S&B Ref No: C2409-001

09/10/2024

Project Manager
Walker Corporation (Adelade)
Level 2, 2 King William Street

Adelade, SA, 5000

Attention: Brent Eddy & Patrick Mitchell

TECHNICAL MEMORANDUM

STORMWATER TREATMENT PERFORMANCE MODELLING

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1 INTRODUCTION

Simmonds & Bristow have been engaged to provide updated MUSIC modelling for the catchment area of Saltwater Lake 1 (SWL1) for the Riverlea development to support the lake design and approval process.

Three Scenarios where considered:

1. Scenario 1 – GPT + Wetlands
2. Scenario 2 – GPT + Propriety (Membrane) Filters
3. Scenario 3 - GPT + Wetlands (Northern Area) + Propriety (Membrane) Filters (Southern Area) - Wetlands remain common for Stages 15, 16, 19 & 20.

Storms of concern are the 2EY to meet local performance guidelines, though devices are fit for purpose to 4EY events. MUSIC modelling ignores storm events, save for high flow bypass flows.

This technical memorandum provides an overview of the modelling procedure, the results of the modelling and indications as to the potential affects nutrient input from stormwater may have on the lake system.

Head Office: 40 Reginald Street, Rocklea, QLD 4106
Postal Address: PO Box 849, Archerfield, QLD 4108
1800 620 690 | +61 7 3434 3800 | Fax: +61 7 3434 3899
info@simmondsbristow.com.au | www.simmondsbristow.com.au
RTO 1735 ABN 33 010 252 418

2 MUSIC Model

MUSIC (the Model for Urban Stormwater Improvement Conceptualisation) has been used to predict performance of site stormwater assets.

A MUSIC model has been prepared based on the stormwater management plan (SMP) provided to Simmonds & Bristow. This SMP was previously prepared WGA in January 2024 and provides details for stormwater management practices, including interim management for Precincts 1 and 2 and the ultimate development.

The modelling provided in this report focuses primarily on the catchment areas for SWL1, the modelling does not include the remaining development area, any parts of the development that aren't contributing to SWL1 have been ignored.

2.1 Weather Data

Metrological data is provided in the SA MUSIC modelling guidelines, with various data provided for different areas of the state. Data for the "Adelade Dry" area was utilised, based on the maps provided.

The data consists of 10 years of 6 min pluviograph data.

2.2 Contributing Catchment Areas

Catchment areas are based on a combination of the areas provided in the WGA report, and discussions with Brent Eddy of Walker Corporation, regarding areas that may be able to be re-directed away from SWL1 to reduce the stormwater input. Primarily these are portions of Stages 17, 18 and the commercial area (marked NC-13 on the maps provided).

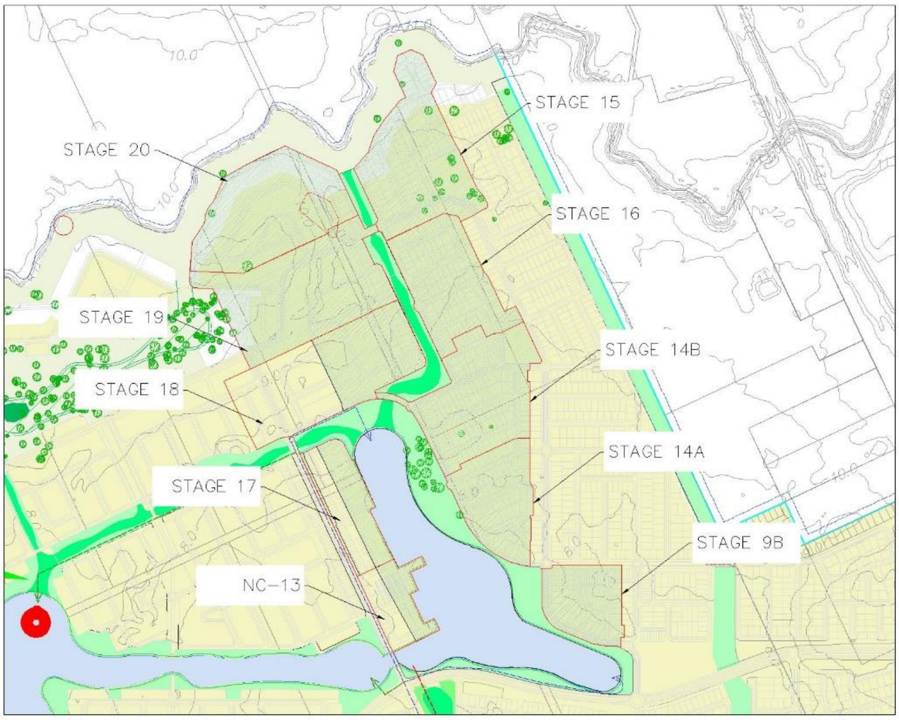

Figure 1: Stages feeding SWL1

The following areas have been utilised in the MUSIC model.

Table 1: MUSIC Model catchment areas

Stage No	SMP Nominated Area (ha)	Estimated Connected Catchment (ha)
Stage 9B	3.83	3.83
Stage 14A	5.02	5.02
Stage 14B	8.17	8.17
Stage 15	6.69	6.69
Stage 16	8.78	8.78
Stage 17	4.04	2.16
Stage 18	10.02	4.8
Stage 19	9.97	9.97
Stage 20	8.94	8.94
NC13	3.11	1.3

A split-catchment modelling approach has been utilised, with lot areas, road areas and other areas (such as parks) estimated based on the layouts provided to S&B at the time of modelling. It is acknowledged that these areas may change as the development is further designed, although it would generally be expected that the overall areas would remain relatively similar.

The split catchment approach utilised splits each area into a roof area, a road area and an "other" area that represents ground areas such as lawns, parks and road verges. Roof areas have been based on an average of roof areas, based on a break-out provided by Walker Corporation.

Table 2: Development Lot and Roof Areas

Lot Type	Lot Area (m^2)	Roof Area (m^2)	Distribution (%)
12.5m x 30m	375	230	12.5
14m x 30m	420	280	30
16m x 30m	480	300	30
18m x 30m	540	350	12.5
7m x 30m	210	170	15

The aggregate of this distribution results in a general proportion of around 66.6% of the overall lot area being roof.

Roads have been estimated using the CAD layout provided. The "other" area includes ground areas, such as yards, and lawns, park areas and road verges.

Area imperviousness has been estimated based on our experience in similar developments.

Table 3: Split Catchment Areas

Stage No	Roof (ha)	Road (ha)	Other (ha)
Stage 16	3.271	1.246	4.263
Stage 20	4.518	1.092	3.33
Stage 15	2.897	0.966	2.827
Stage 19	4.112	1.425	4.433
Stage 18	2.06	0.77	1.962
Stage14A	2.209	0.821	1.99
Stage14B	2.974	1.428	3.769
Stage17	0.759	0.369	1.037
Stage9B	1.418	0.77	1.642
NC13	0.418	0.502	0.451

In addition to these areas, the verge of the lake, and the verges on the drainage channel have been included in the model as "other" area.

Table 4: Pervious/Impervious fractions

Split Catchment Type	Pervious Fraction	Impervious Fraction
Road	10%	90%
Roof	0%	100%
Other	90%	10%
Other (lake & wetland Verge)	100%	0%

Catchment runoff, and pollution generation settings have been taken from the South Australian MUSIC guidelines, published in February 2021.

2.3 Treatment Processes & Nodes

Two stormwater treatment trains have been reviewed as part of the MUSIC modelling. Specifically, the use of constructed wetlands has been compared to the use of proprietary membrane filtration technology (specifically the Atlan Flowfilter product).

2.3.1 Gross Pollutant Traps

Both systems will need to be protected by Gross Pollutant Traps. The GPT arrangements for both models are the same, using the same equipment and design points.

The Atlan Vorticeptor unit has been chosen as the GPT, with the high-flow bypass configured for the 2EY storm flows per guideline requirements. The "offline" variant has been utilised, which allows for high flow bypass to be controlled via an external flow control chamber. At typical flows, stormwater is directed through the vorticeptor, while at high flows the high-flow bypass passes through the flow chamber directly.

