draining to Painkalac Creek and Sand Gully Ocean outfall. The main areas of interest for Anglesea were catchments draining to Anglesea River. When delineating catchments, areas within the floodplain or coastal reserves with limited development potential were excluded as the contribution from these areas for creating new impervious areas are lower than other areas. Catchment areas draining to existing WSUD assets were also delineated separately.

Catchment Fraction Imperviousness (FI) were determined using the weighted average of the typical planning zone FI values (Table 2-1). Corresponding catchment area extent in Aireys Inlet is shown in Figure 2-1 with catchment summary provided in Table 2-2. Corresponding catchment area extent in Anglesea is shown in Figure 2-2 with catchment summary provided in Table 2-3.

Table 2-1 Typical FI adopted for the Assessment

Zone Description	Zone Code	FI
Commercial 1 Zone	C1Z	0.9
Commonwealth Land Not Controlled by Planning Scheme	CA	0.1
General Residential Zone - Schedule 1	GRZ1	0.75
Industrial 3 Zone	IN3Z	0.9
Low Density Residential Zone	LDRZ	0.2
Public Conservation and Resource Zone	PCRZ	0
Public Park and Recreation Zone	PPRZ	0.1
Public Use Zone - Service and Utility	PUZ1	0.5
Public Use Zone - Education	PUZ2	0.7
Public Use Zone - Local Government	PUZ6	0.7
Public Use Zone - Other Public Use	PUZ7	0.6
Rural Conservation Zone	RCZ	0.05
Special Use Zone - Schedule 1	SUZ1	0.05
Special Use Zone - Schedule 3	SUZ3	0.5
Special Use Zone - Schedule 7	SUZ7	0.1
Special Use Zone - Schedule 8	SUZ8	0.8
Transport Zone 2 - Principal Road Network	TRZ2	0.7
Transport Zone 3 - Significant Municipal Road	TRZ3	0.6

Figure 2-1 MUSIC Catchments – Aireys Inlet

Table 2-2 Airey Inlet MUSIC Catchment Summary

ID	Catchment Name	Area (ha)	FI	WSUD Treatment
1	Painkalac_Ck_1	34.665	0.09	No
2	Painkalac_Ck_2	29.438	0.67	No
3	Painkalac_Ck_3	21.132	0.71	No
4	Painkalac_Ck_4	9.42	0.7	No
5	Painkalac_Ck_5	55.38	0.27	No
6	Painkalac_Ck_6	7.459	0.66	No
7	Painkalac_Ck_7	12.338	0.08	No
8	Painkalac_Ck_8	80.653	0.05	No
9	Sand_Gully	112.4	0.48	No
10	Allen_Noble_Reserve_WL	22.919	0.64	Yes
11	Narani_Way_WL	6.443	0.75	Yes

