Bendigo Employment Precinct Stormwater Strategy

Stantec

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Executive Summary

This Stormwater Strategy (SWS) has been prepared to outline the proposed drainage strategy for the proposed Bendigo Employment Precinct in Marong (referred to herein as BREP).

The BREP initiative involves the development of 294 hectares of land situated 1.5km southwest of Marong town centre and is proposed to be developed into an industrial precinct.

The stormwater strategy for BREP has been developed to the satisfaction of Development Victoria, City of Greater Bendigo, North Central CMA, Coliban Water and other relevant standard and guidance documents.

The minor drainage system for BREP will include a system of below ground pipe drains designed with sufficient capacity to collect and convey stormwater flows for all storms up to the 5% AEP plus climate change.

The major drainage system for BREP will be designed to manage flows resulting from storms with a 1% AEP plus climate change. All major stormwater beyond the 5% AEP including climate change flow shall be conveyed overland via the proposed road network and swales.

Stormwater best practice WSUD measures to be implemented to ensure all stormwater discharged from the development meets the pollution reduction targets as set-out in the “Best Practice Environmental Management Guidelines” (CSIRO 1999), as follows:

- Total Suspended Solids (TSS) 80%
- Total Nitrogen (TN) 45%
- Total Phosphorus (TP) 45%
- Gross pollutants (litter) 70%

Three dual function wetland and retardation basins (two basins on the eastern side and a single basin on the western side) are proposed to retard and treat developed flows from the site. Preliminary calculations have been undertaken to determine the minor and major flow rates for the future developed catchment and determine the preliminary sizing requirement for the proposed basins.

1 Introduction

Stantec has been engaged by Development Victoria to deliver a Stormwater Strategy (SWS) for the proposed Bendigo Employment Precinct in Marong. This stormwater strategy identifies the necessary infrastructure required to ensure the proposed development can meet stormwater Best Practice Environmental Management guidelines (BPEMG) and provide supporting evidence that the stormwater discharges from the proposed development shall be to the satisfaction of Development Victoria, City of Greater Bendigo, North Central CMA, Coliban Water and any other relevant authorities.

1.1 Site Overview

This report outlines the stormwater management strategy for the proposed Bendigo Employment Precinct in Marong (the Site). The Precinct is situated 1.5 km southwest of Marong town centre. It is bound by Wimmera Highway to the north and west, Calder Alternative Highway to the east and Cemetery Road to the south. O’Sullivans Road traverses the site north to south. The Site is currently an undeveloped farming zone. The total site area is approximately 294 ha, and it is proposed to develop the land into an industrial precinct.

The precinct is dissected by two waterways. The historical Wilsons Hill Channel, which extends from the southern boundary to the Wimmera Highway western boundary - this water channel provides industrial water needs of several existing customers northwest of the site. There is also the natural watercourse dissecting the area east of O’Sullivans Road which isn’t formally named however conveys the local catchments to the outlet of the site. It is a tributary of Bullock Creek and connects to the main Creek approximately 3.8 km to the north. Refer to Figure 1-1 for the locality map and the location of the water courses intersecting the site.

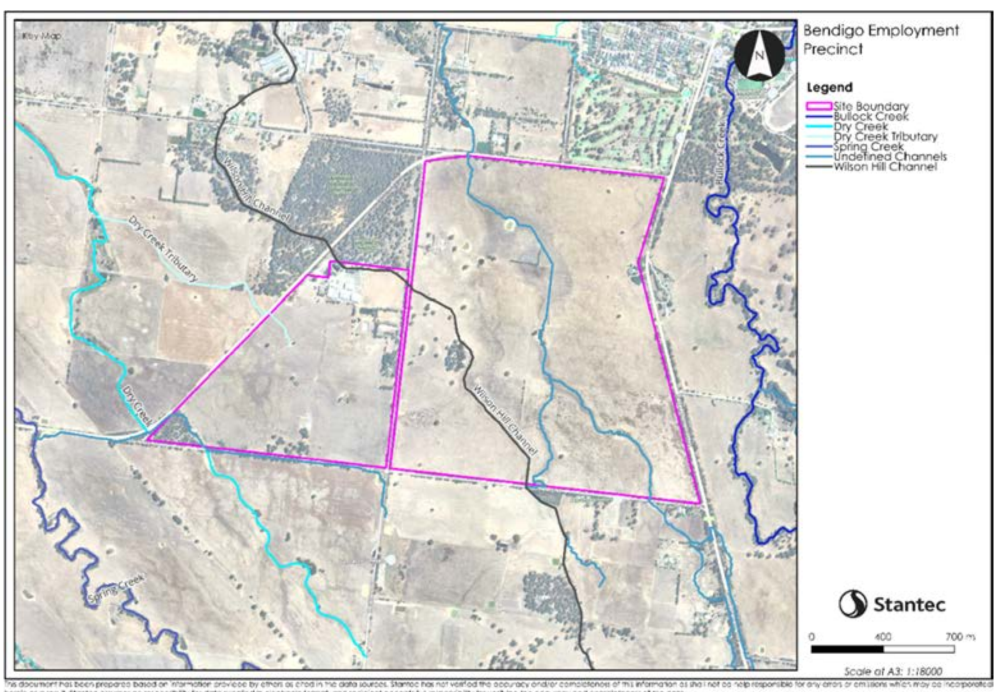

Figure 1-1: Locality Map

1.2 Strategic Context and Authority Requirement

1.2.1 Greater Bendigo Industrial Development Guidelines

City of Greater Bendigo (CoGB) is the responsible authority for management of local drainage facilities within the area. CoGB requires Stormwater Management associated with new industrial developments to be delivered in accordance with the guidelines outlined in "Greater Bendigo Industrial Development Guidelines 2024".

Objectives of Stormwater Management include the following;

- To ensure streets and drainage perform during storm events.
- To minimise any increase in stormwater run-off and protect receiving waters from environmental degradation.
- To capture, retain, treat and re-use stormwater before it is discharged into natural systems.

Clause 6.1.1 of the Stormwater Management Guidelines of CoGB includes the following;

Ensure stormwater and drainage infrastructure is provided in accordance with Council's Engineering Requirements as outlined in the Infrastructure Design Manual (IDM). The following items will be considered to ensure the Site is meeting stakeholder requirements

- Responding to natural site drainage characteristics.
- Treating stormwater on-site before it is discharged into the drainage system or waterways to the satisfaction of the relevant referral authority.
- Meeting the relevant flood protection criteria as determined by the responsible authority.

1.2.2 Discussion with North Central Catchment Management Authority

The summary of discussions with the North Central Catchment Management Authority are outlined below:

- Legal points of discharge discussion
  - Major flows from the eastern side of the site to discharge to the most northern part of the site as per the existing discharge point. Flows from western side of the site to discharge to the west of site as per existing discharge point
  - Potential to convey flows into Bullock Creek assuming no adverse impacts
- The TUFLOW model developed for Bullock Creek Marong was supplied by NCCMA. This flood model focusses on riverine flooding from Bullock Creek and Fletchers Creek within the growth boundary for Marong and suitable for use to assess any adverse flood impacts to Bullock Creek and neighbouring properties from the site.
- Retard flows back to existing conditions with no degradation in water quality
- Use the Marong Flood Study RORB parameters and scale them for this localised catchment

1.2.3 Discussions with Coliban Water

The summary of discussions with Coliban Water are outlined below:

- Wilson Hill Channel
  - Coliban Water have accepted the proposal to alter the alignment of the existing waterway
  - They have accepted the proposal to convert the overland flow path to a piped solution at any chainage along the horizontal alignment.
  - The Waterway will not convey any of the development and will act independently to the site

1.3 City of Greater Bendigo – Marong Structure Plan

Integrated water management objectives in Marong are set out in Marong Structure Plan. BREP is identified as part of the structure plan as shown Figure 1-2.

With respect to stormwater quality requirements as outlined in the structure plan, "Development staging must provide for the delivery of the ultimate waterway and drainage infrastructure network, including stormwater quality treatment. Where this is not possible, development proponents must demonstrate how any interim solution adequately manages and treats stormwater generated from the development and how this will enable delivery of an ultimate drainage solution, all to the satisfaction of the responsible authority".

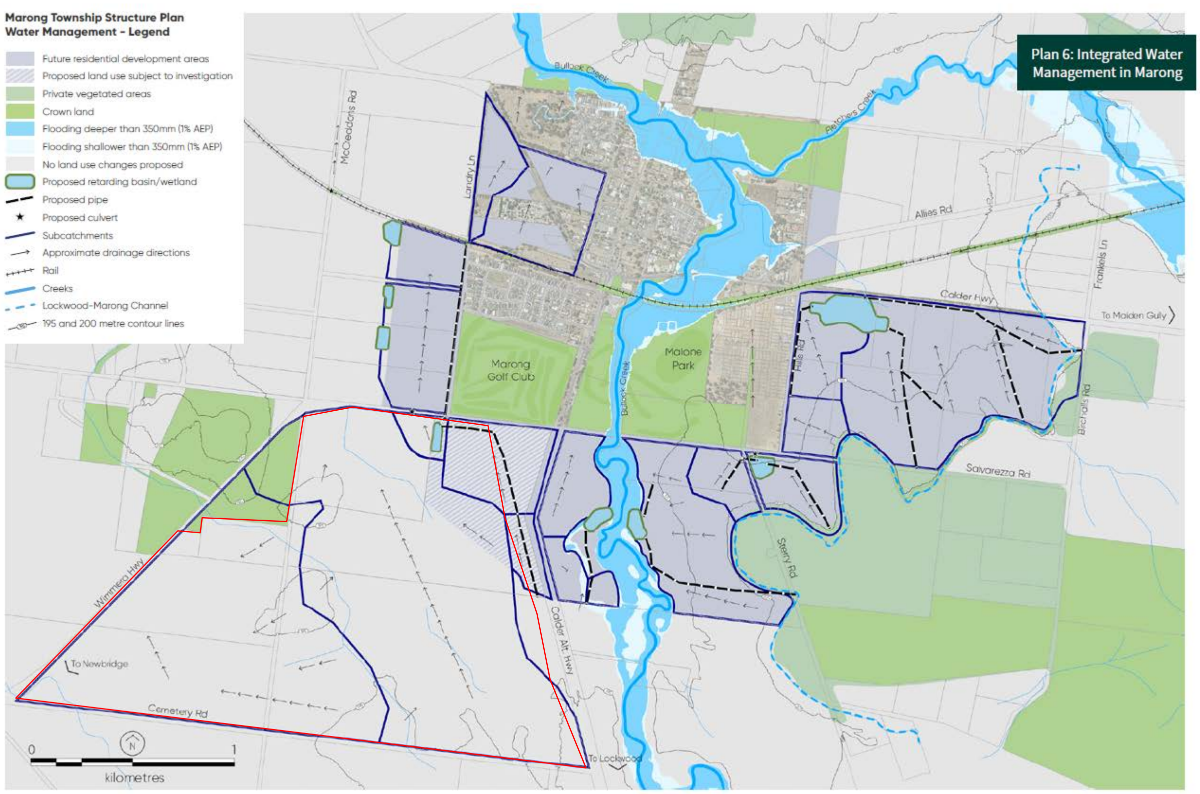

Figure 1-2: Marong Township Structure Plan – Water Management

2 Existing Conditions

The precinct topography covers large areas of very flat land, grading generally southeast to north-northwest at an average gradient of <0.3%. The eastern side of the site grades towards in a northerly direction and the western side grades in a westerly direction. The variation in height across the site ranges from 188m AHD to 198m AHD as shown in Figure 2-1.

The existing Wilsons Hill Channel flows through the centre of the site in a southeast-northwest direction, intersecting the site at Wilsons Hill Bushland Reserve and centrally on the southern boundary. This channel was constructed as a water supply channel with steady grade and hence crosses the natural topography of the site.

The area east of O'Sullivans Road contains an unnamed ephemeral tributary of Bullock Creek that receives flow from the site eastern catchment as well as catchments downstream of the site. This unnamed tributary confluences with Bullock Creek approximately 3.8 km downstream of the site. This traverses a number of rural private properties downstream of site that will experience impacts due to the proposed development. Several farm dams have been constructed along the waterway alignment to reduce the peak flow and increase the timing of the hydrograph.

Dry Creek traverses the site in the southwestern corner of the site, where the internal southwest catchment naturally drains into the creek. Dry Creek is an ephemeral tributary of Bullock Creek that confluences with the main drainage line approximately 12 km downstream (west) of the site. This drainage line comprises of a very flat topography and a combination of farm dams and overland flow paths which channelise and alter the timing and peak flows of the creek. Dry Creek and its local catchments in proximity to the site are shown in Figure 2-1.

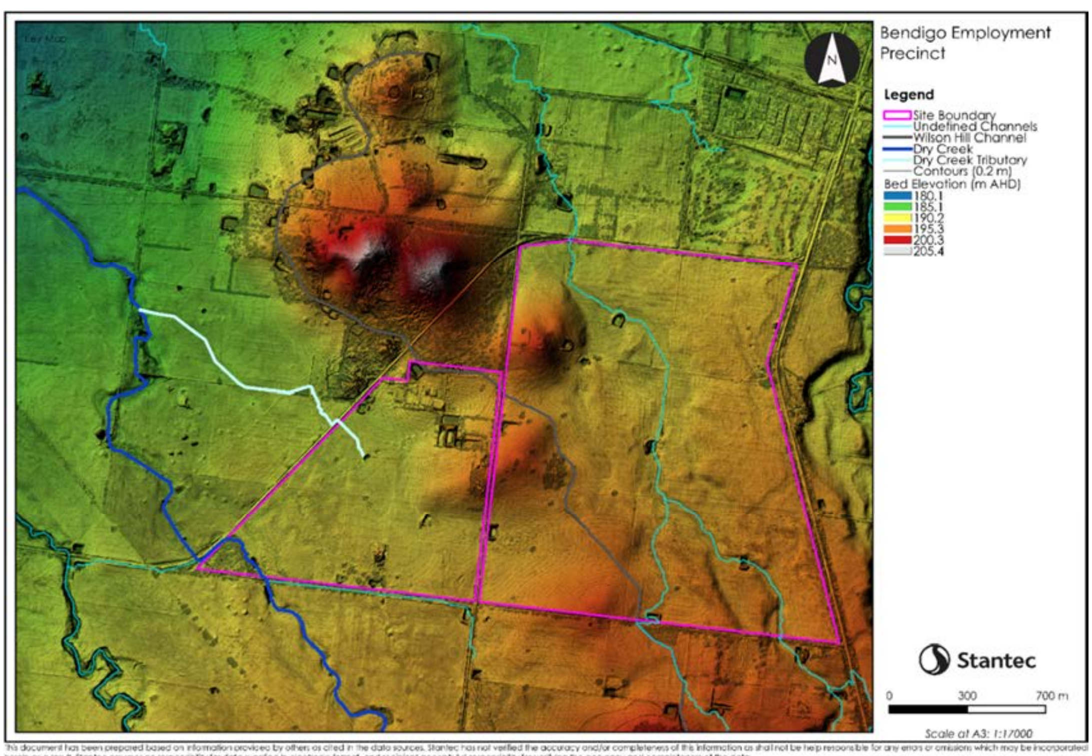

Figure 2-1: Topography Map

Bullock Creek flows south to north past the site along the eastern side of the Calder Alternate Highway. The Site and its upstream catchments are within the greater Bullock Creek catchment. The existing flood mapping for the Bullock Creek catchment adjutant to the site from the North Central CMA flood report is shown in Figure 2-2. This shows that the 1% AEP flood extent does not encroach on the site development.