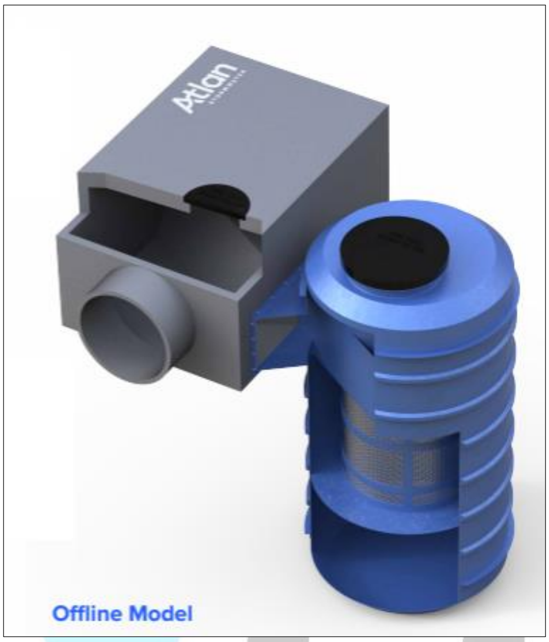

Figure 2: Atlan Vorticeptor

Highflow bypasses have been estimated at between 180L/sec to 360 L/sec depending on the connected catchments.

The Vorticeptor GPT MUSIC model configuration has been provided by Atlan and has been used in the MUSIC modelling. High-flow bypasses have been adjusted based on the model's listed to best match the 2EY stormflow. The models Gross Pollutant, TSS, TP and TN removal performance has not been altered from the base model provided by Atlan.

The peak 2 EY stormflow has been estimated using basic hydrologic modelling.

2.3.2 Scenario 1 – GPT + Wetland System

The wetland system would be constructed in the drainage channel that connects the Gawler River to the northern end of SWL1. This runs between Stages 15, 16 and stages 18, 19 and 20.

This is the system proposed in the SMP report, which proposes the installation of wetlands into the low-flow and riparian areas of these main drainage channels. The SMP report provides a generally good design overview of how the wetlands would be integrated into the channel, providing enhanced habitat, visual amenity, and potential recreation opportunities.

The drain is approximately 40m wide. The approximate area utilised for the wetlands is provided in the drawing below.

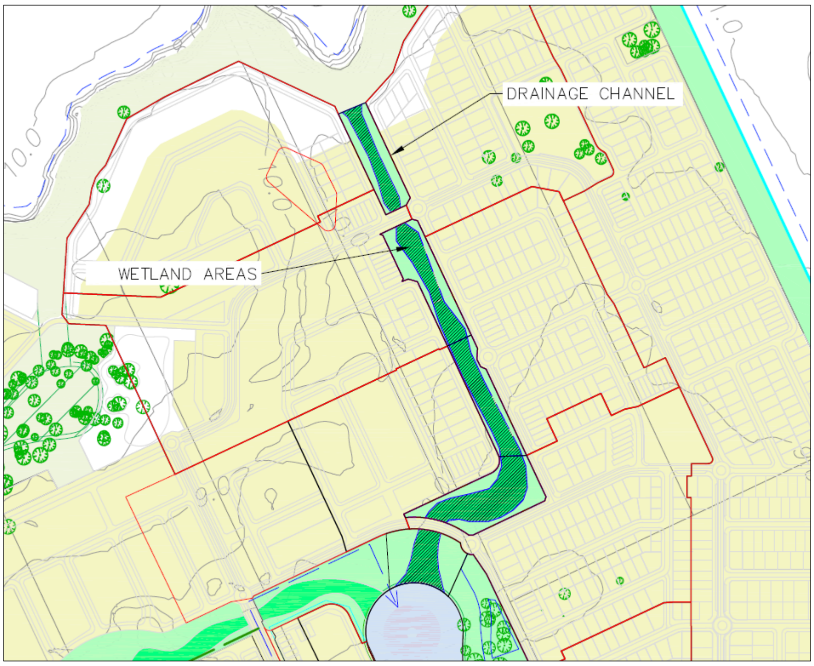

Figure 3: Drainage Channel – Typical in all scenarios

This regional drainage section would service stages 15, 16, 18 (parts of) 19 (parts of), and 20. Sections of stages 18 and 19 are likely to be graded away from SWL1 to reduce the stormwater input into the lake, which will reduce the connected catchment area.

Stages 9B, 14A and, 14B would discharge either through wetlands installed in the verges of the lake, or through flowfilter systems.

For this model, it has been assumed that these stages will discharge through wetlands, however performance using Flowfilter systems is similar, with a 4% improvement in TP load reduction and a 2% decrease in TN load reduction. These wetlands would be close to the built areas, placing them well away from lake edge to reduce potential for saltwater intrusion into the wetlands, as saltwater intrusion would likely kill the wetland plants.

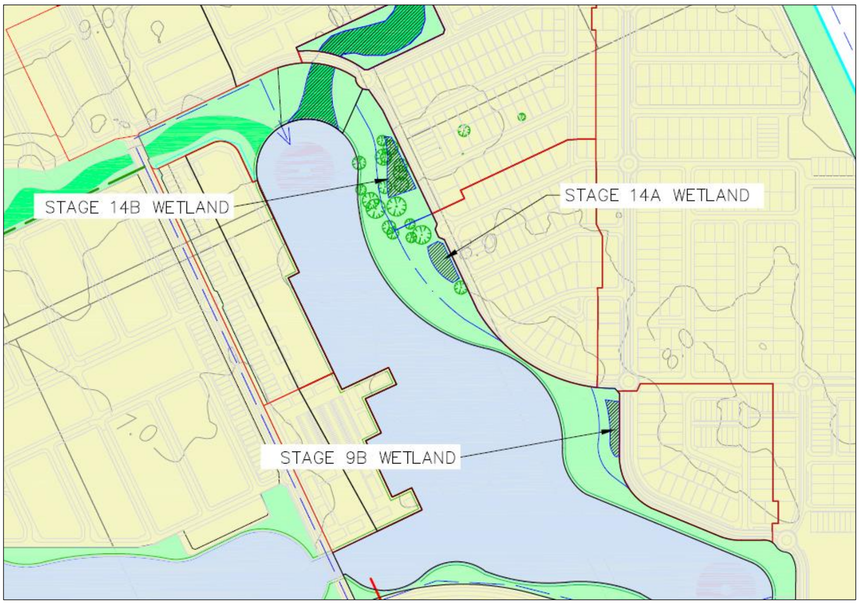

Figure 4: Scenario 1 – GPT + Wetland Treatment (Wetland T'ment to S9B and S14A & 14B)

All wetlands would be protected by a GPT as detailed in Section 2.3.1, and a sedimentation basin.

The Sed Basin has been sized for the 1EY storm flow. The wetlands have high flow bypasses set at the 1:100 ARI (1% AEP) storm as the wetlands need to accommodate the high flows caused by the 1% AEP storm without causing undue damage to the wetland plantings. Drainage design will need to ensure that the velocity through the wetlands at the 1% AEP does not exceed 0.5 m/sec (in accordance with recommendations from the *Constructed Wetland Guidelines – Melbourne Water, April 2010*) to avoid damage.

Stages 17 and the commercial area marked NC-13 will need to be serviced by a flow-filter system as there is not sufficient area within these stages to accommodate a constructed wetland.

The wetlands consist of varying water depths, supporting the growth of shallow and submerged macrophytes with areas of open water. An average depth of 0.4 m has been utilised in the modelling, as recommended in the SA Music Modelling guidelines, as this represents the average of the deep and shallow areas within the wetland arrangement. As noted previously, the SMP provided includes a reasonable description of how the wetlands might be configured.