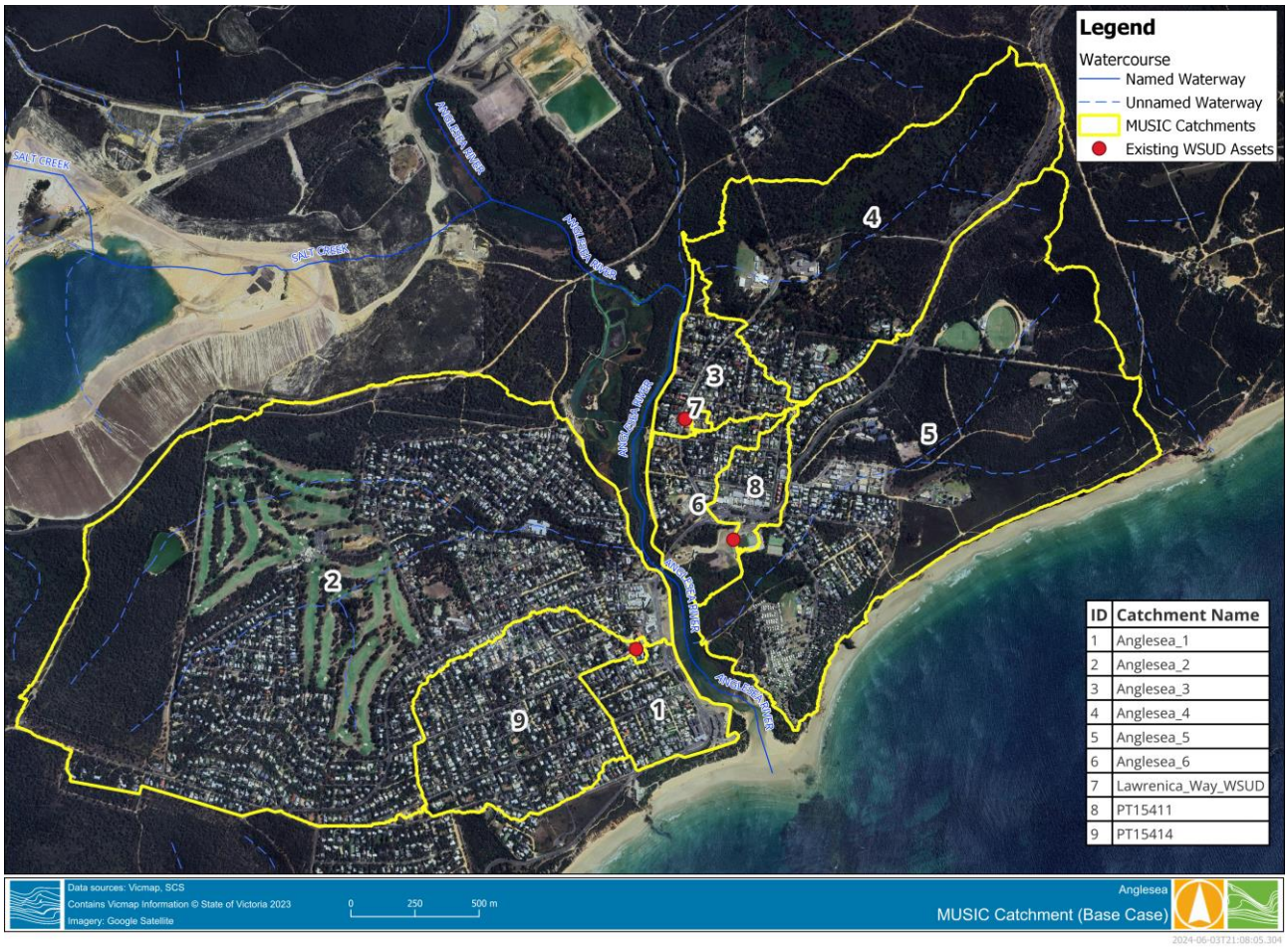

Figure 2-2 MUSIC Catchments – Anglesea

Table 2-3 Anglesea MUSIC Catchment Summary

ID	Catchment Name	Area (ha)	FI	WSUD Treatment
1	Anglesea_1	16.708	0.66	No
2	Anglesea_2	280.012	0.38	No
3	Anglesea_3	16.827	0.71	No
4	Anglesea_4	90.442	0.19	No
5	Anglesea_5	158.075	0.18	No
6	Anglesea_6	19.303	0.55	No
7	Lawrenica_Way_WSUD	0.519	0.75	Yes
8	PT15411	9.782	0.71	Yes
9	PT15414	50.028	0.75	Yes

2.3 MUSIC model setup

2.3.1 Climate Template

In the absence of a corresponding climate template for either township, a new MUSIC meteorological template was developed. Six-minute rainfall data from nearby pluviograh stations[1] were compared against the long-term rainfall records of the two townships. Typically, Bureau of Meteorology (BoM) data is used for estimating the long-term mean annual rainfall site of the interested area. However, due to some missing data from 2000 to 2014 in the Anglesea area, it was decided to use the SILO Point database[2].

SILO Point data consists of a continuous daily time series of data at either recording stations or grid points across Australia. Data at station locations consists of observational records, which have been supplemented by interpolated estimates when observed data are missing. Data at grid points consists entirely of interpolated estimates. The data are taken from our gridded datasets and are available at any pixel on a 0.05° × 0.05° grid over the land area of Australia. Daily rainfall and Morton's wet-environment areal evapotranspiration over land were downloaded for the 50-year period starting from 1/01/1974 to 31/12/2023 for the two grid cell points (Figure 2-3). These data were used to generate the long-term climate statistics (mean annual rainfall, mean monthly rainfall and mean annual PET) for Aireys Inlet and Anglesea.