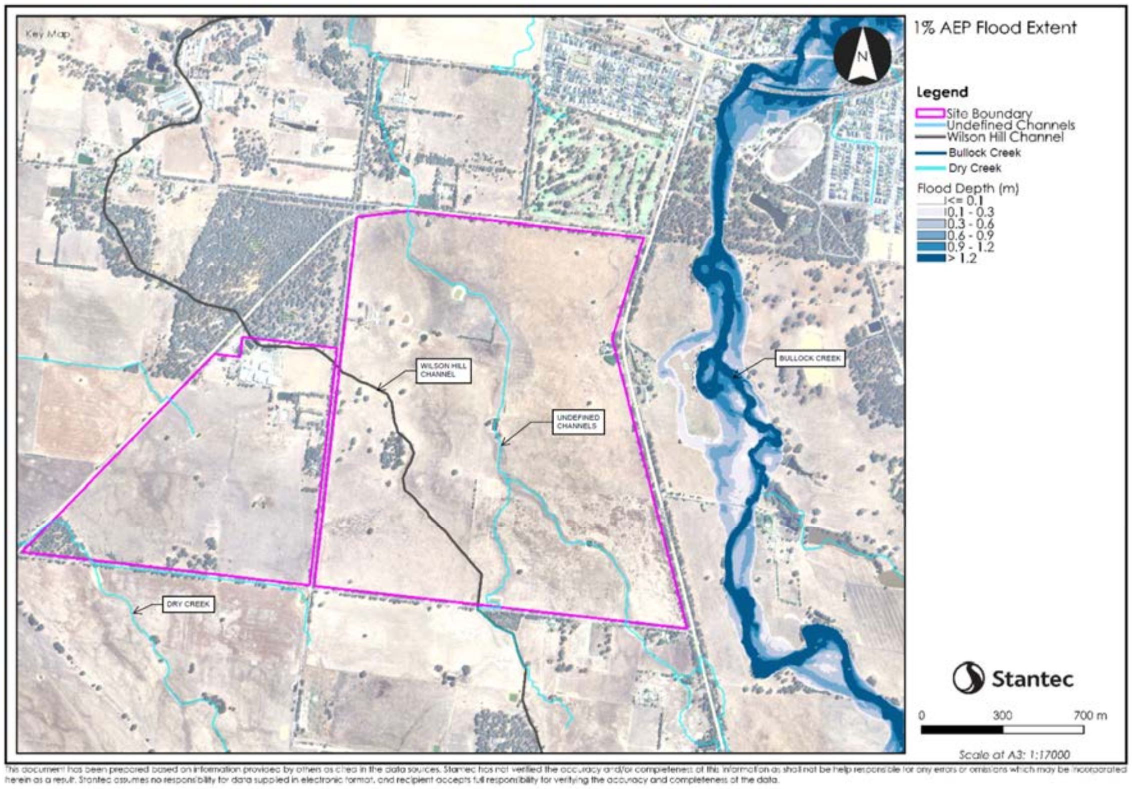

Figure 2-2: Flood Mapping of Bullock Creek in proximity to BREP (NCCMA)

3 Developed Conditions

The initial advice for future zoning of the BREP is predominately Industrial 1 (IN1Z), with complementary Industrial 3 (IN3Z) to mitigate amenity impacts on surrounding residential land.

The stormwater strategy for the site has been developed in accordance with all criteria agreed with local authorities. Provided in the following sections is discussion on the overall drainage strategy for the site including details of drainage conveyance, stormwater retardation and WSUD treatment systems.

The proposed development plan for the site as presented in Figure 3-1 proposes a network of wetlands within detention basins and drainage upgrades to manage flows through the development. End of line systems have been recommended considering benefits such as reduced overall asset footprint, minimised complexity and maintenance requirements of stormwater design with fewer assets to consider.

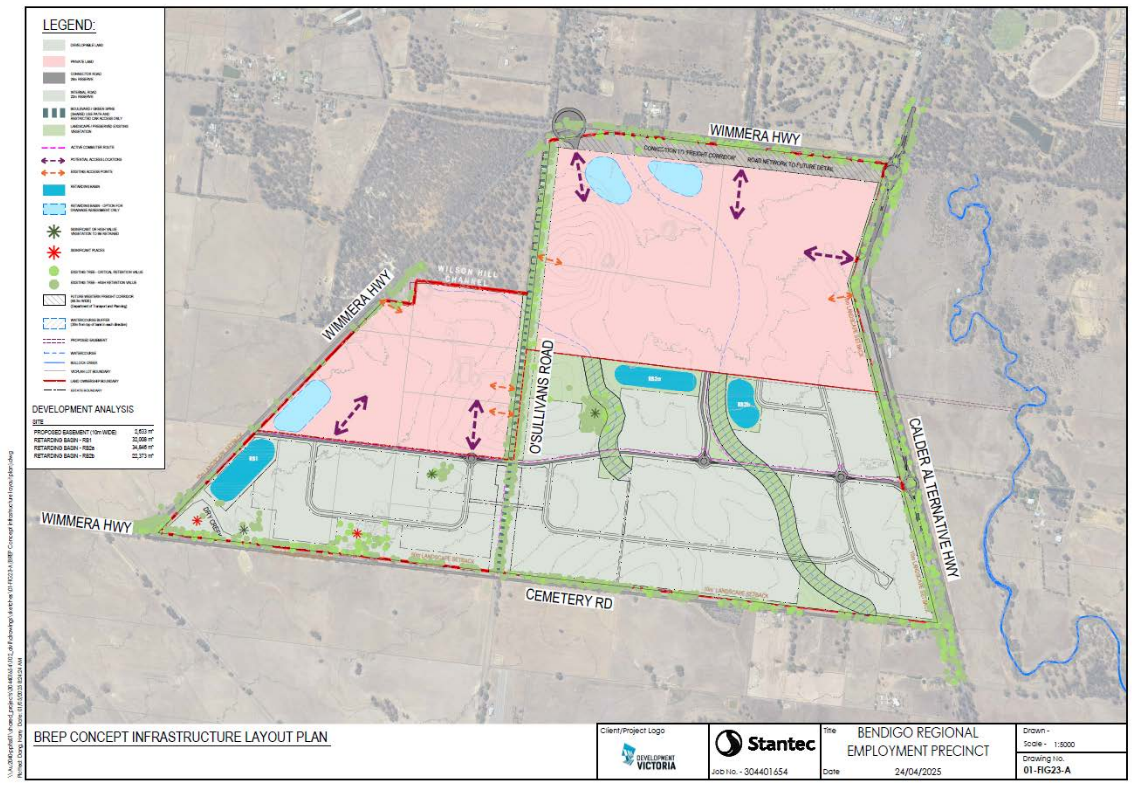

Figure 3-1: Proposed Layout

3.1 Development Plan

The site includes the following considerations for the developed case:

- RB1 is a combination wetland and retarding basin that is positioned on the north end of the site adjacent to Wimmera Highway. Basin RB1 is designed to capture stormwater generated from the upper eastern catchment of the site.
- RB2 is a combination wetland and retarding basin that is positioned central to the site. It is designed to capture stormwater generated from the lower eastern catchment of the site.
- RB3 is a combination wetland and retarding basin that is positioned along the western edge of the site along Wimmera Highway. This is designed to capture stormwater generated from the western catchment of the site.
- The natural unnamed watercourse situated within the eastern side of the site will remain as a designated waterway under proposed conditions which will convey existing condition (pre-development) flows after they have passed through the stormwater assets.
- The drainage system will be designed to convey minor flows from catchments up to the 5% AEP plus climate change design storm events. They may require increased pipe capacities in particular locations to convey partial gap flows and minimise roadway extents due to road flood hazard targets. All major stormwater flows generated from 1% AEP plus climate change storm are conveyed though the proposed development by road reserves and the stormwater drainage network. They will be conveyed through the wetland/retarding basins and into the watercourse and site outfall.
- Typically, floodplain management authorities recommend freeboard of 300 mm to 600 mm for the 1% AEP storm event to the lots finished surface levels (FSL). (Guidelines for Development in Flood Affected Areas, DELWP 2019).

3.2 Sub-Precinct Drainage

The drainage strategy for each sub-precinct has be designed with independent water quality and quantity assets designed to mitigate the sub-precincts as well as mitigating the total development area as well. The three sub-precincts are shown in Figure 3-2. This provides staging flexibility to the drainage strategy.

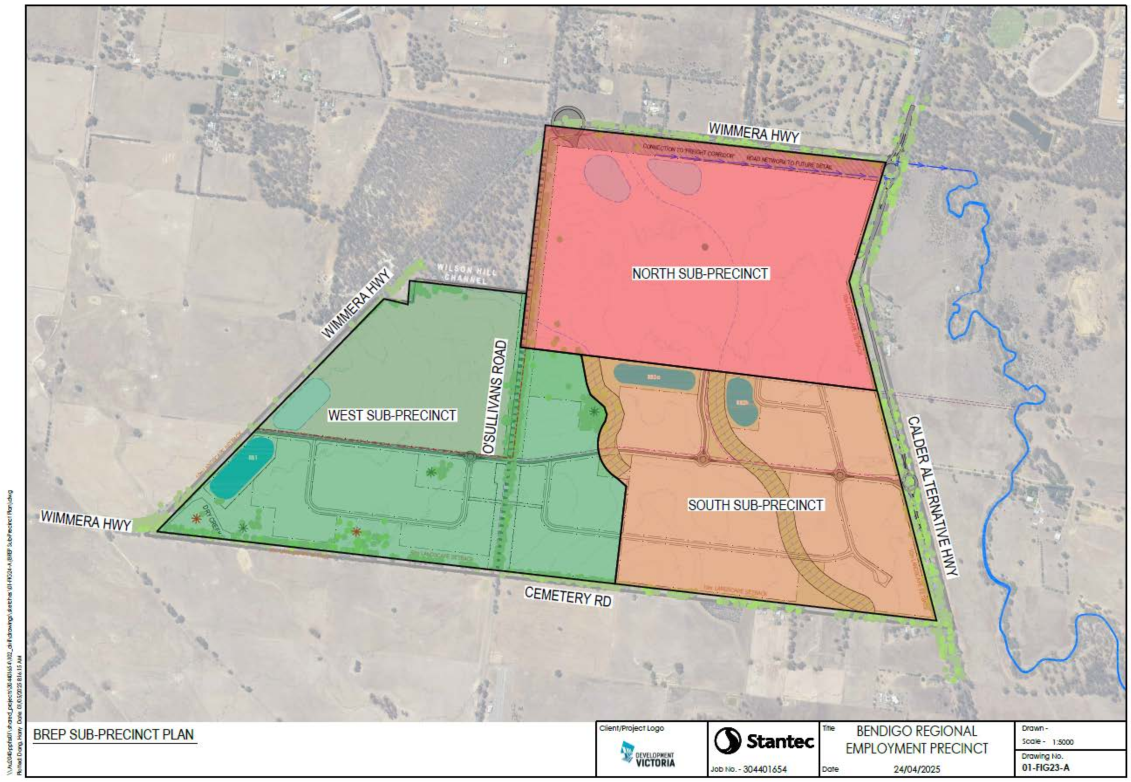

Figure 3-2 Sub-precinct layout

3.3 Climate Resilience and Sustainability Considerations

Climate resilience and sustainability practices related to stormwater have been considered for the proposed development as listed below:

Climate change factor

To ensure stormwater assets are future proofed and sized appropriately, climate change assessments were based on ARR version 4.2 Climate Change Considerations. To model the worst case emission scenarios climate change factors based on Shared Socioeconomic Pathways-5 (SSP5 - 8.5) for 2100 time horizons have been incorporated into the model. With the expectation that runoff and rainfall intensity will increase due to climate change, this consideration will result in conveyance and retarding basin assets being sized to account for these increases.

Basin freeboard

Retarding basins are proposed to have 300 mm freeboard above the 1% AEP plus climate change flood levels. The additional freeboard is used to capture different rainfall intensities and act as a contingency for the larger storm events and climate change.

High developed condition fraction impervious values

The current hydrology model is developed to consider a fraction impervious value of 90%. This takes into consideration increased surface run-off (i.e. asphalt roads, concrete and roofs compared to grassed paddocks) to a high level of imperviousness.

Waterway width

The proposed waterway includes 30 m buffers from the top of bank edge to lot levels. Lot levels are set 600 mm above the 1% AEP plus climate change water level. This will provide contingency by catering for additional flows in the waterway as well as providing space for the watercourse to meander and maintain a natural aesthetic.

Roadway gap flow contingencies

Roadways and associated drainage systems are designed to have a 300 mm maximum overland flow depth and a 0.35 m^2/s maximum depth*velocity allowance for the 1% AEP plus climate change scenario. This will minimise hazardous conditions during extreme rainfall events.

Water treatment

The proposed stormwater strategy of the site includes combined sedimentation basin and wetland systems to detain and treat pollutants generated from the proposed development. This will minimise ecological and environmental impacts to the downstream environment.

3.4 Discharge into Bullock Creek

The flat nature of the site limits the ability to effectively capture and drain detention basins. The discharge waterway for the eastern catchment is very shallow with depths as little as 0.4 m for the surrounding land. Basins would therefore need to be very shallow (and therefore take up significant amount so space) and wouldn’t have the depth required to capture inflows from underground drainage assets which are deeper than the waterway. To appropriately drain and detain the catchment, the site would require significant amounts of fill to create fall between the design surface of the development, to the outlet waterway.