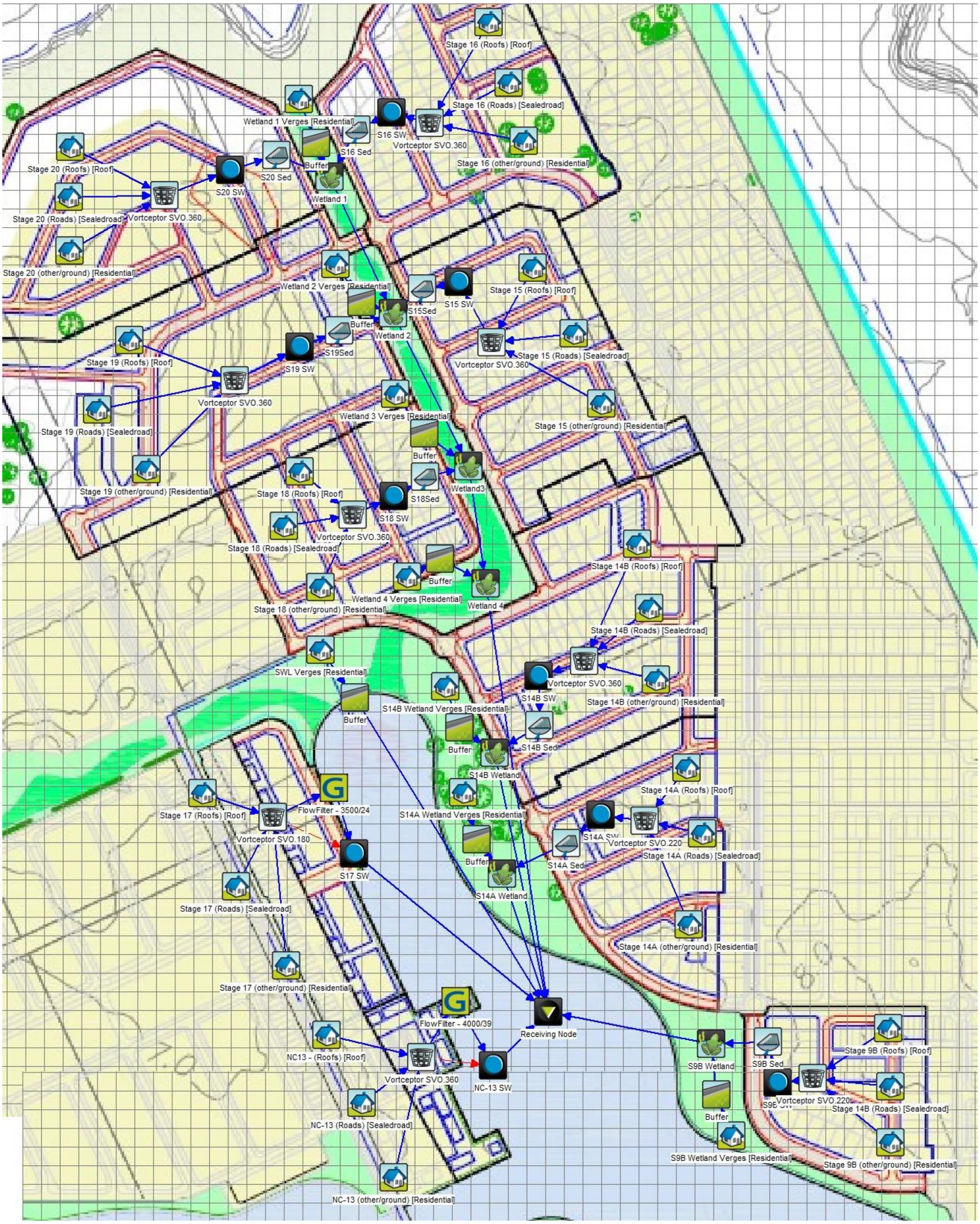

Figure 5: Scenario 1 GPT + Wetland MUSIC Model

2.3.3 Scenario 2 – GPT + Propriety (Membrane) Filter System

The alternative to wetlands is to utilise propriety membrane filtration technology.

The Atlan Flowfilter has been chosen as the preferred treatment technology.

Figure 6: Atlan Flowfilter

A design or stages 14A and 14B has been provided by Atlan stormwater, utilising the Vorticeptor GPT's and the Flowfilter system. This design has informed the sizing and selection of the equipment for the remaining stages (including stage 9B).

The flowfilters adopt full treatment for the 4EY storm, as per the recommendations in the MUSIC modelling guidelines, with the remaining flow bypassed. The high-flow bypass varies from around 120L/sec to 160L/sec depending on the connected catchment.

The Flowfilter MUSIC model configuration has been provided by Atlan stormwater and has been used in the MUSIC modelling.

Highflow bypasses have been adjusted to the closest match for the estimated 4EY stormflow, even though 2EY is the required treatment maximum flow, based on the models listed. Gross Pollutant, TSS, TP and TN removal rates have not been altered from those provided in the model.

The flowfilters are modelled discharging directly to the lakes; they would likely use a drain or channel along the main channel, however due to the way Swales are modelled in MUSIC, they result in a significant degradation in water quality even without the introduction of any additional stormwater. The area of the drain was added to the lake verge to ensure that runoff from that area was captured in the model. Further modelling and mass balancing may improve accuracy of this part of the model.

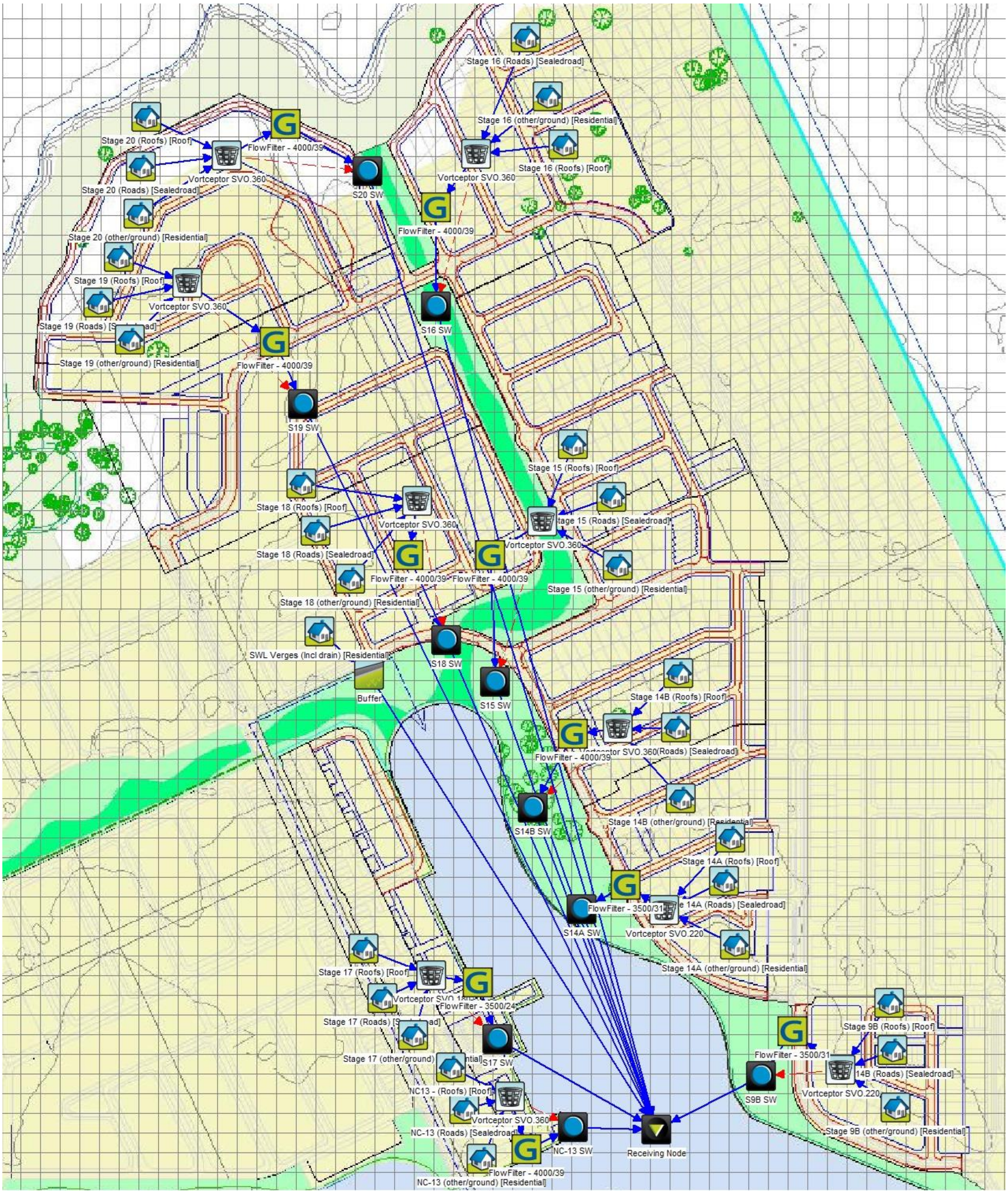

Figure 7: Scenario 2 – GPT + Propriety (Membrane) Filters MUSIC Model

2.4 Scenario 3 – GPT + Wetlands & Proprietary (Membrane) Filter System

The use of Wetlands for treating the northern stages and membrane filters for the southern stages was considered. Stages 15, 16, 18, 19 & 20 are treated with wetland systems and the balance with membrane filter systems. Model setups remain unchanged otherwise for device setup, flows, catchment areas etc as detailed in Scenario 1 & 2.