Figure 2-3 SILO Point Data Download Location (yellow circles)

The nearest pluviograph stations to both Aireys Inlet and Anglesea were Whinchelsea Shire Depot (Gauge ID: 090166) and Whichelsea Post Office (Gauge ID: 090167) respectively. Neither of the stations yielded a 10-year period with comparable mean annual rainfall of Aireys Inlet and Anglesea. Camperdown Donalds Hill pluvigraph station (Gauge ID: 09053) which is approximately 94 km away from Anglesea and 88 km away from

[1] Extracted via eWater pluviograph data tool.
[2] https://www.longpaddock.qld.gov.au/silo/point-data/

Aireys Inlet (Figure 2-4) was found to be the gauge station that can produce comparable mean annual rainfall recorded for Aireys Inlet and Anglesea.

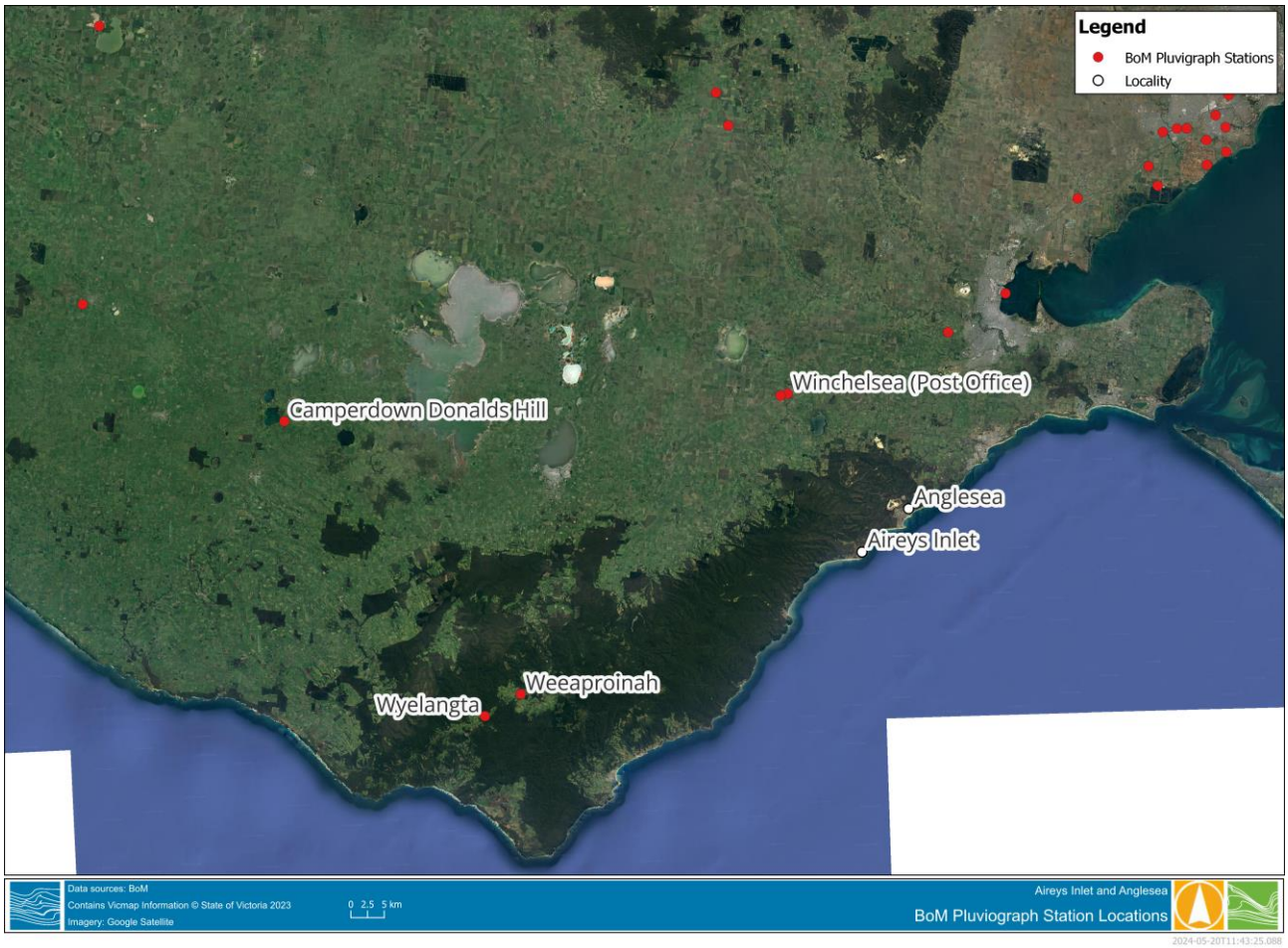

Figure 2-4 BoM Pluviograph Station Locations

A new meteorological template comprising of 6 minute rainfall data from 1/01/1988 to 31/12/1997 (inclusive) for Camperdown Donalds Hill pluvigraph station and the average of mean monthly PET of Aireys Inlet and Anglesea (based on 50 year SILO data) were developed. The mean annual rainfall of the 10-year modelling period was 652 mm (based on Donalds Hill pluvigraph data). In comparison, the 50-year mean annual rainfall for Aireys Inlet and Anglesea were 680 mm and 622 mm respectively (Based on SILO data). A comparison of mean monthly rainfall between the long-term records and MUSIC modelling template is shown in Figure 2-5.

The mean monthly PET of the modelling period is 1070 mm. Monthly distribution of adopted PET values based on SILO data are shown in Figure 2-6.