A solution to this is to construct low flow pipelines between the retarding basins and Bullock Creek to the east of the site. Bullock Creek is considerably deeper and would allow a portion of the flows into the retarding basins to be drained via gravity while higher flows (as the retarding basins fill) would flow into the existing waterway. Section 5.2 within this report demonstrates that diverting these low flows into Bullock Creek do not have significant impacts to the localised flood extents or flood levels of Bullock Creek will only have minor effects to the degree of a less than 15 mm increase in flood levels.

Table 1 and Figure 3-3 show two basin footprint sizes as an example of the required retarding basin footprint for RB1 to detain proposed flows back to existing.

- Basin base constrained by eastern waterway– allows for a basin depth of 0.95 m
- Basin base constrained by Bullock Creek – allows for a basin depth of 1.5 m

Due to the existing topography of the area, a maximum basin depth of 0.95 m can be achieved (practically achievable without extensive filling) without the low flow pipe to Bullock Creek and hence requiring a larger basin footprint. Basins can be built deeper with a low flow pipe to Bullock Creek, where the basin can provide more flood storage below the natural watercourse level. The increased basin depth results in a smaller footprint of the basins.

Table 1. Example of Basin footprint size comparison

Depth	Area (m^2)
0.95 m	90,000
1.5 m	60,000

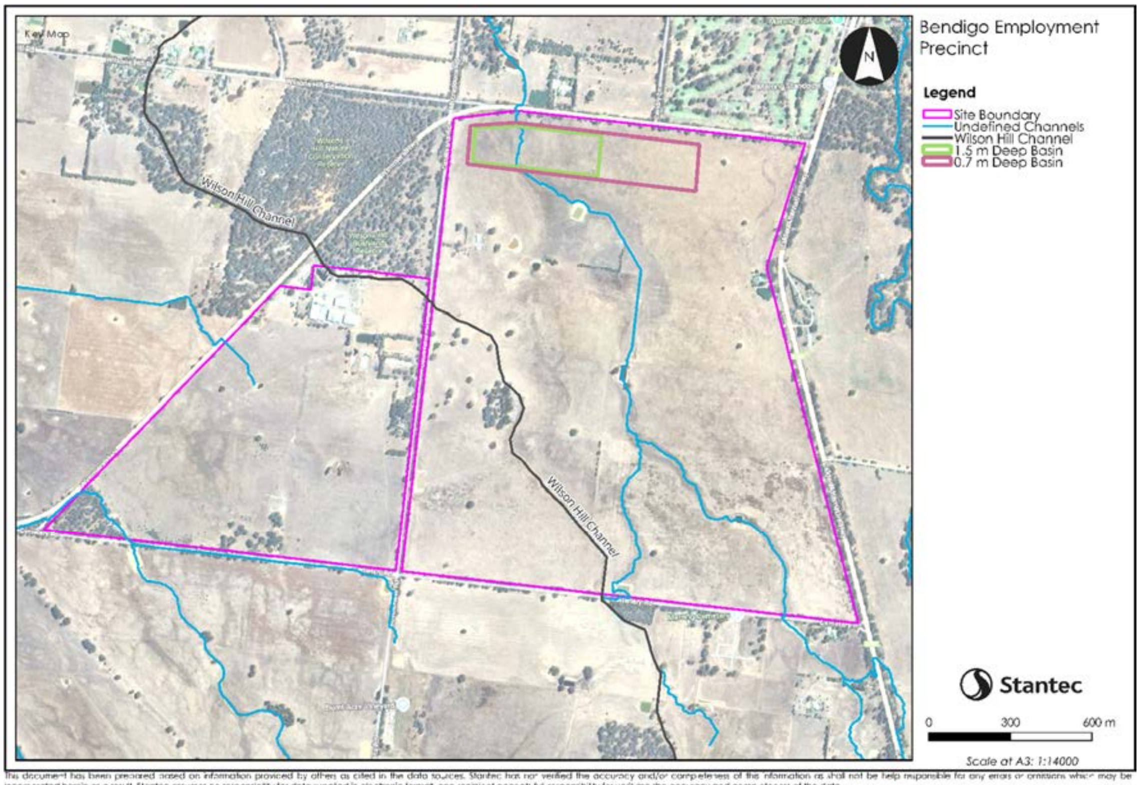

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Figure 3-3: Retarding Basin Footprint Size Comparison

4 Hydrology

Australian Rainfall & Runoff 2019 (ARR19) combined with RORB hydrological software package (Version 6.45) has been used to calculate the stormwater flow for both the existing and developed conditions of the site and its external catchments. RORB is an industry-standard hydrological model that is widely adopted in Australia.

Calculations have been undertaken to determine the minor and major flow rates for the future developed catchment and determine the preliminary sizing requirement for the proposed wetlands and detention basins. Major flows (up to 1% AEP plus climate change) were determined for future design requirements of the WSUD infrastructure and to determine impact on Bullock Creek from proposed outfall arrangements. Very frequent flows (3-month ARI or 4 EY flows) were calculated for inclusion as the high-flow bypass in the water quality modelling.

4.1 Catchment Delineation

The subject site is proposed to be developed into industrial area. The existing and developed condition sub-catchments have been modelled similarly assuming the site will be designed based on the existing natural topography. For the purpose of the hydrologic analysis, the site was delineated into eight internal and five external catchments. These catchments were defined using the natural topography of the site. The overall catchment delineation of the catchment can be seen Figure 4-1 and sub-catchment areas in Table 2.

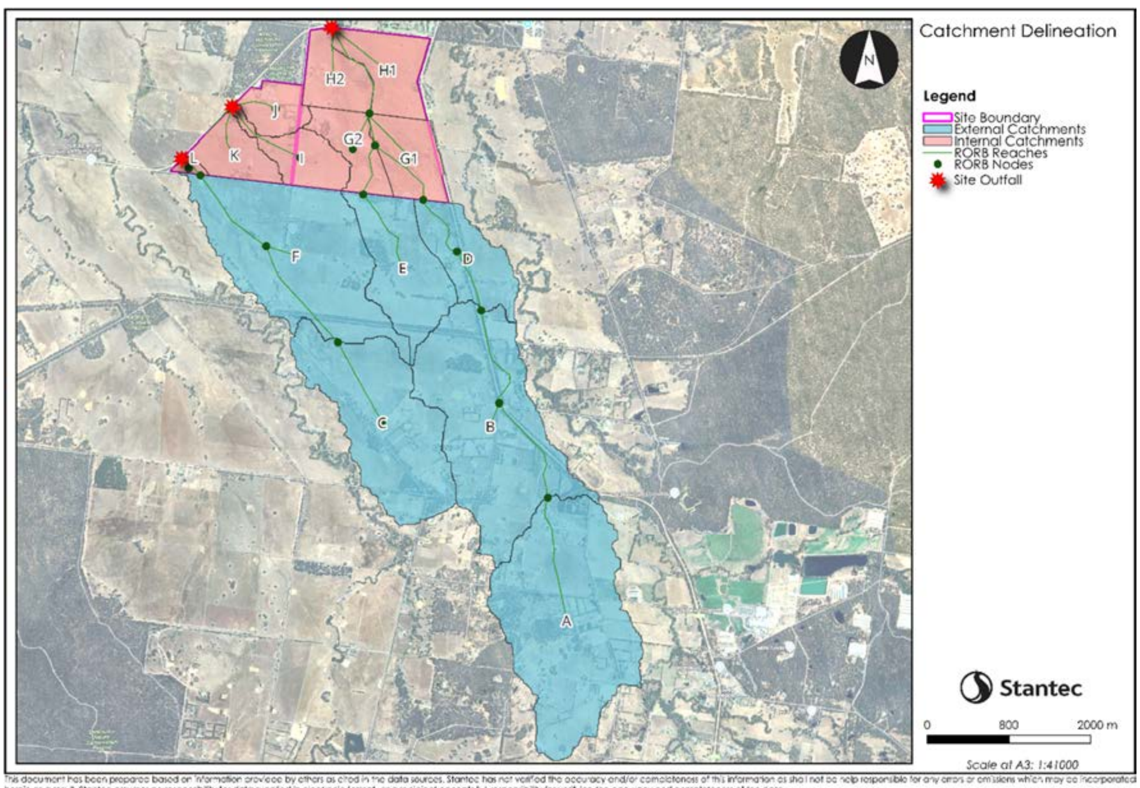

Figure 4-1: Sub-Catchment Delineation

Table 2. Sub-catchment areas

Sub-catchment	Area (ha)
A	260.1
B	234.4
C	175.5
D	66.5
E	95.5
F	218.7
G1	48.9
G2	39.3
H1	53.7
H2	41.4
I	41.9
J	30.1
K	37.0
L	3.96

Development of the Site increases the total impervious surface and therefore peak runoff generated within the catchment. To ensure there is no adverse downstream effects from increased discharge rates and volumes, the detention of additional flow will be contained within retarding basins.

Fraction impervious values used in the model are shown in Table 3 below.

Table 3. Fraction Impervious Values

Zone		Total Impervious Area	Effective Impervious Area (Directly Connected)	Indirectly Connected Area	Pervious Area
Pre-development	Rural Zone	0.10	-	0.10	0.90
Post-development	Industrial Zone (IN1Z, IN2Z and IN3Z)	0.90	0.72	0.28	-
External sub-catchments	Rural Zone	0.10	-	0.10	0.90

4.2 RORB Parameters

Intensity Frequency Duration (IFD) values were obtained from the Bureau of Meteorology (BOM) to use in RORB modelling in conjunction with temporal patterns, aerial reduction factors, and pre-burst information from ARR 2019 Data Hub. *The Marong Flood Study* conducted by NNCMA in 2018 calibrated Bullock Creek to a large September 2016 storm event. As per best practice recommendations, large calibrated local flood studies take priority to the recommended regional and Australia wide Kc and initial and continuing losses. The Kc values have been scaled to match the D_{av} for the RORB model meanwhile the initial and continuing losses were applied directly to this RORB model.

Given the catchment area does not exceed 75 km^2, areal temporal patterns were not required. The RORB model was run in Ensemble mode for all storm events up to 1% AEP and durations 10 min to 168 hours. The obtained hydrological data utilised for this study has been included in Appendix A.

The Kc value within *The Marong Flood Study* has been adopted by calibration to the September 2016 Bullock Creek storm event. The report details how it was validated by using the recommended regional and Australia wide equations and found suitable for their assessment. The Kc value has been scaled for use within this assessment by using the D_{av} of this catchment plan. Table 4 shows the values used for The Marong Flood study as well as the values adopted for this assessment.

Table 4. Kc Scaling Factor

Sub-catchment	Kc/ D_{av} Ratio
The Marong Flood Study	24.8/27.42
Stantec RORB updated values	3.06/3.38

The initial/continuing loss model has been adopted from *The Marong Flood Study.* The study found variable initial and continuing losses for different storm events through calibration of the September 2016 storm event. In reference to loss estimates for Indirectly Connected Areas (ICA), Section 3.5.3.2 of ARR 2019 Book 5 recommends that 60-80% of the rural estimate be used for the initial loss. For this study site, 70% of the rural loss estimate was adopted for the ICA areas.

ARR 2019 also states that values between 1-4 mm/h are an appropriate estimate for continuous loss in Australia, with 2.5 mm/h for most urban areas. If the continuing loss for pervious areas is lower, then the same continuing loss should be maintained. The initial and continuous losses also have a climate change factor applied to them. The Year 2100, SSP5 climate change factors have been applied to these losses are shown in Table 5.

Table 5. Losses Climate Change Multiplier

Sub-catchment	Initial loss	Continuous loss
Climate Change Multiplier	1.33	1.55

The parameters adopted within RORB are summarised in Table 6 which consider the climate change multiplier.

Table 6. RORB Parameters

AEP	Land Use Type	IL	CL	Kc	m
50%	Pervious Area	17.3	3.2	3.06	0.8
	Directly connected Impervious Area	1.0	0.0		
	Indirectly connected Impervious Area	12.1	2.5		
1%	Pervious Area	24.2	4.0		
	Directly connected Impervious Area	1.0	0.0		
	Indirectly connected Impervious Area	16.95	2.5		

Pre-burst rainfalls have been applied as per the process outlined in ARR 2019 using the in-built functionality of RORB. 75% pre-burst data downloaded from the ARR 2016 Data Hub was read into RORB and applied in a single increment prior to the design storm. Appendix A presents the adopted median pre-burst ratios for different storm durations.

As per the updated ARR 2019 guidelines, climate change factors need to be considered to futureproof assets and minimise any potential failures due to higher intensity rainfall. The data for ARR 2019 Shared Socioeconomic Pathways 5 (SSP5) interim climate factors were extrapolated to 2100 as per guideline recommendations. The resulting increases in rainfall intensity was applied as per the duration as shown in Table 7.

Table 7. 2100 SSP5 climate change multiplier

2100	<1 hour	1.5 hours	2 hours	3 hours	4.5 hours	6 hours	9 hours	12 hours	18 hours	>24 hours
SSP5	1.86	1.77	1.71	1.64	1.58	1.54	1.5	1.47	1.43	1.41

The adopted IFDs used for this assessment are shown below in Table 8.

Table 8. IFDs Considering Climate Change

Duration	63.2%	50%	20%	10%	5%	2%	1%
1 min	2.51	2.94	4.37	5.47	6.62	8.30	9.71
2 min	4.15	4.84	7.29	9.23	11.36	14.73	17.71
3 min	5.65	6.58	9.88	12.46	15.27	19.53	23.44
4 min	6.98	8.13	12.13	15.21	18.56	23.62	27.90
5 min	8.11	9.47	14.10	17.63	21.39	27.16	31.81
10 min	12.22	14.25	21.20	26.41	31.81	39.80	46.31
15 min	14.84	17.34	25.85	32.18	38.87	48.55	56.36
20 min	16.76	19.53	29.20	36.46	44.08	55.06	64.36
25 min	18.27	21.39	31.81	39.80	48.17	60.45	70.68
30 min	19.53	22.88	34.04	42.59	51.71	64.91	76.07
45 min	22.51	26.23	39.06	48.92	59.52	75.14	88.35
1 hour	24.74	28.83	42.78	53.57	65.10	82.21	97.09
1.5 hour	26.90	31.15	46.02	57.35	69.56	87.97	103.55
2 hour	28.73	33.17	48.39	60.19	72.68	91.49	107.39
3 hour	31.65	36.41	52.48	64.62	77.57	96.60	112.50
4.5 hour	35.39	40.45	57.35	69.99	83.11	101.91	117.39
6 hour	38.35	43.58	61.29	74.07	87.47	105.80	120.74
9 hour	43.20	49.05	67.95	81.45	95.10	113.25	127.50
12 hour	46.89	53.21	73.21	87.17	101.14	119.07	132.89
18 hour	52.20	59.06	80.94	95.81	110.68	128.99	142.71
24 hour	55.98	63.45	87.00	103.07	118.86	138.04	152.28
30 hour	59.50	67.40	92.78	109.98	127.04	148.05	163.56
36 hour	62.04	70.50	97.43	115.76	134.09	156.51	172.02
48 hour	65.85	75.15	104.48	125.07	145.23	170.61	190.35
72 hour	70.50	80.51	113.51	137.19	160.74	191.76	215.73
96 hour	73.18	83.75	119.00	145.23	170.61	205.86	234.06
120 hour	75.29	86.15	122.39	149.46	177.66	214.32	245.34
144 hour	77.27	88.13	124.64	152.28	180.48	218.55	249.57
168 hour	79.24	89.96	126.34	153.69	181.89	219.96	250.98

Figure 4-2 and Figure 4-3 present the compilation of the existing and developed condition RORB models.