Catchment Model Setup is shown in Figure 8 below:

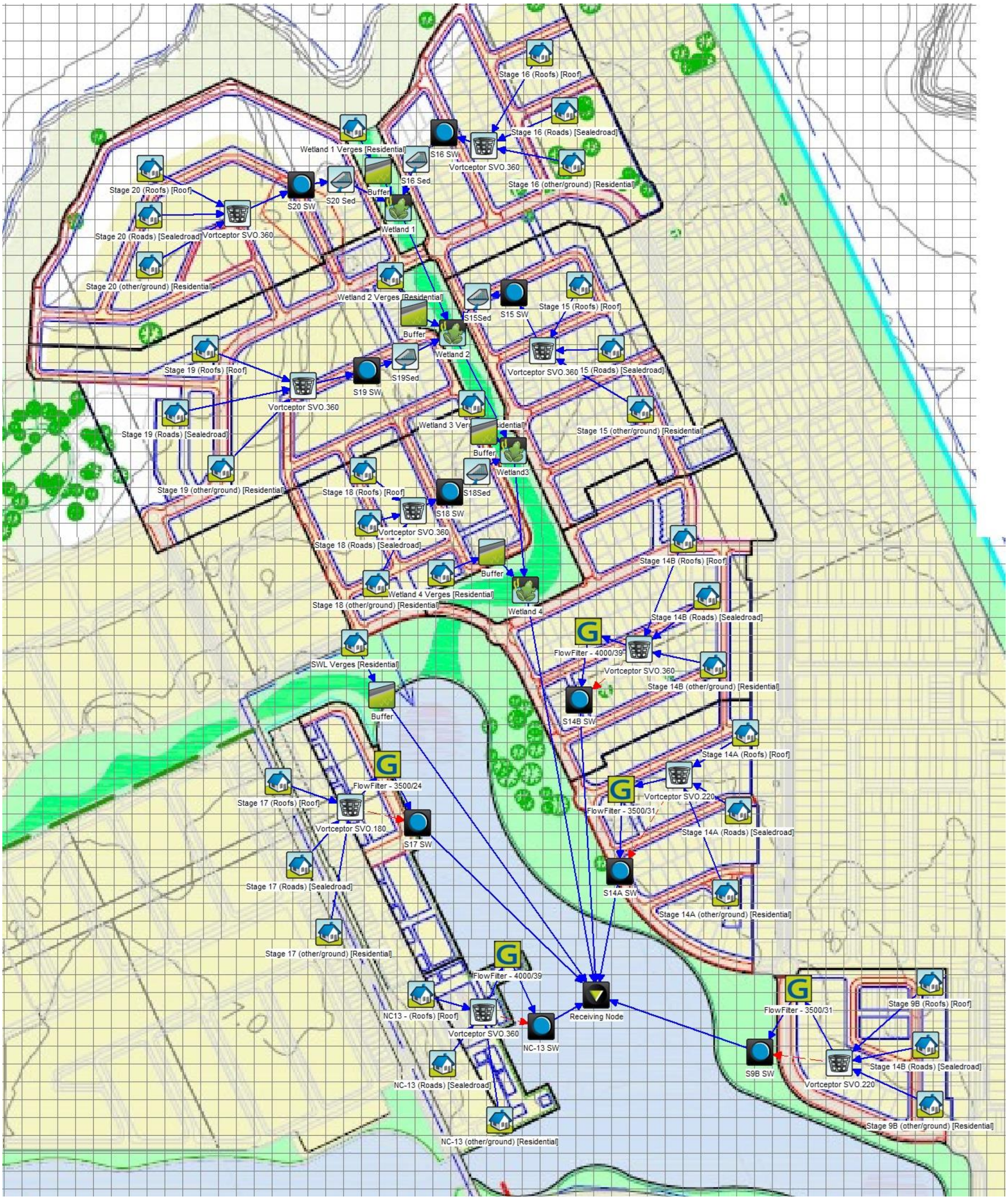

Figure 8 - Scenario 3 – GPT + Wetlands (Northern Area) + Propriety Filters (Southern Area)

3 Model Results

Model results have been compared to load reduction targets to ensure they meet the requirements for South Australia.

Additionally, predicted concentrations have been compared to the capacity of the proposed lake treatment system, to identify whether this system will need to be uprated to deal with potential additional nutrients introduced in stormwater.

3.1 Load Reduction

Based on the Water Sensitive Urban Design requirements for South Australia (*Water Sensitive Urban Design, creating more liveable water sensitive cities in South Australia*), the following load reduction requirements are required for the model.

Table 5: Load Reduction Requirements (double-check)

Parameter	Required load reduction
Total Suspended Solids (TSS)	80%
Total Phosphorus (TP)	60%
Total Nitrogen (TN)	45%
Gross Pollutants	90%

Both systems provided sufficient load reduction to meet the targets.

Table 6: Load Reductions Achieved

Parameter	Load Reduction Target	Scenario 1 GPT + Wetlands	Scenario 2 GPT + Membrane Filters	Scenario 3 GPT + Wetlands and Membrane Filters
Total Suspended Solids (TSS)	80%	94%	95.3%	95%
Total Phosphorus (TP)	60%	78.5%	88.9%	82.8%
Total Nitrogen (TN)	45%	58.2%	48.3%	56.6%
Gross Pollutants	90%	100%	99.6%	99.9%

The membrane filter system provides good removal of phosphorus, while the model predicts better nitrogen removal in the wetland system.

3.2 Predicted Concentrations

MUSIC provides predicted concentrations for the 3 main pollutants, Total Suspended Solids, Total Nitrogen and Total Phosphorus. The following tables provide the mean daily results predicted by the model.

Table 7: Scenario 1 GPT + Wetland System

Parameter	Minimum	10%ile	Median	Mean	90%ile	Maximum
TSS Conc (mg/L)	0	0	6	3.6	6.1	25
TP Conc (mg/L)	0	0	0.05	0.04	0.06	0.2
TN Conc (mg/L)	0	0	1.	0.6	1.1	2.7
TSS Load (kg/day)	0	0	0.3	3	5.	250
TP Load (kg/day)	0	0	0.003	0.02	0.05	1.6
TN Load (kg/day)	0	0	0.07	0.4	0.9	20

Table 8: Scenario 2 – GPT + Membrane Filter System

Parameter	Minimum	10%ile	Median	Mean	90%ile	Maximum
TSS Conc (mg/L)	0	0	0	0.8	3	80
TP Conc (mg/L)	0	0	0	0.01	0.03	0.2
TN Conc (mg/L)	0	0	0	0.4	1.3	1.8
TSS Load (kg/day)	0	0	0	1.9	2.	800
TP Load (kg/day)	0	0	0	0.01	0.02	2.5
TN Load (kg/day)	0	0	0	0.5	1.3	30

Table 9: Scenario 3 – GPT + Wetlands + Membrane Filter System

Parameter	Minimum	10%ile	Median	Mean	90%ile	Maximum
TSS Conc (mg/L)	0	0	0.7	3	6	110
TP Conc (mg/L)	0	0	0.01	0.031	0.060	2.2
TN Conc (mg/L)	0	0	0.6	0.55	1.1	17
TSS Load (kg/day)	0	0	0.3	2	4	260
TP Load (kg/day)	0	0	0.002	0.02	0.04	1.3
TN Load (kg/day)	0	0	0.07	0.4	0.9	20

As indicated by the load reductions, the Wetland system provides better Nitrogen removal while the flow filters provide better phosphorous removal.

4 Potential impact on Lake Water Treatment System (LWTS)

As part of the lake design process, the management of algae and nutrients has been considered. One of the methods considered for controlling these is the use of lake water treatment system (LWTS), a bespoke treatment system targeted at removing primarily nitrogen, but also phosphorus using a biological treatment process.

The treatment process has been primarily designed to treat incoming top-up water for the lakes, with capacity to treat recycled water.

The sizing for the treatment plant has been provided in previous documentation.

Table 10: Nitrification Filter Sizing

Parameter	Value	Unit
Reactor Packing Volume	70	m^3
Packing Specific Surface Area	250	m^2/m^3
Filter Area	17,600	m^2
Nitrification Capacity	17,000	gN/day
	17	kgN/day

Table 11: De-Nitrification Filter Sizing

Parameter	Value	Unit
Filter Contact Time (EBCT)	30	min
Filter Volume	180	m^3
De-nitrification Capacity	17,000	gN/day
	17	kgN/day

Table 12: Filter Loading Rates

Parameter	Value	Unit
Estimated Incoming Water Load	5,400	gN/day
Estimated Lakewater Recirc Load	5,400	gN/day
Estimated Typical Load	10,800	gN/day
	10.8	kgN/day
LWTP Design Capacity	17	kgN/day
Additional Capacity Available	6.2	kgN/day

Table 13: Stormwater Loading Rates

Parameter	Value	Unit
Mean TN	0.37 – 0.47	kgN/day
Maximum TN	21.4 – 31.1	kgN/day

The system has sufficient capacity available to treat the mean TN loading. The maximum predicted loading from stormwater flow is above the treatment plant capacity, however as the storms are short lived, the plant would be capable of catching up the additional capacity over time.