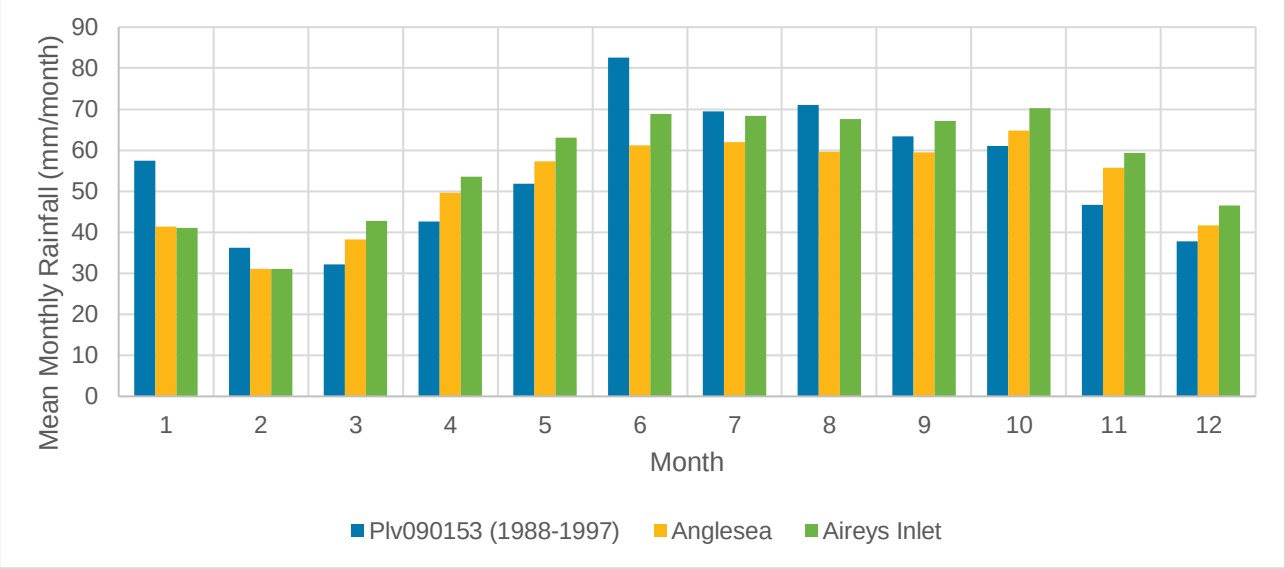

Figure 2-5 Mean Monthly Rainfall Comparison

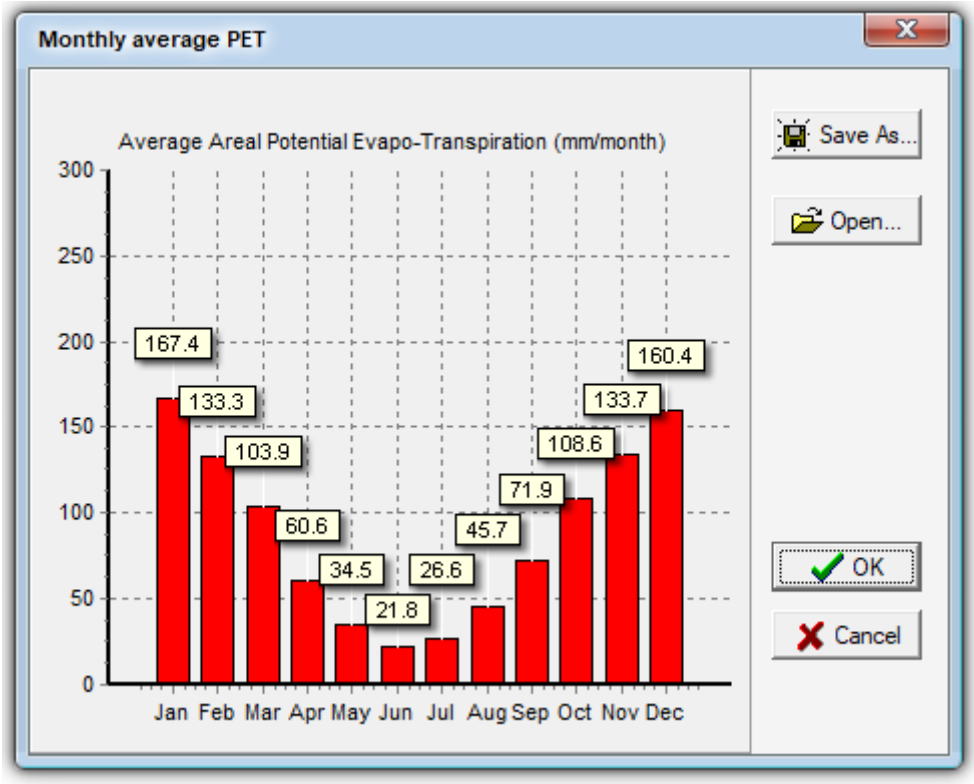

Figure 2-6 MUSIC Monthly Average PET

2.3.2 Catchment Nodes

Lumped catchment approach was adopted for the assessment. Catchment areas and FI described in Section 2.2 was used for MUSIC modelling. All rainfall and runoff generation parameters except for Soil storage capacity and field capacity was kept at default value. Soil storage capacity was set to 120 mm and field capacity was set to 50 mm as per Melbourne Water MUSIC modelling guidelines (2023).

Surface/zone type was set to “Mixed” for all catchments and MUSIC default pollutant generation rates were adopted for modelling.

2.3.3 Treatment Nodes

No additional information was available for WSUD asset apart from their locations, asset type, surface area (sediment ponds and wetlands in Aireys Inlet) and product name (two proprietary assets in Anglesea). Therefore, several assumptions were made to model existing WSUD.

Aireys Inlet

- There are two existing wetlands (including sediment pond pre-treatment) in the area (Figure 2-7).
- Area provided in Council spatial dataset was assumed to be area at Normal Water Level (NWL)
- The depth of sediment ponds were extracted from WSUD Audit Report
  - Allen Noble Reserve sediment pond depth = 1 m
  - Narania Way sediment pond depth = 0.9 m
- Sediment ponds were assumed to have 1 in 3 batter slope below NWL
- Average depth of wetland was assumed to be 0.4 m
- An Extended Detention Depth (EDD) of 0.35 m was assumed for sediment ponds and wetlands.
- An approximate notional detention time of 72 hrs was assumed for wetlands.
- No allowance is made to account for the impact of asset condition (rating allocated in the 2019 WSUD asset) on treatment effectiveness
- Corresponding MUSIC modelling Parameters of the two wetlands are summarised in Table 2-4.