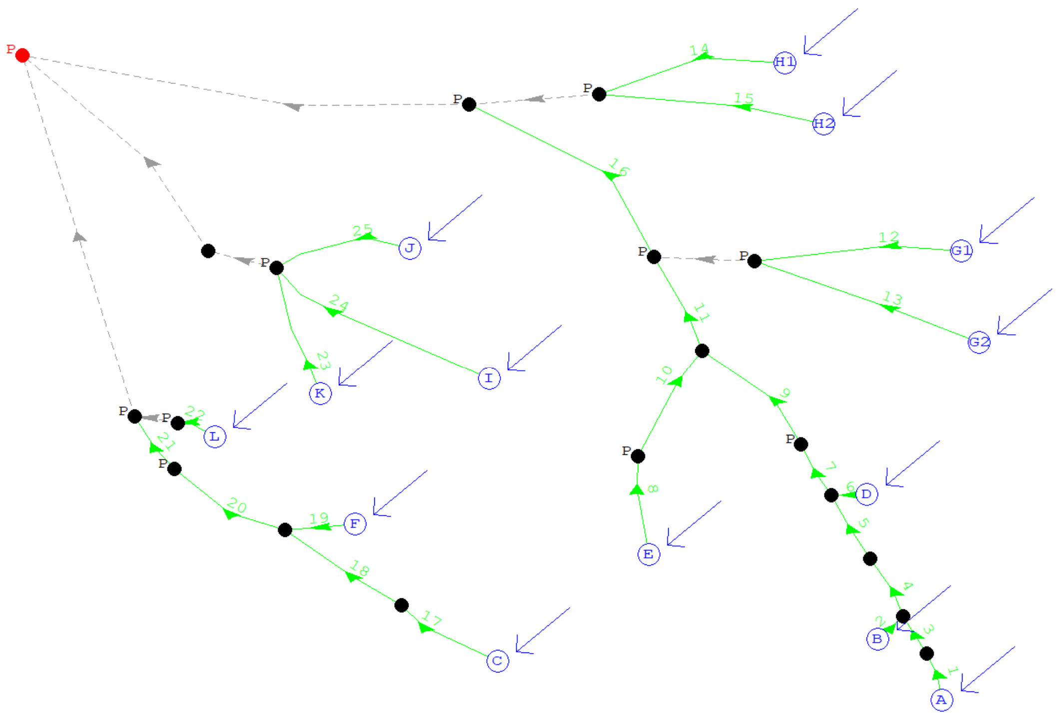

Figure 4-2: Existing Conditions RORB Model

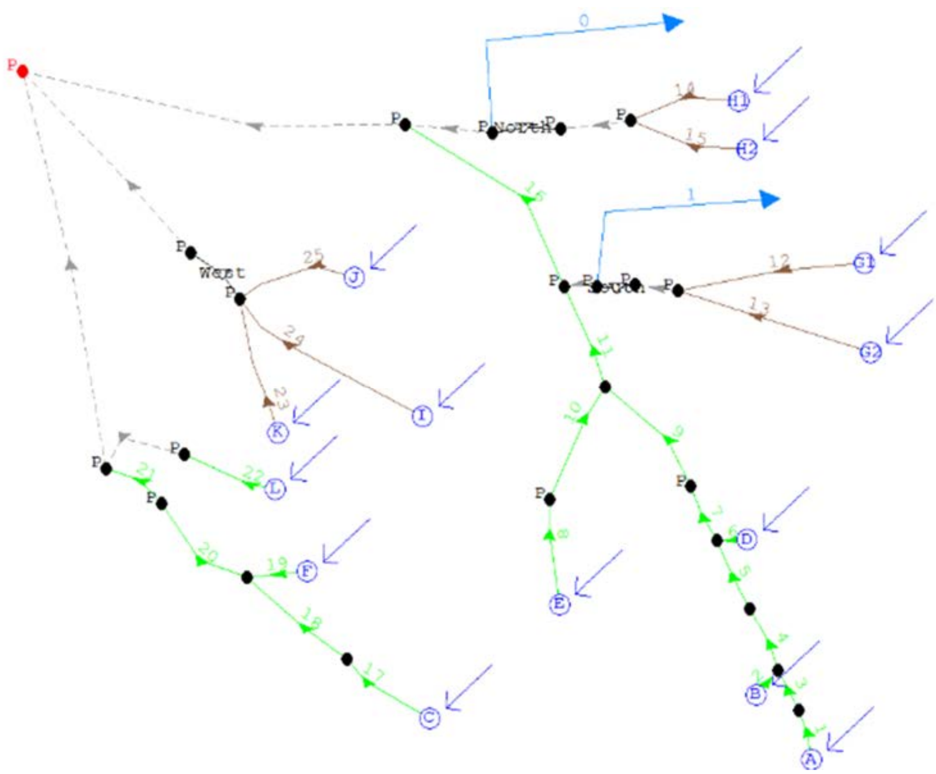

Figure 4-3: Developed Conditions RORB Model

4.3 RORB Results

The RORB results of the pre-development and post-development discharges at the site outfall locations are shown in Table 9 and Figure 4-4. A comparison of the pre-development and post-development discharge rates was performed to establish the additional flow due to the proposed development and to determine required detention capacity of the site. The proposed conditions have a climate change factor applied meanwhile existing conditions do not. This is in line with updated ARR 2019 guidelines.

Table 9. Peak Discharge

	63% AEP		1% AEP	
Location	**Existing**	**Developed (+ CC)**	**Existing**	**Developed (+ CC)**
Flow at G (m^3/s)	1.67	13.33	8.44	39.26
Volume at G (m^3)	7,320	3,7800	42,400	80,100
Flow at H (m^3/s)	1.586	13.52	8.16	40.73
Volume at H (m^3)	7,890	40,700	45,300	86,400
Flow at J (m^3/s)	1.75	14.6	9.04	44.37
Volume at J (m^3)	9,050	46,500	52,000	99,100
Flow at L (m^3/s)	0.11	0.60	0.61	1.77
Volume at L (m^3)	328	1,690	1,930	3,600

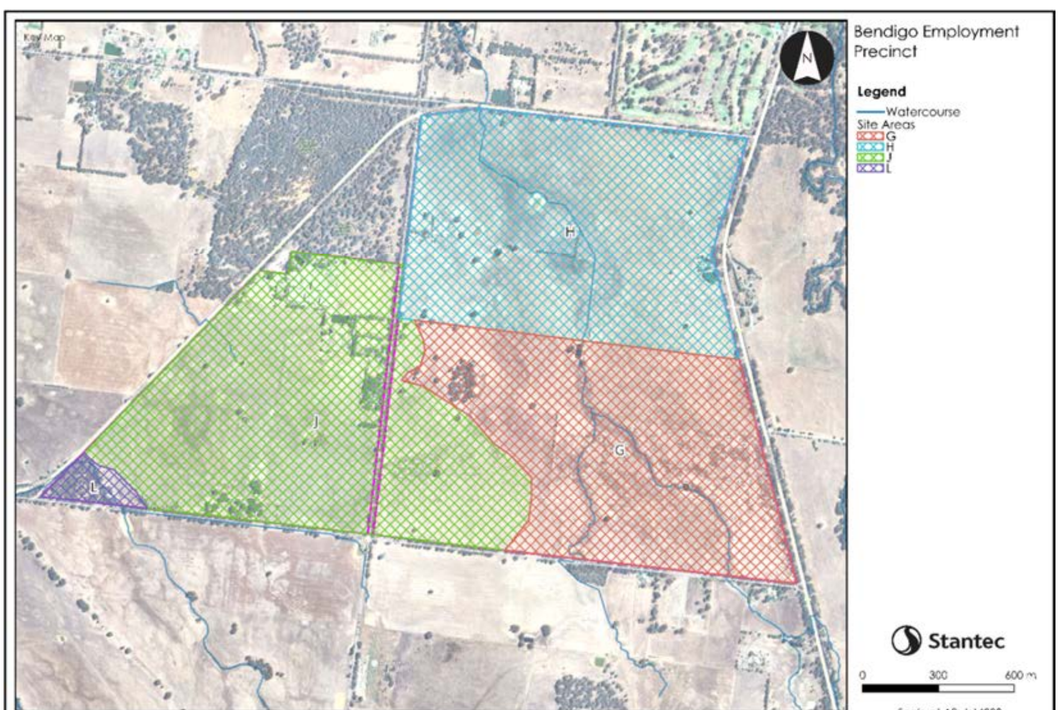

Figure 4-4: Flow Areas

5 Stormwater Quantity

To ensure downstream conditions have not been negatively impacted by the development of the site, a stormwater quantity analysis has been conducted including detention storage, within major stormwater assets and 1% AEP gap flow road size checks.

5.1 Estimation of Detention Storage

Three detention storages are proposed for the site as shown in Figure 5-1, two basins for the eastern side (one for each sub-precincts North and South) and a basin for the Western sub-precinct to retard the proposed development flows back to existing conditions.

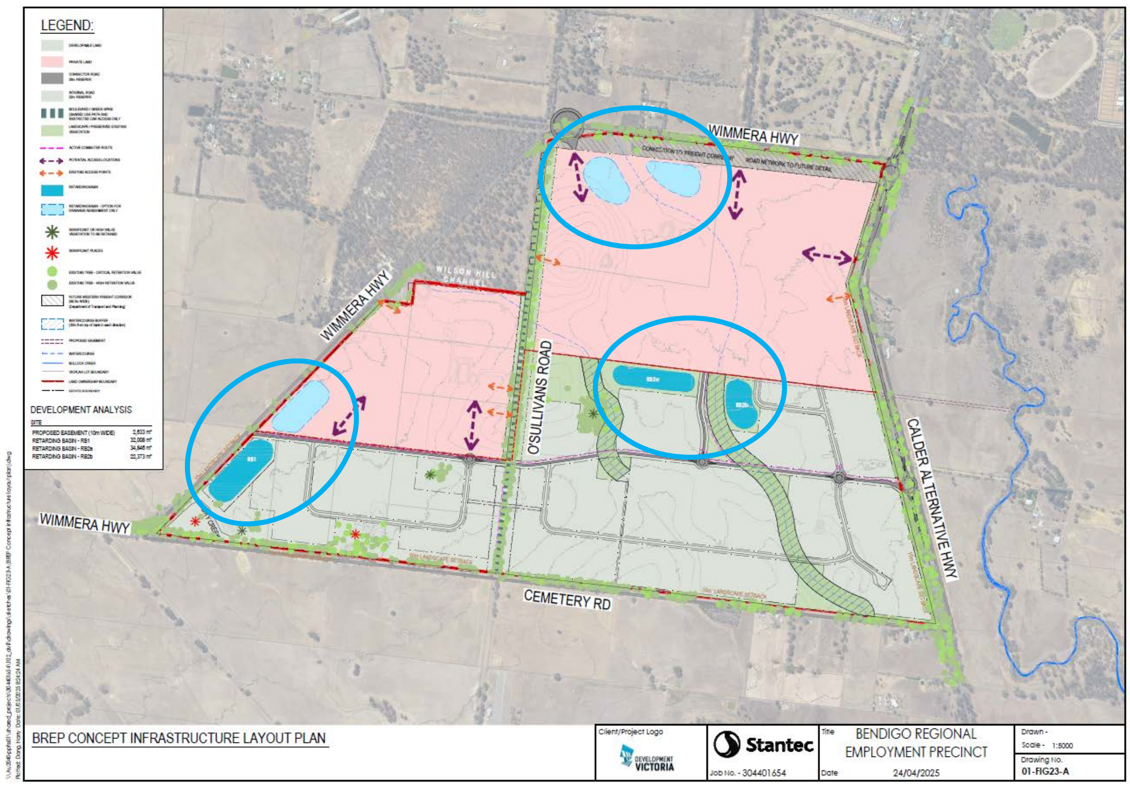

Figure 5-1: Proposed Detention Basins of the Site

The estimated detention volume was modelled in RORB as storage nodes to ensure permissible discharge at each sub-precinct is achieved. Details of the adopted properties of the storage nodes in RORB are shown in Table 10 to be updated at detailed design stage.

Table 10. Parameters Used in RORB

Parameter	North sub-precinct (RB1)	South sub-precinct (RB2)	West sub-precinct (RB3)
Spillway Crest Elevation (m AHD)	189.51	191.86	189.3
Top of Basin Elevation (m AHD)	189.81	192.16	189.6
Basin Bottom Elevation (m AHD)	188.31	190.66	188.7
1% AEP+CC Outlet Area Requirement (m^2)	9.81	27.05	14.14
1% AEP+CC Outlet Entrance Invert (m AHD)	188.86	191.46	188.7
63% AEP+CC Outlet Area Requirement (m^2)	0.80	0.80	-
63% AEP+CC Pipe Entrance Invert (m AHD)	188.31	190.66	-
1% AEP+CC Storage (m^3)	64,100	62,100	69,400
Storage including Freeboard (m^3)	83,493	80,000	106,426

5.2 Detention Results

RORB results for proposed development including detention basins are shown in Table 11. Results indicate that the developed flows at each sub-precinct are below their associated existing condition flows.