Table 14: Annualised Loading Rates

Parameter	Value	Unit
Annual TN Loading	135 - 180	kg/year
Annualised Additional LWTS Capacity	2,250	kg/year

5 CONCEPT BUDGET CAPEX & OPEX

Capital (CAPEX) and Operational (OPEX) estimates have been based on concept budget data provided by Atlan (Appendix B).

OPEX for Wetland systems year on year are likely in the range of 2-5%. Atlan indicate in their data that the lower end of the range is likely and this has been adopted.

Contractors margins are not included in the pricing table.

Development Stage	Wetland Area m^2	Construction & Installation Costs					Total CAPEX			Maintenance - 50 Year			Total OPEX - 50 Years		
							Scenario						*Scenario*		
		Wetland	GPT	Membrane Filter	GPT	Membrane Filter	1	2	3	Wetland	GPT	Filter	1	2	3
Stage 9	600	$60,000	$0	$0	$112,500	$262,500	$172,500	$375,000	$375,000	$484,500	$201,000	$690,000	$685,500	$891,000	$891,000
NC13	0	$0	$120,000	$330,000	$0	$0	$120,000	$450,000	$450,000	$472,500	$205,000	$840,000	$677,500	$1,045,000	$1,045,000
Stage 14	2500	$250,000	$120,000	$330,000	$112,500	$262,500	$482,500	$825,000	$825,000	$522,500	$406,000	$1,530,000	$928,500	$1,936,000	$1,936,000
Stage 15	1437	$143,700	$120,000	$330,000	$0	$0	$263,700	$450,000	$263,700	$501,240	$205,000	$840,000	$706,240	$1,045,000	$706,240
Stage 16	965	$96,500	$120,000	$330,000	$0	$0	$216,500	$450,000	$216,500	$491,800	$205,000	$840,000	$696,800	$1,045,000	$696,800
Stage 17	0	$0	$120,000	$0	$112,500	$262,500	$232,500	$495,000	$495,000	$472,500	$406,000	$690,000	$878,500	$1,096,000	$1,096,000
Stage 18	10000	$1,000,000	$120,000	$330,000	$0	$0	$1,120,000	$450,000	$1,120,000	$672,500	$205,000	$840,000	$877,500	$1,045,000	$877,500
Stage 19	1392	$139,200	$120,000	$330,000	$0	$0	$259,200	$450,000	$259,200	$500,340	$205,000	$840,000	$705,340	$1,045,000	$705,340
Stage 20	965	$96,500	$120,000	$330,000	$0	$0	$216,500	$450,000	$216,500	$491,800	$205,000	$840,000	$696,800	$1,045,000	$696,800
Contingency 25%							$770,850	$1,098,750	$1,055,225				$1,713,170	$2,548,250	$2,162,670
Engineering 20%							$770,850	$1,098,750	$1,055,225						
Totals							$4,625,100	$6,592,500	$6,331,350				$8,565,850	$12,741,250	$10,813,350

6 DISCUSSION & CONCLUSION

Both the GPT + Wetland based stormwater treatment process, and the GPT + membrane filter-based treatment processes resulted in acceptable load reductions, meeting the required load reduction targets.

Providing Wetland treatment for northern catchments and membrane filters for southern catchments, supported both by GPTs also provides acceptable load reductions and should meet required load reduction targets.

There is sufficient design overhead within the proposed SWL treatment process to accommodate the predicted nutrient loading from the development, based on the loads predicted by MUSIC. While the maximum daily load is above the SWTP's treatment daily treatment capacity, this loading would be a comparatively rare event that should be able to be resolved over time.

Further mass balance modelling should be conducted to examine the recovery times.

CAPEX and OPEX estimates provided by ATLAN have been consolidated and summarised for each catchment for financial comparison.

We trust this summary is suitable for your requirements. Please do not hesitate to contact the undersigned should you have any enquires, or if we can be of further assistance to you.

Yours faithfully

SIMMONDS & BRISTOW PTY LTD

Approved by

Terrence Allen *BE(Chem)*

Process Engineer

David Bristow *BE(Chem), RPEQ, CPEng, NER*

Managing Director & Chief Engineer

Revision History

Rev No.	Date	Author	Reviewer	Description of Revision	Status
0-1	18/09/24	TA	DJB	Internal Draft	Draft
1-0	18/09/24	TA	DJB	External Draft	Draft
2-0	8/10/2024	TA/DB	DJB	External Draft Final	Final Draft
3-0	9/10/2024	TA/DB	DJB	Final	Final

APPENDIX A:
SMP Document

WGA

Walker Buckland Park Developments Pty Ltd

Precinct 1 and 2 Interim and Ultimate Development

STORMWATER MANAGEMENT PLAN – 2024

WGA080163

WGA080163-RP-CV-0034_B

29 January 2024

Revision History

REV	DATE	ISSUE	ORIGINATOR	CHECKER	APPROVER
A	20 Dec 2023	For review	GLS/CIT	DB	DB
B	29 Jan 2024	For review	GLS/CIT	DB	DB

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1 INTRODUCTION

The Riverlea development covers an approximate area of 1,308 hectares. The site is situated approximately 32km north of the Adelaide CBD, bounded by Gawler River to the north, existing Cheetham salt fields to the south and west, Port Wakefield Road to the east.

The Riverlea Precinct is part of a proposed staged subdivision located in Buckland Park in northern Adelaide.

This report outlines the interim Stormwater Management Plan for Precinct 1 and Precinct 2 prior to the construction of the proposed Saltwater Lakes through the construction of a temporary open channel network to connect to Thompson's Outfall Channel, and includes the temporary condition when the first salt water lake is constructed.

The report also presents the Ultimate Development condition, representing all salt water lakes constructed, and the large proposed detention basin developed at the southwestern corner of the site.

This is in accordance with the 'Playford Council Development Plan,' October 2011, for the purpose of Council approval. This report is an update of the previous SMP and includes all stages within Precinct 2 and the Ultimate development.

The intent of this report is to provide the design basis for the multi-objective management of stormwater on the development based on the following:

- Internal network drainage design (interim for Precinct 1 & 2 and Ultimate)
- Design of regional flood conveyance channels
- The management of stormwater quality and its integrated approach within the overall project
- The management of stormwater within an overall risk management framework
- Staged implementation of the stormwater strategy

A previous stormwater study 'Stormwater Management, Water, Wastewater and Recycled Water – Technical Paper,' prepared by Wallbridge & Gilbert dated December 2023 for the Buckland Park Environmental Impact Assessment has been considered as part of this SMP for the Precinct 2. This previous report developed the strategy for flood protection across the entire site and was at the time reviewed by the relevant State Government agencies including Emergency Services.

This Stormwater Management Plan (SMP) relates to Precinct 1 and Precinct 2 of the Riverlea development as Shown in Figure 1.

Figure 1: Extent of the Precinct 1 & 2 – Interim Arrangement

Figure 2 shows the interim arrangement when Salt Water Lake 1 is constructed. It includes a 750mm outlet pipe that connects directly to Thompson’s Outfall Channel.

Figure 3 shows the Ultimate arrangement when all 3 salt water lakes are constructed including the large detention basin at the southern end of the site.

All of the catchments in red are covered in the Interim solution. The green lines represent the proposed channels to be constructed to service Precinct 2 prior to development of the lakes.