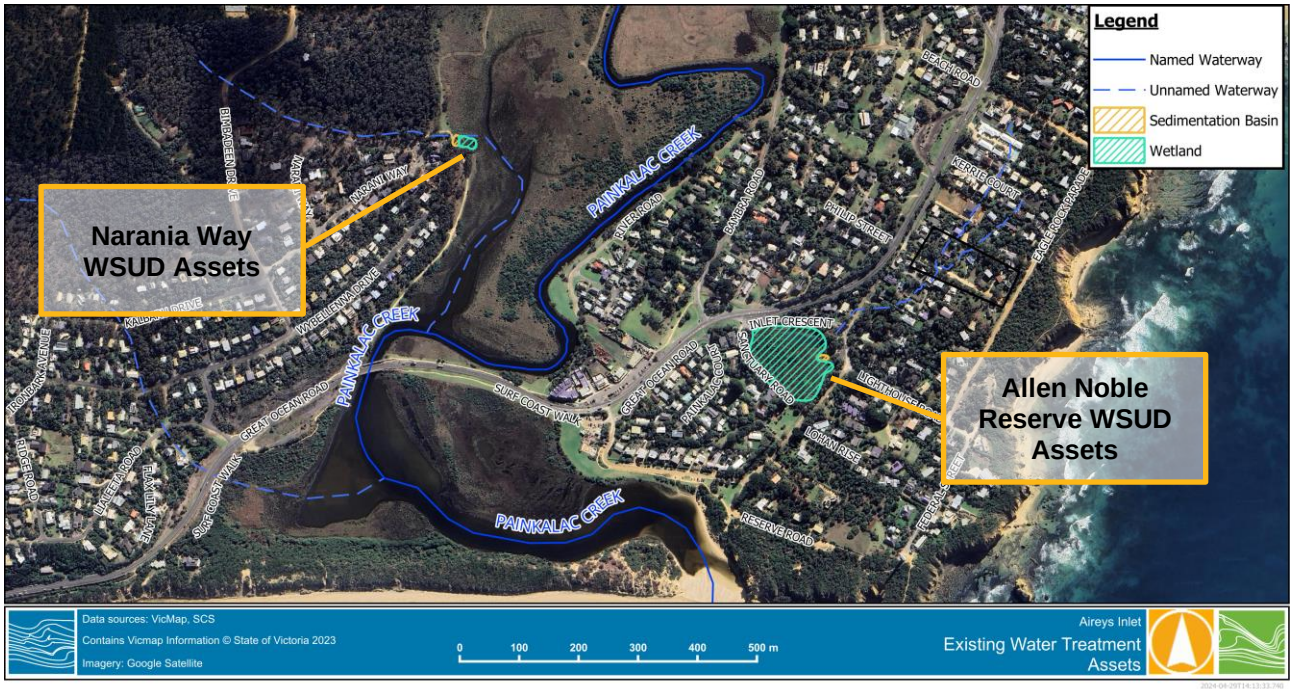

Figure 2-7 Existing WSUD Assets – Aireys Inlet

Table 2-4 Wetland Modelling Parameter Summary

Parameter	Allen Noble Reserve Wetland	Narania Way Wetland
Inlet pond volume (m3)	71	90
EDD (m)	0.35	0.35
Surface area (m2)	12817	474
Permanent pool volume m3)	5126.8	189.6

Anglesea

- There are four WSUD assets in Anglesea (Figure 2-8)
- All of the WSUD assets are identified as “Stormwater Quality Improvement Device (<300L/s)”
- The device type was set to “Gross Pollutant Trap” in the Council WSUD asset spatial dataset for two of the assets.
  - These two assets were identified as Rocla CDS units in the WSUD Audit report.

  Diversion weir height recorded in the WSUD Audit Report was used to determine the appropriate proprietary product model[3].
    - PT15411 (Bowls Club, Cameron Road) was considered a CDS 1012 Unit
    - PT15414 (McMillan Street) was considered a CDS 1015 unit
  - MUSIC modelling nodes provided by the supplier for two units were used for MUSIC modelling. A summary of MUSIC modelling parameters is provided in Table 2-5.
- The remaining two assets were located at Lawrenica Way.
  - Two WSUD assets appeared to be in series with a SPEL Offline Stormceptor (currently known as Flowceptor[4]) followed by a SPEL Hydrosystem (currently known as Flowfileter[5]).
  - Relevant MUSIC modelling parameters were extracted from supplier’s product brochures[4,5] available online
  - Corresponding MUSIC modelling parameters are summarised in Table 2-5.