Table 11. Peak Discharge of the site including detention basins

Flow Location	Existing	Developed with Proposed Detention Basins (+CC)
North sub-precinct RB1 Outflow (m^3/s)	8.16	8.14
1% AEP Volume (m^3)	-	64,100
South sub-precinct RB2 Outflow (m^3/s)	8.44	8.43
1% AEP Volume (m^3)	-	62,100
West sub-precinct RB3 Outflow (m^3/s)	9.04	8.67
1% AEP Volume (m^3)	-	69,400

5.3 Conveying low flows to Bullock Creek

It is proposed to divert minor flows (63% AEP existing conditions) from the eastern basins to minimise basin land take and earthwork requirements considering the minimal elevation change in the site. Proposed diversion flows are approximately equivalent to 1.1 m^3/s from each basin. The Western basin cannot be diverted and is not considered in the below section.

The Bullock Creek TUFLOW model provided by the CMA was used to assess any flood impacts on Bullock Creek and downstream areas from the proposed pipe diversions. Pipe outlets were modeled as inflow hydrographs into Bullock Creek. Hydrographs were extracted from the RORB model to represent actual change in flow with time.

The modelling results (shown in Figure 5-2) indicate increased water levels in Bullock Creek in a 1% AEP event. A water level increase below 15 mm is observed in Bullock Creek near the RB1 pipe outfall and otherwise does not significantly impact the creek water levels or flood extents. Diverting any storm event flow higher than the 63% AEP existing conditions flow will exceed the 15 mm NCCMA afflux allowance.

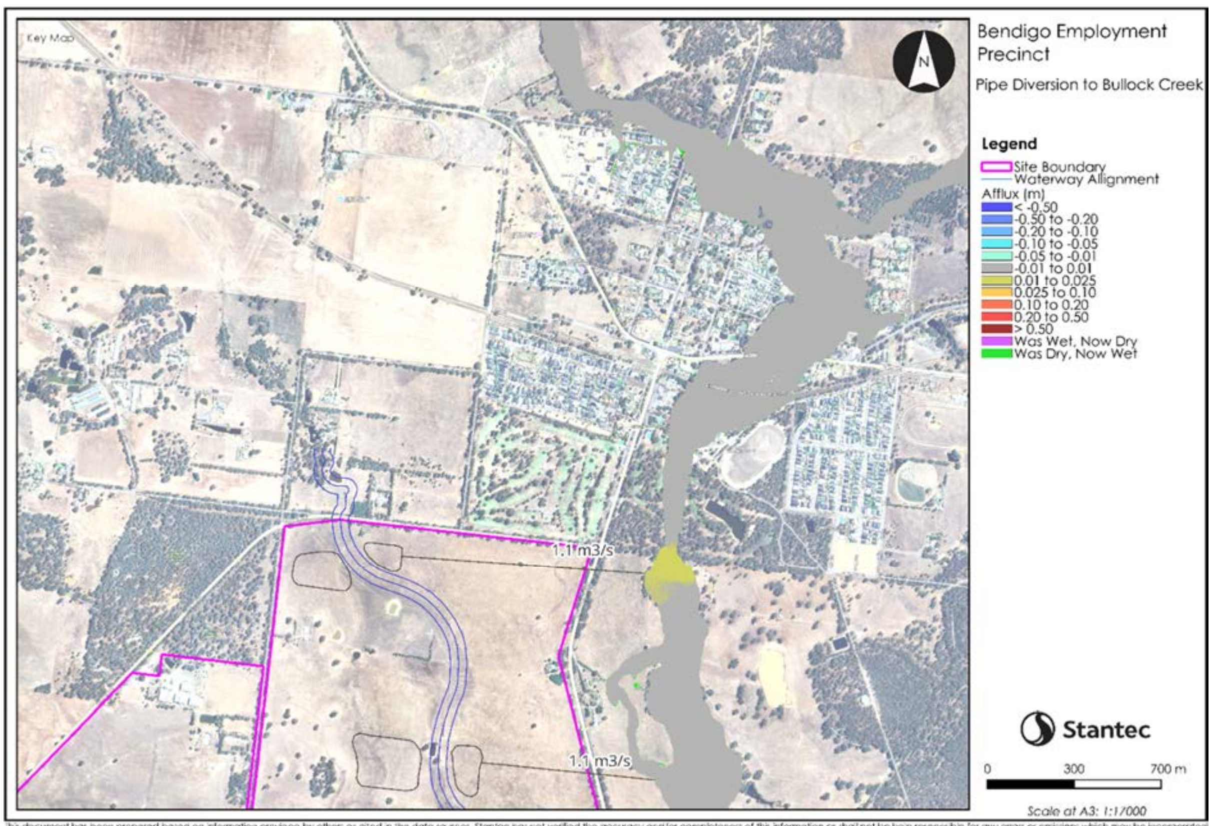

Figure 5-2: Afflux Map

5.4 1% AEP+CC Gap Flow Roadway Check

Roads will convey any gap flows (1% AEP+CC flows minus stormwater network AEP+CC) to the stormwater assets. Flow conveyance capacity checks were conducted for three key roadway locations upstream of each basin to ensure flow depth, velocity and hazards are within safety limits. In these cases, the stormwater pipe network is required to convey the 5% AEP+CC event flow to maintain feasible roadway widths at these locations. Roadways will be able to convey the gap flow of the 1% AEP+CC minus the 5% AEP+CC. The gap flows at each major roadway location are shown in Table 12. Their locations are shown in Figure 5-3.

Table 12. Gap Flows

Flow Location	1% AEP+CC Flow	5% AEP+CC Flow	Gap Flow
Just upstream of North sub-precinct RB1 (m3/s)	40.73	28.54	12.19
Just upstream of South sub-precinct RB2 (m3/s)	39.26	27.97	11.29
Just upstream of West sub-precinct RB3 (m3/s)	44.37	30.45	13.92

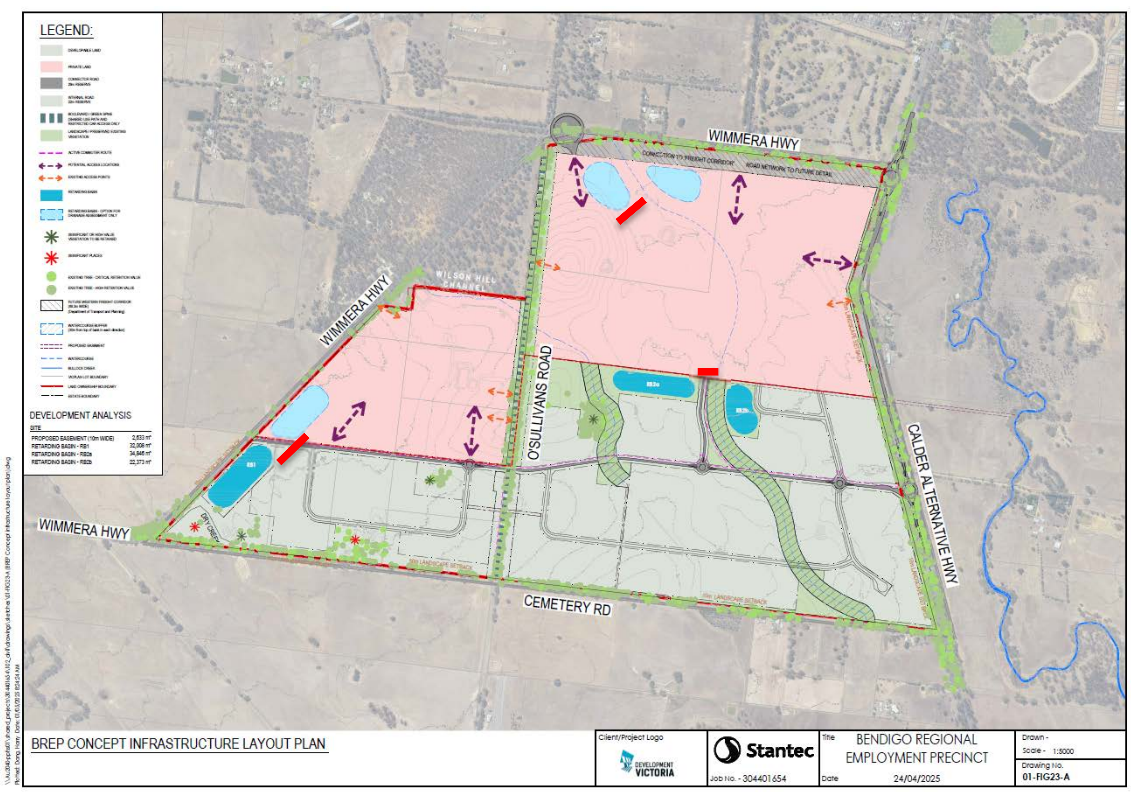

Figure 5-3: Cross-Section Locations

To convey these high gap flows, manning's 'n' equation was used to assess the road conveyance capacity. Considering the high gap flows, a swale or pipe arrangement in conjunction with the road is required to ensure the road meets the minimum hazard requirements. The cross section shown in Figure 5-4 illustrates an example of a 26 m road reserve with a swale. If incorporating a swale there will need to be multiple drainage links along the road so water can flow into the swale.

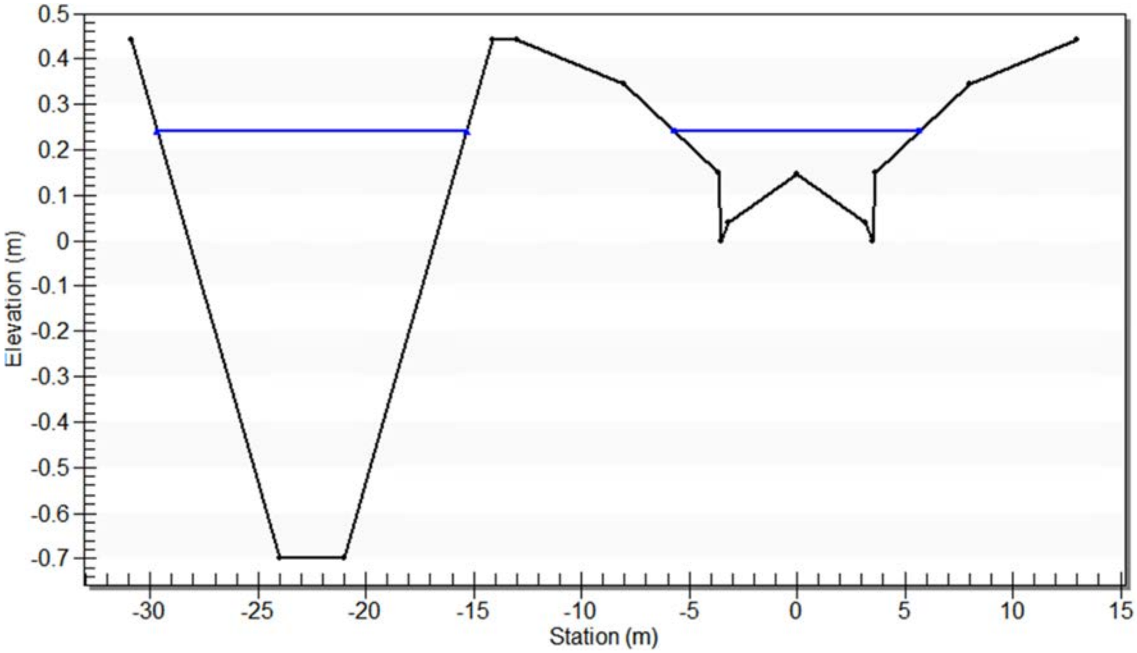

Figure 5-4: Flow conveyance check on road cross section

The road conveys approximately 0.8 m^3/s. The average velocity (Vav) of 0.60 m/s multiplied by the average depth (D_{av}) of 0.2 m is 0.12 m^2/s which is less than the 0.35 m^2/s allowance. D_{av} is less than 0.3 m and therefore under guideline recommendations. Therefore, the proposed road is sized to stakeholder requirements. The maximum depth is 240 mm which is under guideline recommendations of 300 mm. The swale parameters are shown in Table 13 allow for the conveyance of the remaining gap flow (i.e. that the roadway cant convey safely) with a low velocity.

Table 13. Swale beside Road

Parameter	**Value**
Flow (m^3/s)	13.1
Bottom width (m)	2
Top width (m)	15
Side slope (m:m)	1:6
Longitudinal slope (m/m)	0.004
Manning's roughness	0.035
1% AEP+CC minimum depth (m)	0.9
Freeboard (m)	0.3
Total Depth (m)	1.2
Velocity (m/s)	1.7
Required Area of Flow (m^2)	8.782

6 Stormwater Quality

The water quality objectives for the site are based on “Best Practice Environmental Management Guidelines” (CSIRO 1999). In order to achieve the required treatment objectives, water quality treatment measures will be incorporated into the site layout. The best practice water quality target is detailed in Table 14.

Table 14. Stormwater Treatment Objectives

Pollutant Type (Nutrient)	Pollutant Removal Efficiency (%)
Suspended Solids (SS)	80 %
Total Phosphorus (TP)	45 %
Total Nitrogen (TN)	45 %
Gross Pollutants	70%

Combination of a sedimentation basin discharging into a wetland system are proposed in the site to achieve water quality targets of the development. These assets are proposed to sit within the retarding basins which are located as shown in Figure 6-1.