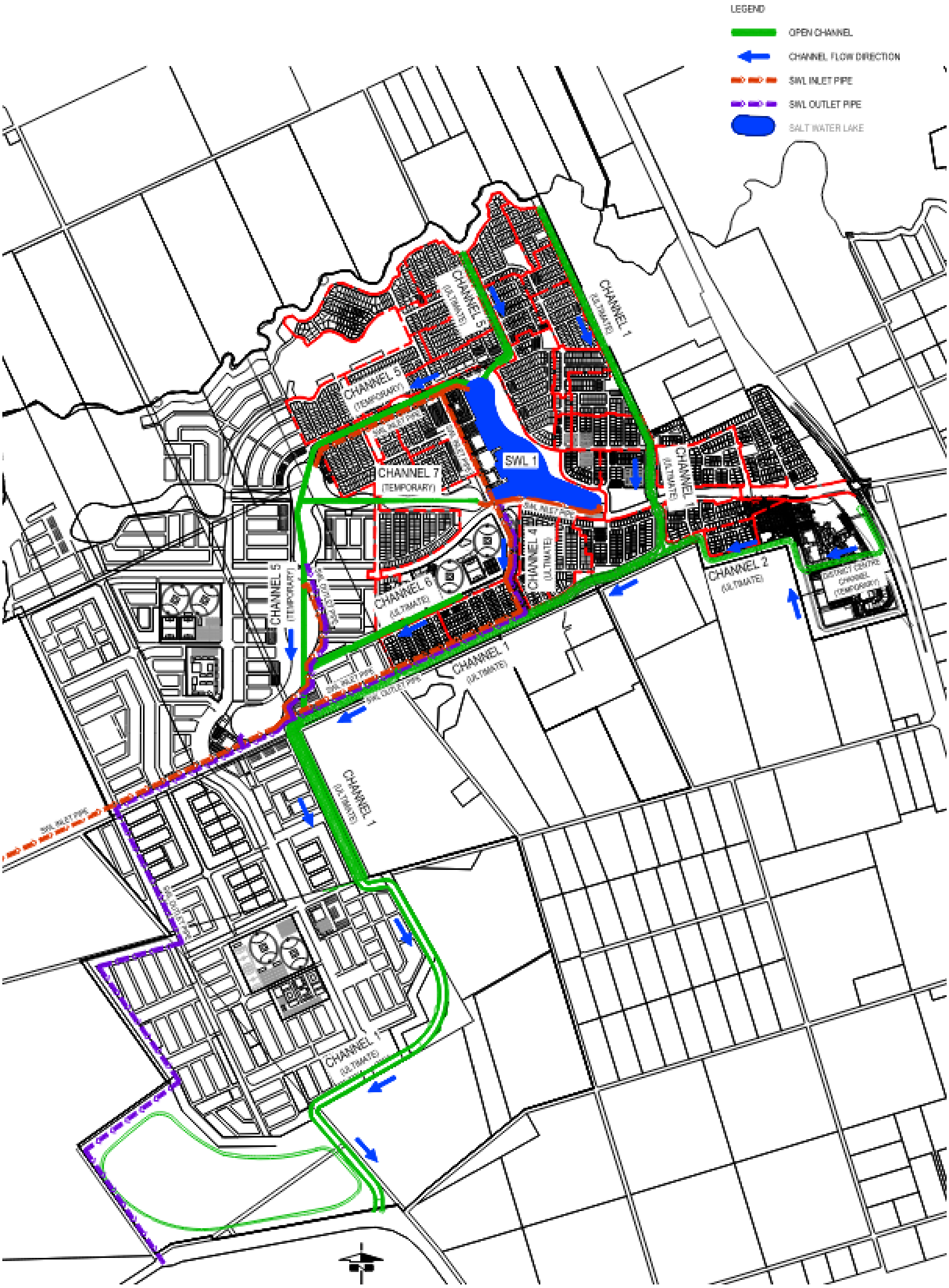


Figure 2: Extent of the Precinct 1 & 2 – Interim Arrangement with Salt Water Lake 1 Constructed

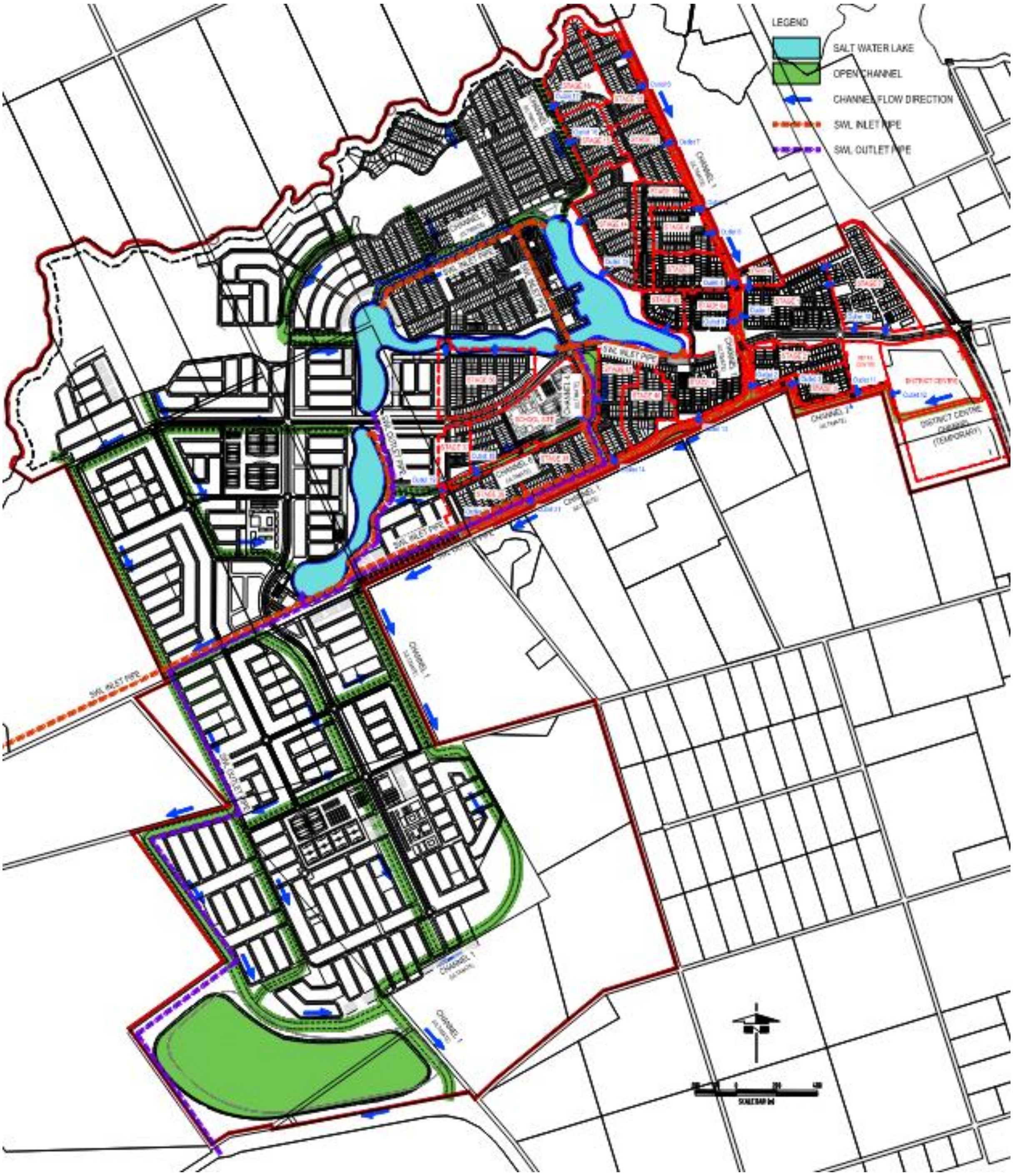


Figure 3: Ultimate Arrangement – Saltwater Lakes and Open Channel Network

1.1 Changes Since Previous Revision

As the previous revision of this report was prepared in July of 2022, this section has been incorporated to provide a summary of changes made to the Riverlea Precinct since the previous revision:

- DRAINS Model has been extended to include the Precinct 2 catchments shown in Figure 1 and the proposed open channel network which includes some temporary channels until the future Saltwater Lakes are constructed.
- DRAINS Model also developed to include the temporary condition where Salt Water Lake 1 is constructed.
- HEC-RAS Model has been extended to capture the proposed channel arrangements for Precinct 1 and 2.
- A separate HEC-RAS Model also developed to include the temporary condition where Salt Water Lake 1 is constructed and a separate piped outfall is constructed to Thompson's Outfall Channel.
- TUFLOW Model has been used to model the Ultimate development condition with the Saltwater Lakes and open channel network including the proposed southern detention basin, to demonstrate the performance of the system when complete. Refer to WGA report, 2009 Technical Paper Update – Flood Assessment, November 2003 that outlines in detail the TUFLOW Modelling parameters.
- TUFLOW modelling of the channel network has been updated and provided to demonstrate:
  - Compliance to provide flood protection within the floodplain (flooding from Gawler River).
  - Demonstrate flood capacity for a localised 1% AEP storm from within the development has suitable capacity to prevent flooding within the development and downstream to Thompson Creek.
- Risk assessment matrix and flood modelling have been updated following further flood plain modelling undertaken to demonstrate that flood risks have been addressed for flooding from Gawler River as well as 1% AEP runoff from within the development is detained within the new channel network.

1.2 Stormwater Management Requirements

The City of Playford and the Environmental Protection Authority provide their own guideline and requirements as relevant to stormwater management. These have been outlined below.

Environment Protection Authority

The EPA adopts the WSUD management approach which essentially define their requirements, which relate to management of both stormwater quantity and quality.