[3] https://civilmart.com.au/product/cds-units-continuous-deflection-separation-technology/#download-modal
[4] https://atlan.com.au/flowceptor/

[5] https://atlan.com.au/flowfilter/

Figure 2-8 Existing WSUD Assets – Anglesea

Table 2-5 Proprietary WSUD Asset Modelling Parameter Summary

Parameter	CDS1012	CDS1015	SPEL Off-Line Stormceptor Class 1 (OL.4215.C1-K38900-2A Fibreglass)	SPEL Hydrosystem 1500 Series (HS.1500/4.A.225.FG-K38900-2B)
High flow bypass rate (L/sec)	140	180	15	16
TSS load reduction rate (%)	70	70	87	85
TP load reduction rate (%)	30	30	11	66
TN load reduction rate (%)	0	0	23	43
GP load reduction rate (%)	80	80	100	100

3 RESULTS

3.1 Aireys Inlet

3.1.1 Pollutant Load Generation

Mean annual pollutant load generated from each catchment is summarised in Table 3-1. The highest annual pollutant load is generated in Sand Gully catchment which is also the largest modelled catchment. The largest pollutant load entering Painkalac Creek is generated in “Painkalac_Ck_2” which has a relatively high FI of 67%.

Table 3-1 Aireys Inlet Catchment Pollutant Generation Summary

ID	Catchment Name	TSS (kg/year)	TP (kg/year)	TN (kg/year)	GP (kg/year)
1	Painkalac_Ck_1	4,118	15	154	515
2	Painkalac_Ck_2	21,383	45	328	4,984
3	Painkalac_Ck_3	16,371	34	246	3,723
4	Painkalac_Ck_4	7,139	15	108	1,644
5	Painkalac_Ck_5	16,834	43	360	4,200
6	Painkalac_Ck_6	5,419	11	82	1,250
7	Painkalac_Ck_7	1,314	5	53	142
8	Painkalac_Ck_8	6,053	29	321	300
9	Sand_Gully	59,302	132	999	1,4795
10	Allen_Noble_Reserve_WL	15,733	34	247	3,757
11	Narani_Way_WL	5,229	11	78	1,178

3.1.2 Treatment Train Effectiveness

The estimated treatment train effectiveness of Allen Noble Reserve Wetland and Narania Way Wetland are presented in Table 3-2 and Table 3-3 respectively. The combined effectiveness of all WSUD assets is summarised in Table 3-4. It is evident from MUSIC modelling that only the Allen Noble Reserve wetland achieves the current Best Practice Environmental Management (BPEM) pollutant reduction targets. Narania Way wetland does not meet the BPEM targets. However, it is worth noting that the current water quality assessment was undertaken in the absence of original design parameters. Therefore the adopted catchment area and wetland design parameters could be different to the original design intent.

Due to only 7% of catchment area being receiving WSUD treatment, the overall pollutant load reduction for the whole catchment is well below the BPEM targets. It is recommended to prioritize areas with high pollutant generation and typically high FI for implementing new mitigation measures.

Table 3-2 Allen Noble Reserve Wetland Treatment Train Effectiveness

Pollutant	Sources	Residual Load	% Reduction	BPEM Target
Total Suspended Solids (kg/year)	15,800	872	94.5	80%
Total Phosphorus (kg/year)	33.5	5.1	84.8	45%
Total Nitrogen (kg/year)	250	80	68	45%
Gross Pollutants (kg/year)	3690	0	100	70%

Table 3-3 Narania Way Wetland Treatment Train Effectiveness

Pollutant	Sources	Residual Load	% Reduction	BPEM Target
Total Suspended Solids (kg/year)	5,230	2,470	52.7	80%
Total Phosphorus (kg/year)	10.9	6.26	42.4	45%

Pollutant	Sources	Residual Load	% Reduction	BPEM Target
Total Nitrogen (kg/year)	78.2	59.4	24.1	45%
Gross Pollutants (kg/year)	1170	0	100	70%

Table 3-4 Aireys Inlet Overall Treatment Effectiveness

Pollutant	Sources	Residual Load	% Reduction	BPEM Target
Total Suspended Solids (kg/year)	159,000	141,000	11.1	80%
Total Phosphorus (kg/year)	375	341	8.9	45%
Total Nitrogen (kg/year)	2,980	2,790	6.2	45%
Gross Pollutants (kg/year)	35,500	30,700	13.7	70%

3.2 Anglesea

3.2.1 Pollutant Load Generation

Mean annual pollutant load generated from each catchment is summarised in Table 3-1. The highest annual pollutant load is generated in “Anglesea_2” which is also the largest modelled catchment. The second highest pollutant load entering Anglesea River is generated in “PT15414” which has a relatively high FI of 75% and currently modelled as being treated by a GPT (PT15414).