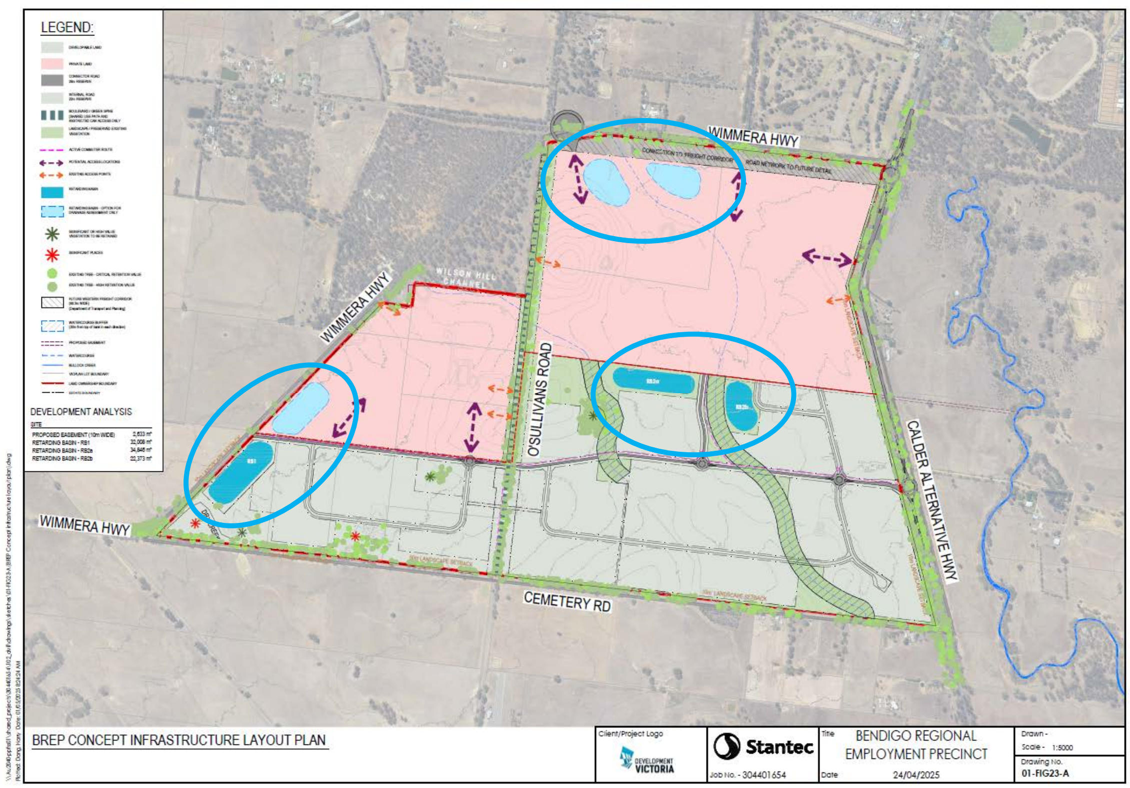

Figure 6-1: Proposed Locations of Water Quality Assets

The catchments and stormwater treatment train have been modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 6, the Melbourne Water MUSIC

Guidelines (2024) and Deemed to Comply Criteria of the Melbourne Water Constructed Wetlands Design Guidelines (2020).

6.1 MUSIC Model Setup

The main parameters used in the MUSIC model are described below:

- Rainfall and Evaporation: of the MUSIC supplied 6-minute data from the Bendigo rainfall gauge was used for the model
- Rainfall-Runoff Parameters - The appropriate rainfall-runoff parameters were adopted in this assessment as discussed in below sections.

Combined sedimentation basins and wetland systems are proposed for the sediment control and to achieve water quality targets within the study site; two wetland systems within the eastern catchments and one in the western catchment. Preliminary sizing of the proposed sediment basins was established using the Fair and Geyer (1954) formula as per WSUD Engineering Procedures: Stormwater (CSIRO/Melbourne Water, 2005) Chapter 4. Parameters used in the estimation are shown in Table 15. These wetlands will be contained within the retarding basins.

Table 15. Design Parameters of the Sedimentation Basin

Parameter	South sub-precinct (RB2)	North sub-precinct (RB1)	West sub-precinct (RB3)
Settling Velocity of target sediment (mm/s)	11	11	11
Hydraulic Efficiency	0.4	0.4	0.4
Permanent Pool Depth (m)	1.5	1.5	0.9
Extended Detention Depth	0.35	0.35	0.35
Design Discharge (Three Month ARI) (m^3/s)	2.43	2.41	2.32
Capture Efficiency	95%	95%	95%
Estimated Area of Basin (m^2)	2,250	1,650	1,400

As per Deemed to Comply Criteria of the Melbourne Water Constructed Wetlands Design Guidelines (2020), the inlet capacity to the sediment pond must convey all flows up to and including the 3-month ARI (or 4EY) flow. A flow of 2.43 m^3/s, 2.41 m^3/s and 2.32 m^3/s (3-month flow or 4 EY) was applied to the High Flow Bypass of the Sediment Basin and the Wetland Basin respectively for East (South basin), East (North basin) and Western basin. Due to the use of historical rainfall data, climate change factors were not applied to the modelled flows as this could result in increased performance.

Table 16 and Table 17 detail the adopted properties of the sediment basin and wetland nodes in the MUSIC model, respectively.

Table 16. MUSIC Parameters for Sedimentation Basin

Parameter	South sub-precinct (RB2)	North sub-precinct (RB1)	West sub-precinct (RB3)
Low Flow By-Pass (m^3/s)	0	0	0
High Flow By-Pass (m^3/s)	2.43	2.41	2.32
Surface Area (m^2)	2,250	1,650	1,400
Permanent Pool Volume (m^3)	2,250	1,650	1,400
Initial Volume (m^3)	2,250	1,650	1,400
Exfiltration Rate (mm/hr)	0	0	0
Evaporative Loss as % of PET	75	75	75
Equivalent Pipe Dia (mm)	113	97	89
Overflow Weir Width (m)	2.0	2.0	2.0
Notional Detention Time (hrs)	12.4	12.4	12.5

Table 17. MUSIC Parameters for Wetland

Parameter	South sub-precinct (RB2)	North sub-precinct (RB1)	West sub-precinct (RB3)
Low Flow By-Pass (m^3/s)	0	0	0
High Flow By-Pass (m^3/s)	23.79	23.26	25.97
Extended Detention Depth (m)	0.35	0.35	0.35
Surface Area (m^2)	27,000	29,000	45,000
Permanent Pool Volume (m^3)	10,800	11,600	18,000
Initial Volume (m^3)	10,800	11,600	18,000
Exfiltration Rate (mm/hr)	0	0	0
Evaporative Loss as % of PET	125	125	125
Equivalent Pipe Dia (mm)	162	168	210
Overflow Weir Width (m)	3	3	3
Notional Detention Time (hrs)	72.6	72.5	72.0

The MUSIC model developed for the site is shown in Figure 6-2 below.

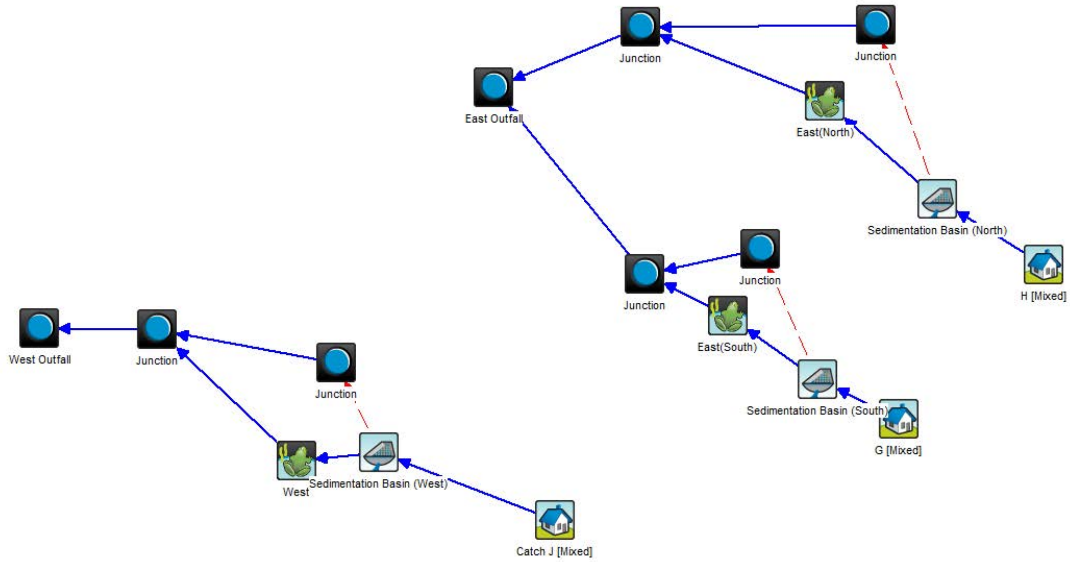

Figure 6-2: MUSIC Model

6.2 MUSIC Model Results

As per the results of MUSIC modelling (Presented in Table 18), the proposed water treatment infrastructure is capable of meeting the best practice water quality targets for the proposed development at the site at each sub-precinct.

Table 18. Music Model Results: Treatment Train Efficiency Percentages

Parameter	South sub-precinct (RB2)	North sub-precinct (RB1)	West sub-precinct (RB3)
Total Suspended Solids (kg/yr)	81.6	80.6	82
Total Phosphorus (kg/yr)	72.3	70.9	73.8
Total Nitrogen (kg/yr)	50.8	50.3	56.6
Gross Pollutants (kg/yr)	92.3	91.5	89.8

6.3 Basin Footprints Summary

Table 19 below illustrates final footprint required for the proposed wetlands taking into consideration sedimentation basin and dry out areas. It also shows that the retarding basins have enough space to incorporate the water quality aspects within them.

Table 19. Basin Footprints Summary

Parameter	South sub-precinct (RB2)	North sub-precinct (RB1)	West sub-precinct (RB3)
Wetland Area (m^2)	27,000	29,000	45,000
Sediment Basin Area (m^2)	2,250	1,650	450
Sediment Dry Out Area (m^2)	4,500	3,300	900
Final Water Quality Area (m^2)	33,750	34,950	46,350

6.4 Waterway Design

The existing waterway situated within the eastern side of the site will remain as a designated waterway under proposed conditions. It carries water from upstream catchments through the site and to the site outfall. At this time, the proposed waterway is assumed to follow the existing site gradient from south to north and will have 30 m buffers from the top of bank edge.

RORB modeling results indicate that the peak flow rates of the waterway at the downstream location of the site is approximately 50.15 m^3/s in the 1% AEP event including climate change.

The Manning's n equation has been used to verify the minimum waterway parameters to convey the flow and to fit within the 60 m easement restrictions. Refer to Figure 6-3 which illustrates the proposed waterway cross-section.

Refer to Table 20 below which shows the minimum waterway parameters. The waterway requires a total depth of 1.3 m with a total width of 50 m. It demonstrates that it fits within the 60m reserve requirement. The low velocity of 1.5 m/s fits within the allowable velocity range and should not be subject to erosion. Further assessments would be required during detailed design when the shape and bathymetry of the waterway is known.

Table 20. Channel Parameters

Parameter	Value
Flow (m^3/s)	50.15
Bottom Width (m)	41.5
Top Width (m)	50
Side Slope (m:m)	1:6
Longitudinal Slope (m/m)	0.005
Manning's roughness	0.035
1% AEP minimum Depth (m)	0.7
Freeboard Requirement (m)	0.6
Total Depth (m)	1.3
Velocity (m/s)	1.5

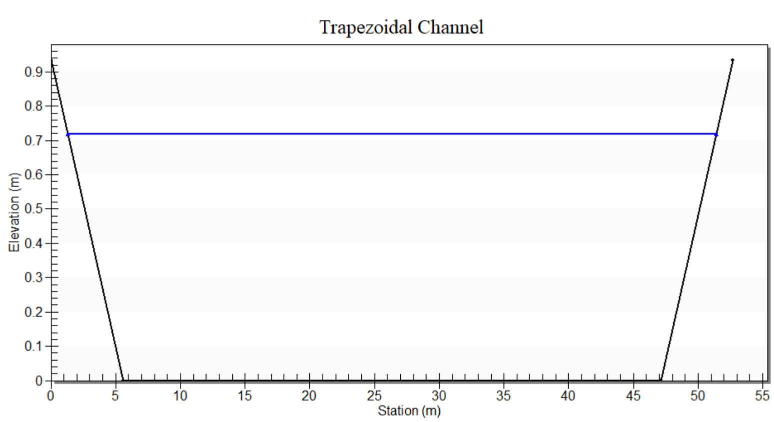

Figure 6-3: Waterway Cross-Section

7 Geotechnical Considerations

A desktop geotechnical assessment for the site was conducted to provide preliminary information on the geology and how any proposed infrastructure assets may be affected. This is attached in *Appendix E "Desktop Geotechnical Assessment for Bendigo Regional Employment Precinct"* as part of the overarching *"Bendigo Regional Employment Precinct Infrastructure Strategy"* report.

The assessment suggests that the primary concern with working in this type of soil (predominately clay, silt, gravel and fine to coarse-grained sand) is the potential occurrence of tunnel and surface erosion. It's advisable to treat the soil with limestone (or similar) to improve the soil for the proposed stormwater assets and infrastructure on the site. Further investigation during detailed design is recommended to verify the suitability of the soil for the stormwater assets discussed as part of this strategy.

8 Conclusion and Recommendations

The Stormwater Management Plan outlines the stormwater management systems for the proposed development.

- 2100 and SSP5 factors have been applied to rainfall depths to mitigate future climate change impacts to the site.
- The proposed development shall include a pipe system to convey all minor stormwater flow. All major stormwater beyond the 5% AEP+CC flow shall be conveyed overland via the proposed road network and swales.
- Three dual function wetland and retardation basins are proposed for the site, two basins in the eastern side and a single basin in the western side. Preliminary calculations have been undertaken to determine the minor and major flow rates for the future developed catchment and determine the preliminary sizing requirement for the proposed basins.
- Table 21 provides a summary of the assets and their sizes. It should be noted that these sizes are based on either detention requirement or water quality requirement targets (whichever is larger).

Table 21. Summary of Asset Footprints

Asset	Asset Area (m^2)	Existing RB inlet flow (m^3/s)	Developed RB inlet flow (+CC) (m^3/s)	Developed RB outlet flow (+CC) (m^3/s)
South sub-precinct RB2	60,000	8.16	40.73	8.14
North sub-precinct RB1	57,600	8.44	39.26	8.43
West* sub-precinct RB3	122,000	9.04	44.37	8.64

** It should be noted that the Western basin has a larger footprint because of a basin depth of 0.9 m compared to the eastern basins which can be constructed to be 1.5 m in depth.*

- These asset footprints are based on the assumption that it is possible to divert minor flows for RB1 and RB2 into Bullock Creek. Worst case conditions associated with the pipe diversion was assessed based on the NCCMA TUFLOW model.

Key recommendations from this assessment undertaken are:

- The current hydrology model developed for the site is based on a conservative approach assuming whole development catchments are industrial and hence consider higher fraction impervious value compared to actual development conditions. It is recommended to update the model to represent actual development conditions to optimise stormwater assets and roadway widths in future stages.
- Proposed pipe diversion into Bullock Creek needs to be further assessed in feasibility stage when more detailed designed basin and wetland designs can be incorporated into the TUFLOW model to mitigate any adverse impact on the creek and surrounding properties and any backflow impacts.
- It is recommended to conduct earthwork and geotechnical checks and proper engineering design for the proposed basins, roads and waterway in the future stages.
- Verification for the Wimmera Highway cross-drainage culverts along the northern edge of the eastern site area and along the western edge of the west site area is recommended in future stages to match with waterway design and climate change considerations.