The EPA's minimum requirements are as follows:

- Where practical and feasible run-off rates should not exceed the rate of discharge from the site that existed pre-development.
- Water quality treatment reduction targets of the typical urban average annual load as follows:
  - Total Suspended Solids (TSS) 80%
  - Total Phosphorus (TP) 60%
  - Total Nitrogen (TN) 45%
  - Retention of litter greater than 50 mm for flows up to a 3-month Average Recurrence Interval (ARI) peak flow
  - No visible oils for flows up to a 3-month ARI peak flow
- Environment Protection Policy (Water Quality) 2015, under the Environment Protection Act, 1993.

City of Playford

Further to the EPA requirements outlined above, there are a number of general Council requirements relating to stormwater design and assets as outlined below.

Council's guidelines require minimum gradients for both pipe and road grades. These are based on providing suitable provision to accommodate maintenance requirements and hydraulic performance. Council acknowledge that road gutter gradients have been reduced in some instances where necessary to accommodate the flatness of the terrain. In this regard, Council has advised the following compliance requirements:

- Councils standard minimum grade is 0.5%. This is considered the target minimum gradient that Council seeks to be achieved in the design.
- In some instances where constraints will result in the minimum gradient cannot be achieved, then Council may accept the following minimum gradients:
    a. 375 RCP – 0.5%
    b. 450 – 600 RCP at 0.4%
    c. 600 RCP and larger up 0.3%
- All road crossings to shall not be less than 0.5%
- In the upper reaches of the system, at the start of the stormwater network, the minimum grade is 0.5% (in order to achieve a sufficient velocity prior to joining the larger network).
- At Council's discretion an assessment of self-cleansing velocity check may be required.

2 CATCHMENT AREA OVERVIEW

2.1 Soils and Groundwater Setting

The geological survey of South Australia indicates that the majority of the site should be underlain by the Pooraka formation, typically comprising of pale red-brown sandy clay containing calcareous lenses. Bedrock is not expected to occur in the upper 30 m depth at the site. Reference is made to a geotechnical investigation undertaken by Coffey (1998) across the majority of the proposed development.

As a part of the initial site investigations ground water mapping was undertaken by Resource and Environmental Management (now Jacobs). This mapping indicated that the depth to ground water within the site ranges from 0.2 metres to 7 metres below the natural surface level. It can be seen in Figure 4 that approximately 75% of the site has a depth to ground water of approximately 3 metres below the surface level. Groundwater was found to be saline ranging from 1000 ppm to 5000 ppm.

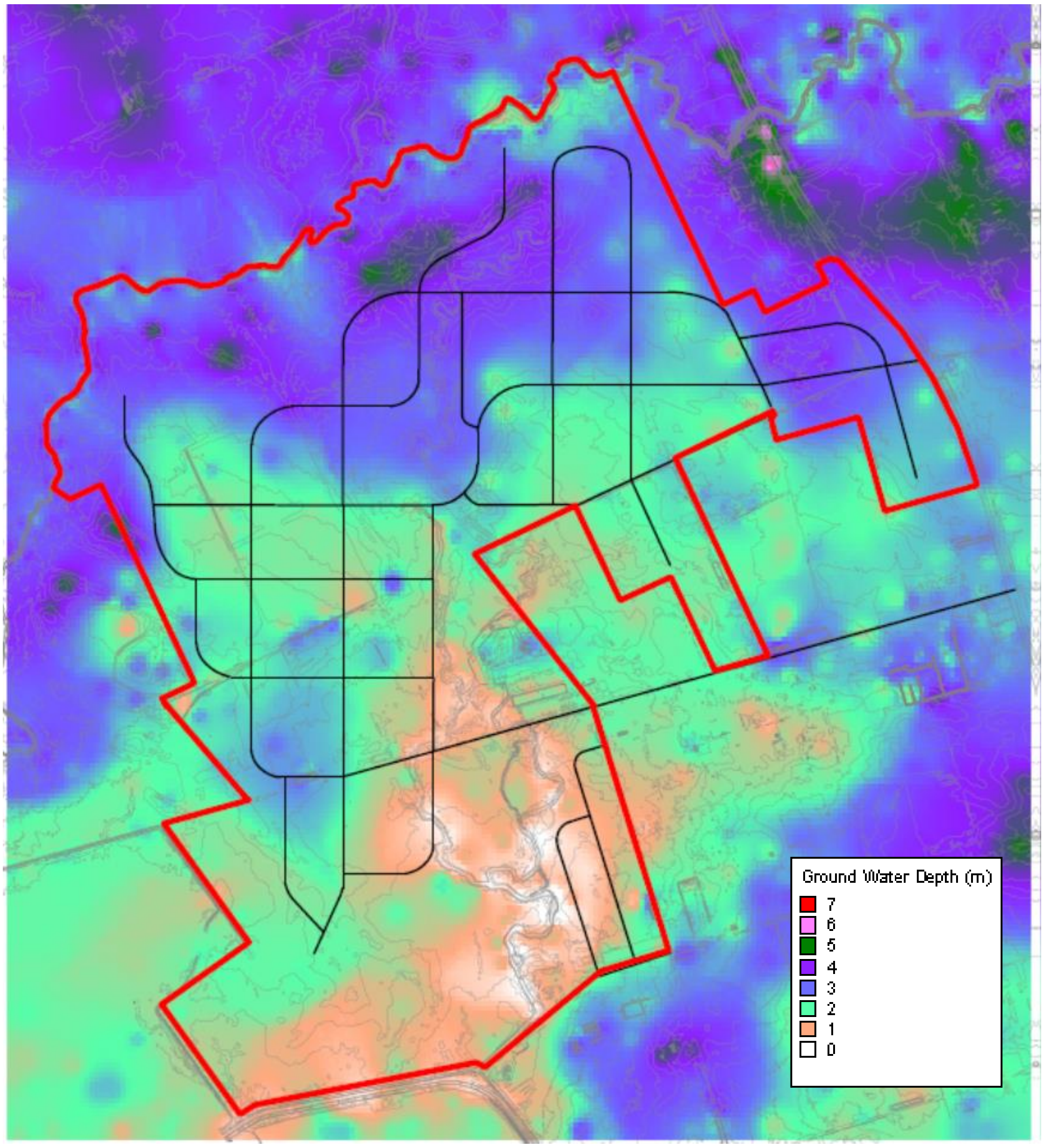


Figure 4: Depth to Groundwater

2.2 Existing Catchment

The Buckland Park site is situated approximately 2.7 kilometres inland of the Gulf St Vincent coastline and it is for this reason not considered to be a coastal site. The topography of the site is relatively flat with an approximate fall of 0.2% across the site from east to west. The site also lies within the Gawler River flood plain.

The Buckland Park site generally drains away from the Gawler River in a south westerly direction towards the Thompson Outfall Channel. The Development will naturally drain to Thompsons Creek and channel to the west of the site.

The Gawler River is situated within the Northern section of the Buckland Park site and is a perched river system. As the banks of the Gawler River are higher than the adjacent floodplain, stormwater runoff from the Buckland Park site will not drain to the Gawler River nor to the Buckland Park Lake System as they are both effectively located upstream of the Buckland Park development area.

Figure 5 shows the site levels in metres to Australian Height Datum (AHD) and shows that the site falls away from the Gawler River towards the Thompson Outfall Channel.