Table 3-5 Aireys Inlet Catchment Pollutant Generation Summary

ID	Catchment Name	TSS (kg/year)	TP (kg/year)	TN (kg/year)	GP (kg/year)
1	Anglesea_1	11,884	25	184	2,799
2	Anglesea_2	118,555	277	2,169	30,080
3	Anglesea_3	12,904	27	196	2,965
4	Anglesea_4	19,847	56	507	4,478
5	Anglesea_5	33,592	95	865	7,285
6	Anglesea_6	11,550	25	187	2,830
7	Anglesea_7	416	1	6	95
8	Lawrenica_Way_WSUD	7,570	16	113	1,723
9	PT15411	40,400	84	600	9,145
10	PT15414	11,884	25	184	2,799

3.2.2 Treatment Train Effectiveness

The estimated treatment train effectiveness of Lawrenica Way WSUD, Bowls Club GPT (PT15411) and McMillan Street GPT (PT15414) are presented in Table 3-6,.Table 3-7 and Table 3-8 respectively The combined effectiveness of all WSUD assets is summarised in Table 3-9. Out of the existing WSUD assets,

only Lawrenica Way WSUD strategy meets the current BPEM pollutant load reduction targets with relative to its local drainage catchment. Given the other two locations only adopted primary treatment, additional secondary or tertiary treatment will be needed to meet the BPEM targets for these two catchments. At present, only 9% of the modelled catchment is treated via WSUD.

Due to only 9% of catchment area being receiving WSUD treatment, the overall pollutant load reduction for the whole catchment is well below the BPEM targets. It is recommended to prioritize areas with high pollutant generation and typically high FI for implementing new mitigation measures.

Table 3-6 Lawrenica Way WSUD Treatment Train Effectiveness

Pollutant	Sources	Residual Load	% Reduction	BPEM Target
Total Suspended Solids (kg/year)	416	5.8	98.6	80%
Total Phosphorus (kg/year)	0.877	0.281	67.9	45%
Total Nitrogen (kg/year)	6.26	2.84	54.7	45%
Gross Pollutants (kg/year)	93.9	0.241	99.7	70%

Table 3-7 Bowls Club GPT (PT15411) Treatment Train Effectiveness

Pollutant	Sources	Residual Load	% Reduction	BPEM Targets
Total Suspended Solids (kg/year)	7,570	2,700	64.3	80%
Total Phosphorus (kg/year)	15.7	11.3	27.9	45%
Total Nitrogen (kg/year)	113	113	0	45%
Gross Pollutants (kg/year)	1,700	82.9	95.1	70%

Table 3-8 McMillan Street GPT (PT15414) Treatment Train Effectiveness

Pollutant	Sources	Residual Load	% Reduction	BPEM Targets
Total Suspended Solids (kg/year)	40,400	22,500	44.4	80%
Total Phosphorus (kg/year)	84.4	67.9	19.4	45%
Total Nitrogen (kg/year)	600	600	0	45%
Gross Pollutants (kg/year)	9,050	2,210	75.6	70%

Table 3-9 Anglesea Overall Treatment Effectiveness

Pollutant	Sources	Residual Load	% Reduction	BPEM Targets
Total Suspended Solids (kg/year)	257,000	23,4000	9	80%
Total Phosphorus (kg/year)	607	585	3.5	45%
Total Nitrogen (kg/year)	4,830	4,820	0.1	45%
Gross Pollutants (kg/year)	59,200	50,700	14.4	70%

4 SUMMARY AND NEXT STEPS

The current water quality assessment estimated the existing (or base case scenario) pollutant loading generated within Aireys Inlet and Anglesea townships and the treatment effectiveness of existing Water Sensitive Urban Design (WSUD) assets within the two areas. The existing WSUD assets are inadequate for meeting the BPEM water quality targets at the township scale for both study areas. At the same time, it may not be cost-prohibitive to implement a catchment-wide WUSD strategy. The next step would be to identify the priority locations or catchments for implementing a water quality treatment strategy and recommend a suitable set of WSUD assets for these catchments/locations. This step will be undertaken during the next phase of the project.