Appendices

Appendix A Data Hub Inputs

Results - ARR Data Hub
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720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
[PREBURST25_META]
Time Accessed,22 November 2024 11:01AM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST25]From preburst class

75% Preburst Depths
[PREBURST75]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),11.1 (0.713),14.4 (0.622),16.6 (0.573),18.7 (0.531),17.1 (0.384),15.9 (0.303)
90 (1.5),12.2 (0.689),14.4 (0.549),15.8 (0.484),17.2 (0.434),16.9 (0.339),16.7 (0.284)
120 (2.0),11.6 (0.597),14.6 (0.511),16.5 (0.466),18.4 (0.429),18.2 (0.339),18.1 (0.287)
180 (3.0),12.0 (0.539),14.0 (0.435),15.3 (0.386),16.6 (0.349),20.6 (0.347),23.6 (0.341)
360 (6.0),6.7 (0.237),11.1 (0.278),14.0 (0.289),16.8 (0.294),18.3 (0.263),19.3 (0.244)
720 (12.0),2.2 (0.060),7.0 (0.139),10.2 (0.170),13.2 (0.191),15.8 (0.193),17.8 (0.194)
1080 (18.0),1.1 (0.026),4.3 (0.075),6.4 (0.094),8.4 (0.107),12.0 (0.132),14.8 (0.146)
1440 (24.0),1.1 (0.024),3.6 (0.058),5.2 (0.071),6.8 (0.080),8.4 (0.085),9.5 (0.087)
2160 (36.0),0.0 (0.000),0.5 (0.008),0.9 (0.011),1.2 (0.013),1.8 (0.016),2.2 (0.018)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.4 (0.003),0.6 (0.005)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
[PREBURST75_META]
Time Accessed,22 November 2024 11:01AM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST75]From preburst class

90% Preburst Depths
[PREBURST90]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),21.7 (1.394),26.2 (1.133),29.2 (1.009),32.1 (0.912),30.7 (0.690),29.6 (0.565)
90 (1.5),21.5 (1.216),24.1 (0.921),25.8 (0.791),27.4 (0.693),31.0 (0.621),33.8 (0.574)
120 (2.0),24.0 (1.232),29.3 (1.027),32.8 (0.925),36.1 (0.844),41.5 (0.770),45.5 (0.720)
180 (3.0),24.6 (1.102),27.6 (0.857),29.6 (0.746),31.6 (0.662),42.3 (0.713),50.3 (0.728)
360 (6.0),17.5 (0.613),21.9 (0.546),24.8 (0.512),27.6 (0.483),37.1 (0.535),44.2 (0.559)
720 (12.0),10.0 (0.274),17.6 (0.351),22.7 (0.379),27.5 (0.396),30.8 (0.376),33.2 (0.364)
1080 (18.0),14.5 (0.347),17.7 (0.310),19.8 (0.293),21.9 (0.280),25.0 (0.274),27.3 (0.270)
1440 (24.0),11.8 (0.260),13.7 (0.220),14.9 (0.202),16.1 (0.189),20.6 (0.209),24.1 (0.220)
2160 (36.0),8.2 (0.163),9.7 (0.139),10.6 (0.128),11.5 (0.120),17.0 (0.152),21.0 (0.170)
2880 (48.0),0.4 (0.007),2.4 (0.032),3.8 (0.042),5.0 (0.049),7.1 (0.058),8.6 (0.063)
4320 (72.0),0.0 (0.000),1.3 (0.017),2.2 (0.023),3.1 (0.027),7.5 (0.055),10.8 (0.070)
[PREBURST90_META]
Time Accessed,22 November 2024 11:01AM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST90]From preburst class

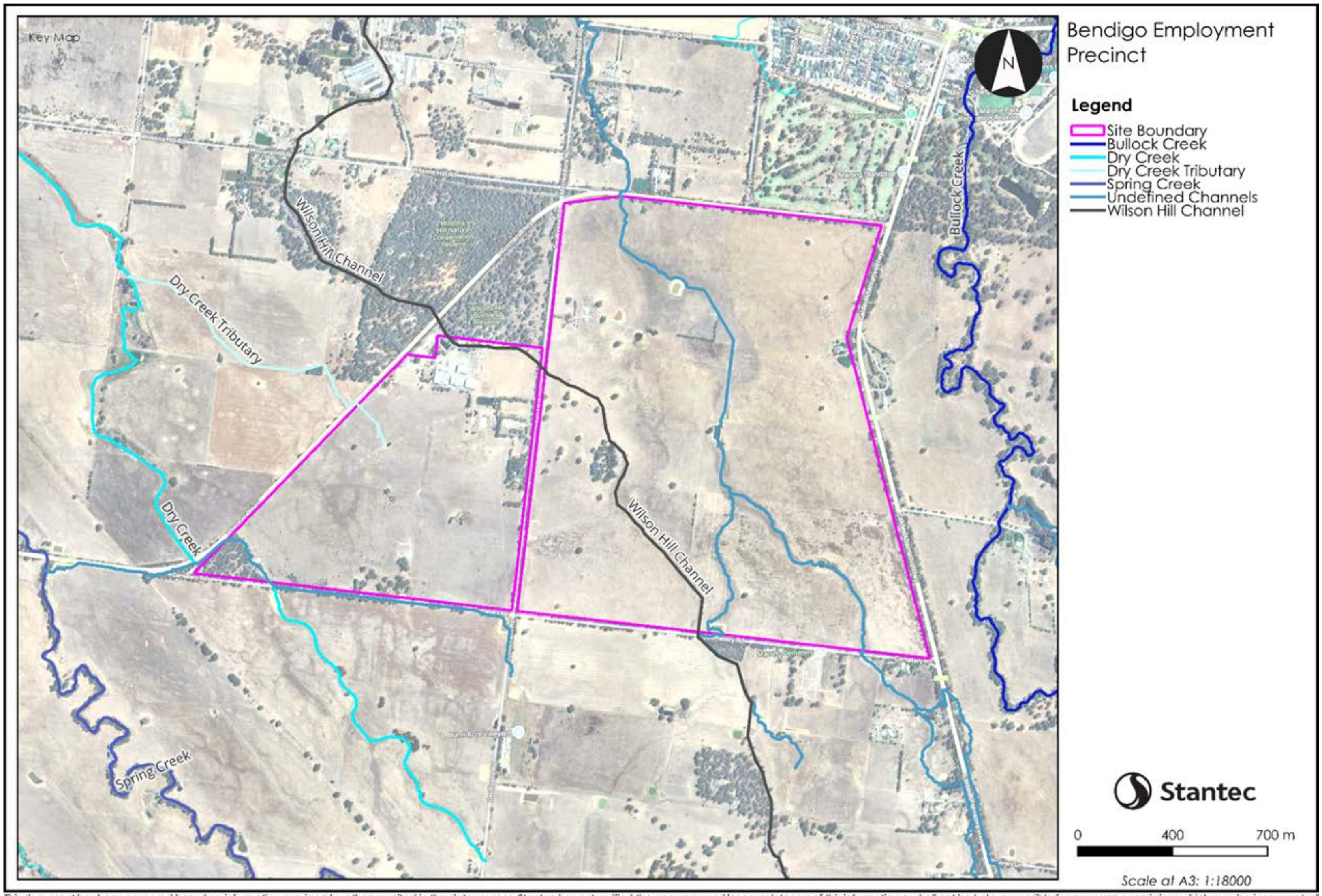
Climate Change Factors
[CCF]
[SSP1-2.6]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1
2040,1.21,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.11,1.11
2050,1.22,1.2,1.18,1.17,1.15,1.15,1.14,1.13,1.12,1.11
2060,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2070,1.24,1.22,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2080,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2090,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2100,1.22,1.2,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.12
[END_SSP1-2.6]
[SSP2-4.5]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1
2040,1.22,1.2,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.12
2050,1.27,1.24,1.23,1.21,1.19,1.18,1.17,1.16,1.15,1.14
2060,1.3,1.27,1.25,1.23,1.21,1.2,1.19,1.18,1.16,1.16
2070,1.33,1.3,1.28,1.26,1.24,1.22,1.21,1.19,1.18,1.17
2080,1.37,1.33,1.31,1.28,1.26,1.24,1.22,1.21,1.2,1.19
2090,1.4,1.36,1.34,1.31,1.28,1.26,1.24,1.23,1.21,1.2
2100,1.41,1.37,1.35,1.32,1.29,1.27,1.25,1.24,1.22,1.21
[END_SSP2-4.5]
[SSP3-7.0]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1
2040,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2050,1.29,1.26,1.24,1.22,1.2,1.19,1.18,1.17,1.16,1.15
2060,1.35,1.32,1.3,1.27,1.25,1.23,1.22,1.2,1.19,1.18
2070,1.42,1.38,1.35,1.32,1.29,1.28,1.26,1.24,1.22,1.21
2080,1.5,1.45,1.42,1.38,1.35,1.33,1.3,1.28,1.26,1.25
2090,1.59,1.53,1.49,1.44,1.4,1.38,1.35,1.33,1.3,1.29
2100,1.66,1.59,1.55,1.5,1.45,1.42,1.39,1.37,1.34,1.32
[END_SSP3-7.0]
[SSP5-8.5]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.2,1.18,1.17,1.16,1.14,1.13,1.13,1.12,1.11,1.11
2040,1.26,1.24,1.22,1.2,1.18,1.17,1.16,1.15,1.14,1.14
2050,1.34,1.31,1.29,1.26,1.24,1.23,1.21,1.2,1.18,1.18
2060,1.42,1.38,1.35,1.32,1.29,1.28,1.26,1.24,1.22,1.21
2070,1.52,1.47,1.43,1.4,1.36,1.34,1.31,1.29,1.27,1.26
2080,1.63,1.57,1.52,1.48,1.43,1.4,1.37,1.35,1.33,1.31
2090,1.77,1.69,1.64,1.58,1.52,1.49,1.45,1.42,1.39,1.37
2100,1.86,1.77,1.71,1.64,1.58,1.54,1.5,1.47,1.43,1.41
[END_SSP5-8.5]
[Climate_Change_INITIAL_LOSS]
,Losses SSP1-2.6,Losses SSP2-4.5,Losses SSP3-7.0,Losses SSP5-8.5
2030,1.04,1.04,1.04,1.04
2040,1.04,1.04,1.05,1.05
2050,1.04,1.05,1.06,1.07
2060,1.05,1.06,1.07,1.08
2070,1.05,1.07,1.08,1.1
2080,1.05,1.07,1.09,1.11
2090,1.05,1.07,1.11,1.13

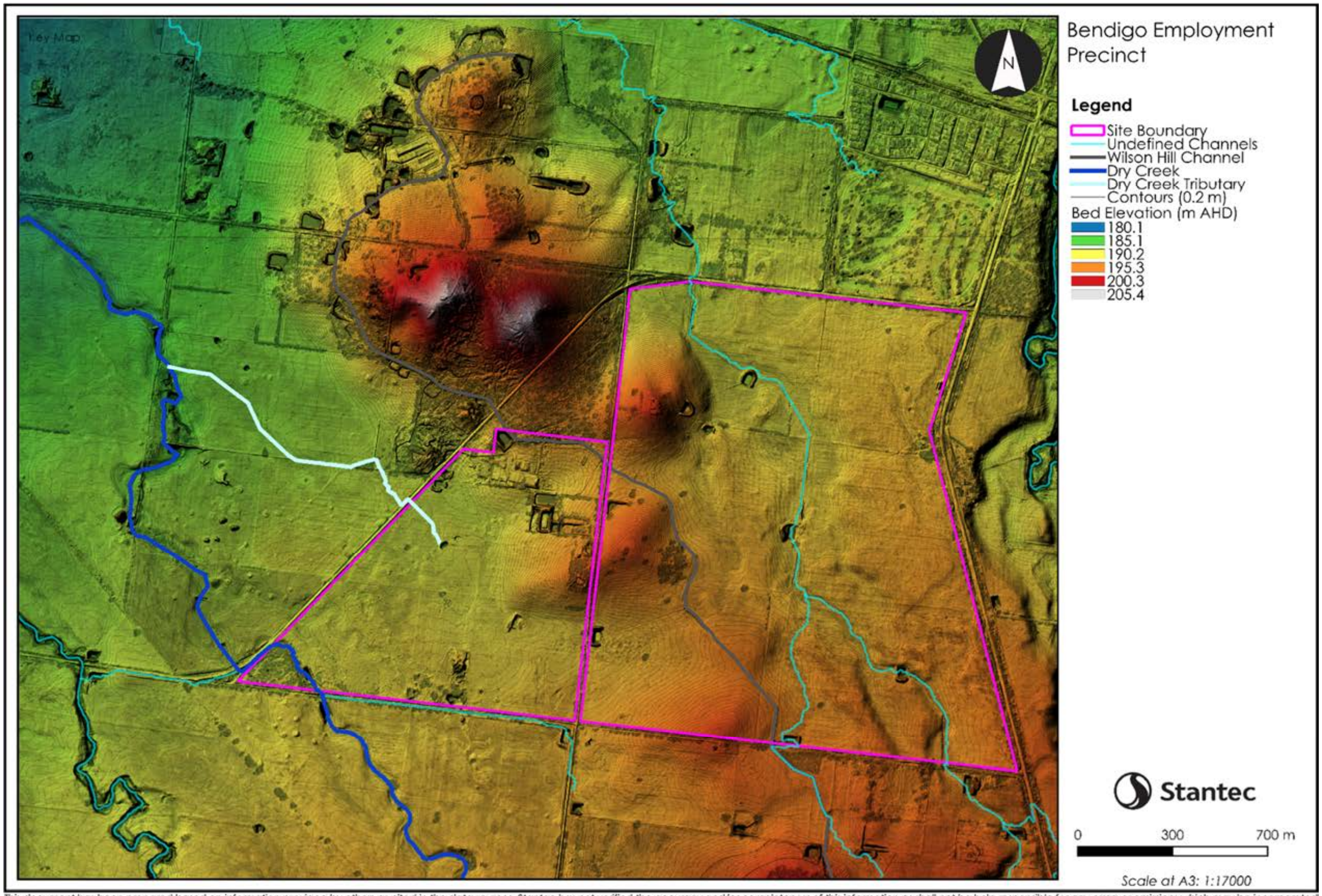
2100,1.04,1.08,1.12,1.15
[END_Climate_Change_INITIAL_LOSS]
[Climate_Change_CONTINUING_LOSS]
,Losses SSP1-2.6,Losses SSP2-4.5,Losses SSP3-7.0,Losses SSP5-8.5
2030,1.08,1.08,1.08,1.09
2040,1.09,1.1,1.1,1.11
2050,1.1,1.11,1.13,1.14
2060,1.1,1.13,1.15,1.18
2070,1.1,1.14,1.18,1.21
2080,1.1,1.16,1.21,1.25
2090,1.1,1.17,1.24,1.3
2100,1.1,1.17,1.27,1.33
[END_Climate_Change_CONTINUING_LOSS]
[TEMPERATURE_CHANGES]
,SSP1-2.6,SSP2-4.5,SSP3-7.0,SSP5-8.5
2030,1.2,1.2,1.2,1.3
2040,1.3,1.4,1.5,1.6
2050,1.4,1.7,1.8,2.1
2060,1.5,1.9,2.2,2.5
2070,1.5,2.1,2.5,3.0
2080,1.5,2.2,2.9,3.5
2090,1.5,2.4,3.3,4.1
2100,1.4,2.5,3.6,4.5
[END_TEMPERATURE_CHANGES]

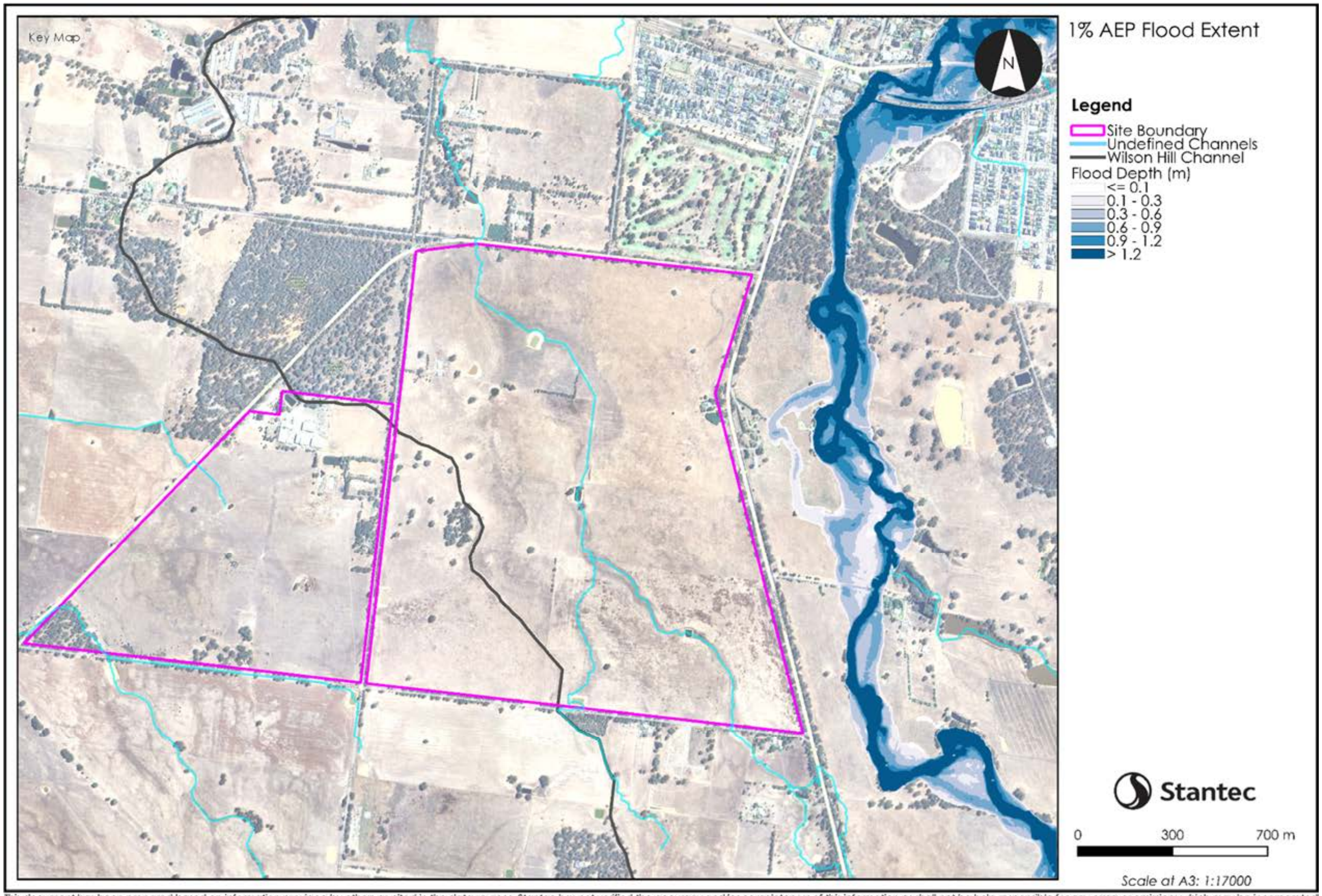
[CCF_META]
Time Accessed,22 November 2024 11:01AM
Version,2024_v1
Note,Updated climate change factors for IFD Initial loss and continuing loss based on IPCC AR6 temperature increases from the updated Climate Change Considerations (Book 1: Chapter 6) in ARR (Version 4.2). ARR recomends the use of Current and near-term (2030 midpoint). Medium-term (2050 midpoint) and Long-term (2090 midpoint)
[END_CCF]

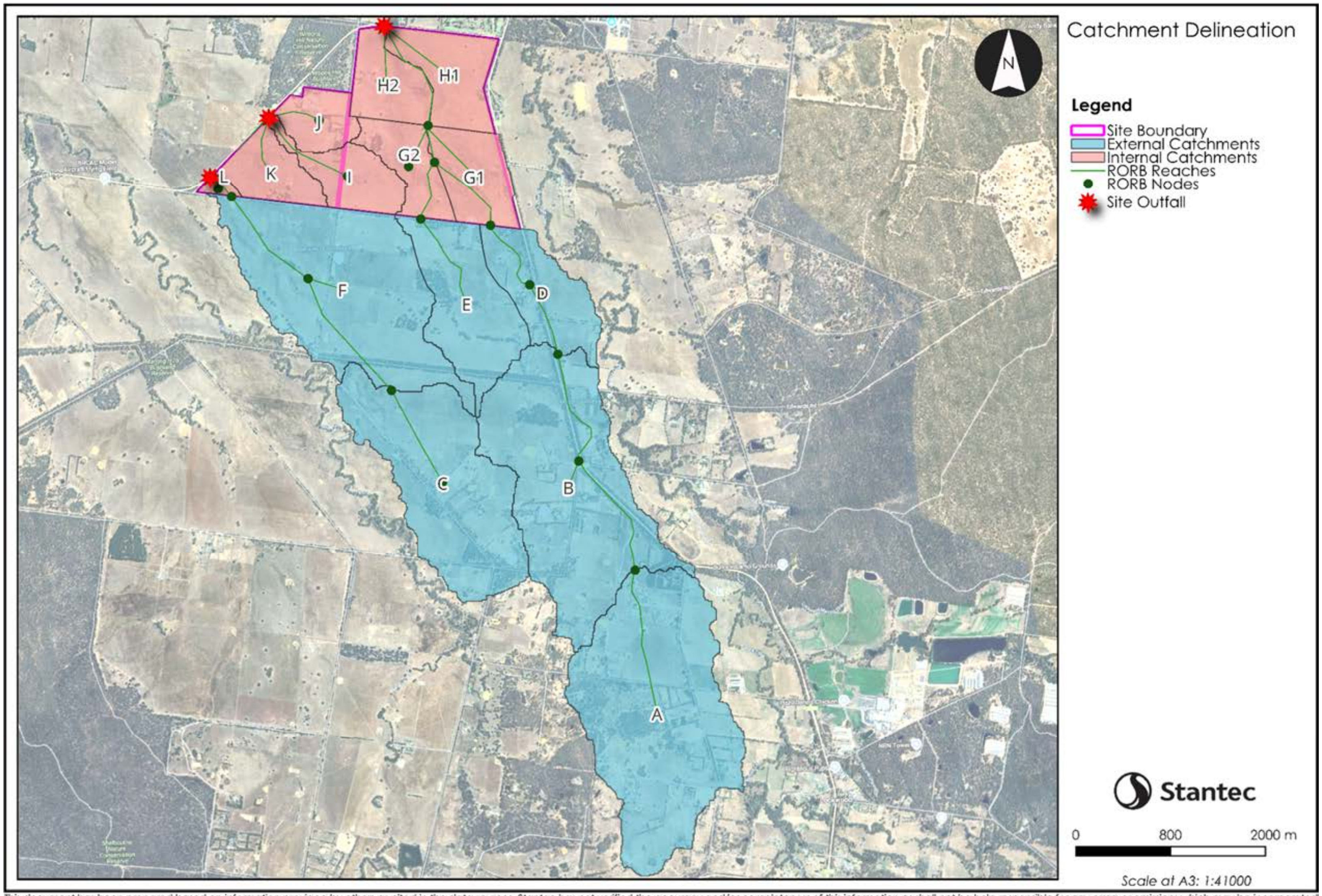
[ENDTXT]

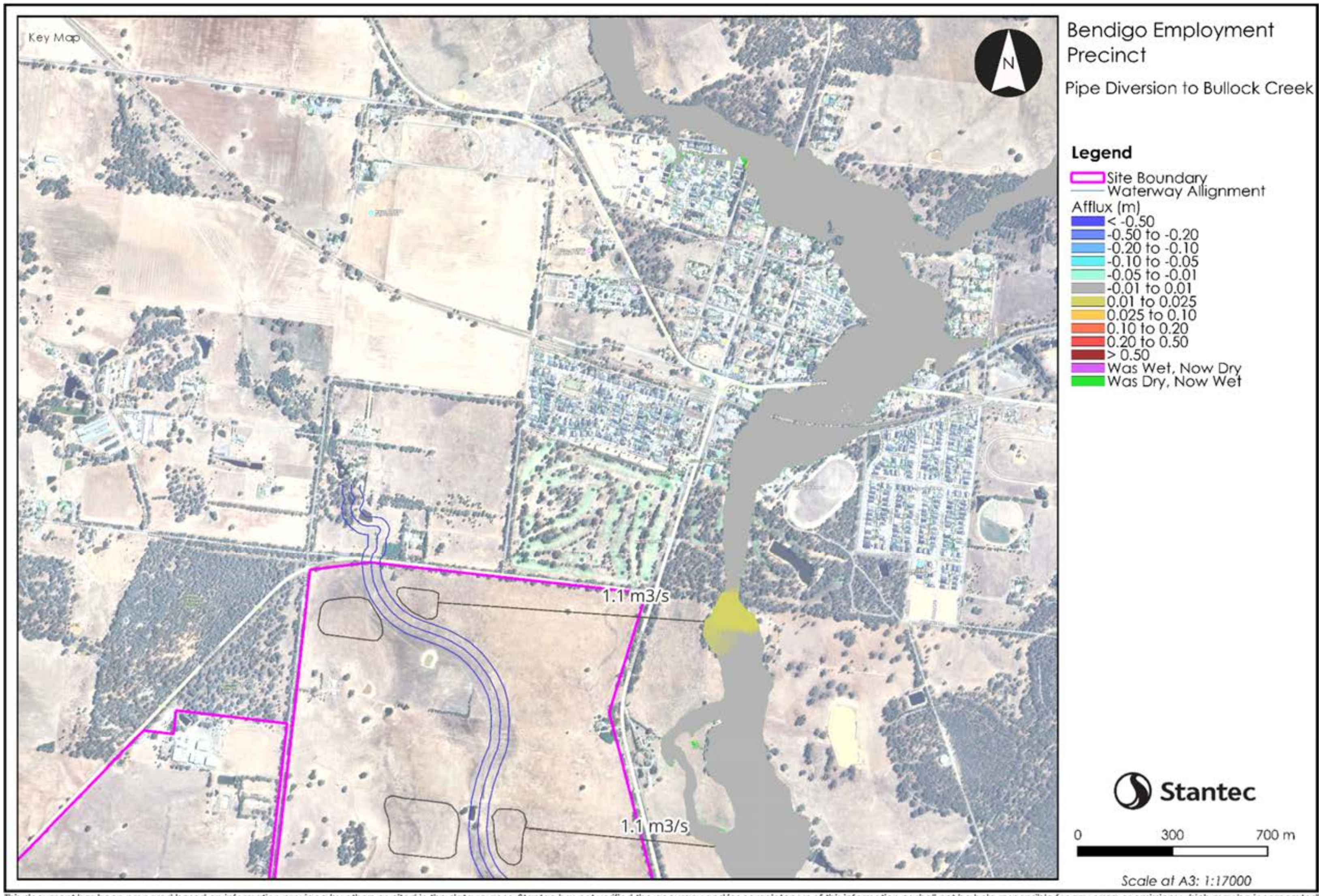
Appendix B Flood Maps


Key Map
Bendigo Employment Precinct
N
Legend
Site Boundary
Bullock Creek
Dry Creek
Dry Creek Tributary
Spring Creek
Undefined Channels
Wilson Hill Channel
Wilson Hill Channel
Dry Creek Tributary
Dry Creek
Wilson Hill Channel
Bullock Creek
Spring Creek
Stantec
0
400
700 m
Scale at A3: 1:18000


Bendigo Employment Precinct
N
Legend
Site Boundary
Undefined Channels
Wilson Hill Channel
Dry Creek
Dry Creek Tributary
Contours (0.2 m)
Bed Elevation (m AHD)
180.1
185.1
190.2
195.3
200.3
205.4
Stantec
0
300
700 m
Scale at A3: 1:17000


Key Map
N
1% AEP Flood Extent
Legend
Site Boundary
Undefined Channels
Wilson Hill Channel
Flood Depth (m)
<= 0.1
0.1 - 0.3
0.3 - 0.6
0.6 - 0.9
0.9 - 1.2
> 1.2
Stantec
0
300
700 m
Scale at A3: 1:17000


Catchment Delineation
N
Legend
Site Boundary
External Catchments
Internal Catchments
RORB Reaches
RORB Nodes
Site Outfall
H2
H1
J
G2
K
L
I
G1
F
E
D
C
B
A
Stantec
0
800
2000 m
Scale at A3: 1:41000


Key Map
N
1.1 m3/s
1.1 m3/s
Bendigo Employment Precinct
Pipe Diversion to Bullock Creek
Legend
Site Boundary
Waterway Allignment
Afflux (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.025
0.025 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50
Was Wet, Now Dry
Was Dry, Now Wet
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0 300 700 m
Scale at A3: 1:17000

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Stantec is a global leader in sustainable architecture, engineering, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.