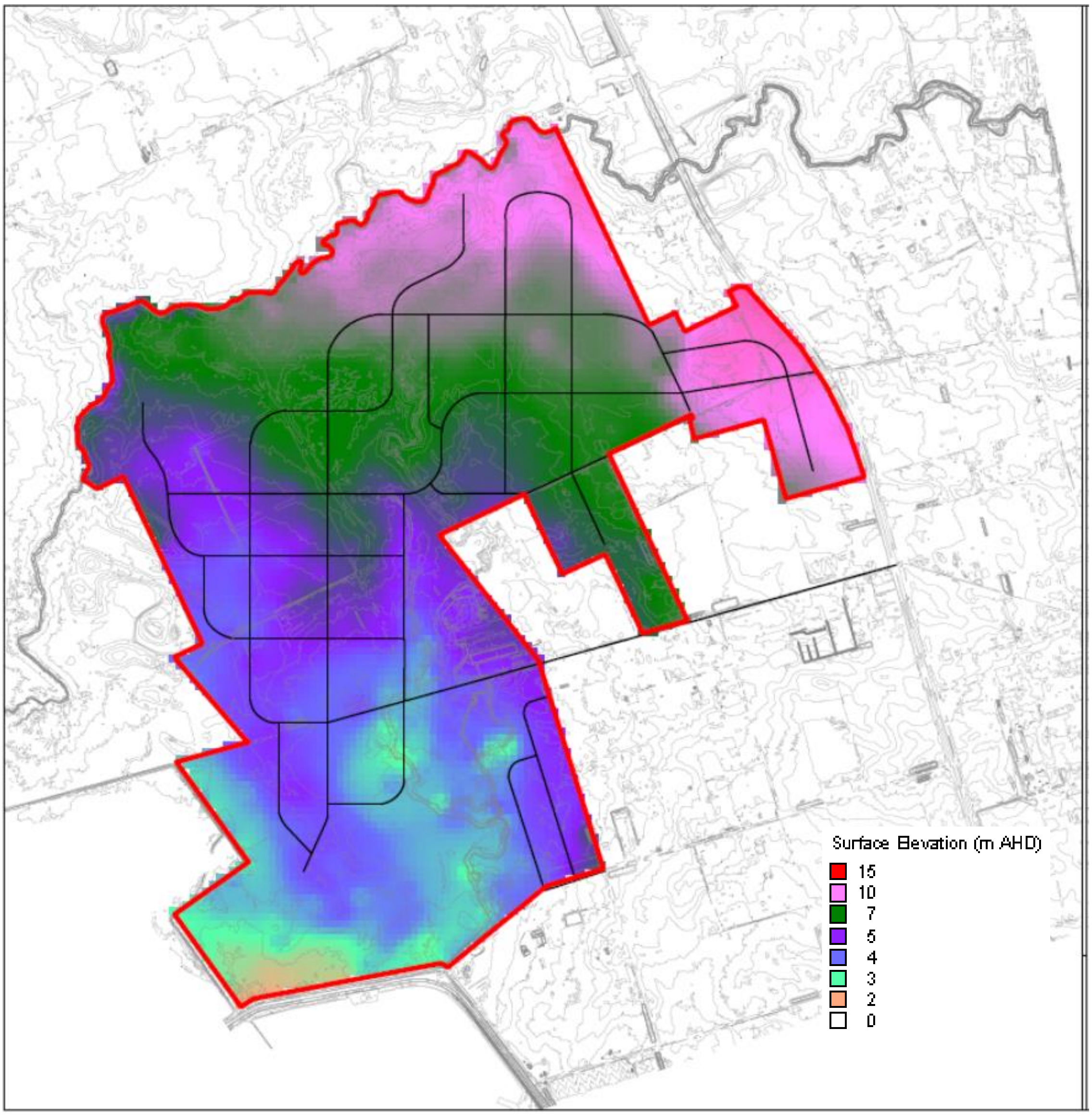


Figure 5: Existing Site Levels

2.3 Development

Precinct 1 and 2 including all stages are currently a combination of greenfield sites including current areas already developed or under construction with a total area of approximately 346 Ha. The development comprises of mixed size urban allotments. In order to facilitate appropriate gradients along proposed roadways and allotments, Precinct 1 and 2 allotments will be filled in some areas with material excavated from the new extensive open channel network and graded to ensure Council's minimum road and pipe network grades are achieved. This allows drainage (above and below ground) to drain to the proposed regional drainage channels and future lakes through the development. This is required as the overall natural site gradient is flatter than the permissible minimum gradients for kerb and water table and stormwater pipes.

As the site is characterised by relatively flat topography, stormwater drainage from Precinct 1 and Precinct 2 is proposed to discharge at a number of distinct locations to a proposed regional channel system which includes some temporary channels. Post development of Precinct 2 with its interim channel arrangement, the project will begin to introduce the proposed Saltwater Lake system which will be used to provide stormwater detention and amenity for the northern catchments within the development.

2.4 Existing Known Assets

The current method of stormwater management within the Buckland Park site relies on a system of natural open channel lines and roadside open drains and culverts to move the stormwater runoff through the catchment and discharge it to the ocean via the Thompson Creek Outfall Channel. It is also understood that some groundwater is pumped to the Thompsons Creek from the Virginia area, however to date, no details have been able to be obtained. As this is a pumped arrangement, the volumes and peak flows are small compared to the predicted ultimate site runoff and this arrangement will not have any significant impact on the flood capacity of the proposed stormwater network.

WGA contacted Tony Fox of the Adelaide and Mount Lofty Ranges Natural Resource Management Board (AMRNRMB) in regard to obtaining further details about the system. Tony confirmed to date none are available. He did confirm that the outlet size from the pump discharge is only a 90 mm to 100 mm pipe, which confirms that the impact on flood capacity from this discharge is negligible.

3 IDENTIFICATION OF PROBLEMS AND OPPORTUNITIES

3.1 Risk Management

This risk management process aims to determine the potential nature, scale and likelihood of any impacts on water quality during the design, construction and operational phases of the development. This process is undertaken to assist in identifying appropriate management measures to manage the project impacts, and/or determine if intervention is required to manage these risks.

The main steps in the risk management process are:

- Identify risks – as determined by site and its characteristics
- Analyse risks – how likely is it to happen, what are the likely consequences
- Evaluate risks – against the likelihood and consequence matrix
- Treat risks – prioritise, address and mitigate identified risks

This Risk Management process covers a significant proportion of Precinct 1 and Precinct 2 of the development. The information sourced to inform this risk management process comes from various technical reports that have been undertaken for the Buckland Park development. These reports have been based on investigations associated with the site characteristics including groundwater, vegetation, soils and other physical aspects. These reports are listed below for reference to provide the background to this process:

- Buckland Park ASR, Groundwater Modelling, AGT (2011).
- Buckland Park Drain Model, AGT (2011).
- Buckland Park Flood Modelling Maps, AWE (2011).
- Buckland Park Biodiversity Strategy, EBS Ecology (2011).
- Bulk earthworks Modelling, W&G (2012).
- Buckland Park Country Township Master Planning Report, Connell Wagner (2007).
- Buckland Park Residential Development Stage 1, Geotechnical Investigation, Coffey Geotechnics (2011).
- Preliminary Acid Sulphate Soils Investigations, Buckland Park, Golder Associates (2008).
- Buckland Park Country Town Development, Thompson Creek Outfall Capacity Assessment, Connell Wagner (2007).
- Riverlea Development - Recycled Water Strategy, WGA (2012).
- Aquifer Storage and Recovery Potential for Buckland Park, REM (2008).
- Stage 1A and 6A Flood Management System Modelling, AWE (2012).
- Buckland Park Stage 1 Stormwater Quality Management, WGA (2011).
- Western Catchment Stormwater Master Plan, Tonkin (2008).
- Enviro Development Technical Standards National Version 1, UDIA (2011).
- Water Technology Floodplain modelling and mapping (updated 12 December 2021 and included in report).

Following a review of the referenced texts above the risk assessment has been prepared for the design, construction and operational phases of the project. This is presented in Table 2 and Table 4 inclusive. The likelihood and consequence matrix are provided in Table 1 for reference.

3.2 Strategies to Manage Risk

The response measures are outlined in the Risk Management Table 2 to Table 4 inclusive for Precinct 1 and Precinct 2. In addition to these management measures, the Construction Contractor will be required to prepare a Construction Environmental Management Plan (CEMP) including a Soil Erosion and Drainage Management Plan (SEDMP).

Water Sensitive Urban Design (WSUD)

A design framework that uses the principles of WSUD to manage risks is a widely accepted approach to manage stormwater in an environmentally sensitive approach. In this regard the design of the regional channels would adopt the multi-objective approach to stormwater management such that the development incorporates corridors not solely for conveyance of flood waters. As part of this project a framework will provide the methodology for the design of the regional channels project.

Principles in this framework are proposed for:

- Reducing mains water usage
- Improving quality runoff
- Managing the rates of runoff
- Managing the volume of runoff
- Enhancement in amenity, environmental values, habitat and biodiversity

Table 1: Likelihood and Consequence Matrix

	CONSEQUENCE		
LIKELIHOOD	**Low** Minor adverse social or environmental impact	**Medium** Measurable adverse environmental or social impact. Will result in annoyance or nuisance to community	**High** Significant damage or impact on environmental systems and local community
Low The event could occur only rarely, or is unlikely to occur	Low Risk	Low Risk	Medium Risk (could be high)
Medium The event will occur occasionally or could occur	Low Risk	Medium Risk	High Risk
High The event will occur often or is most likely to occur	Medium Risk	High Risk	High Risk

Table 2: Design Phase Risk Management Process

1. DESIGN PHASE							
ID	**Issue**	**Potential Impact**	**Likelihood**	**Consequence**	**Level of Risk**	**Response/Management Measure**	**Notes**
A	Flooding - local catchment	Increased flooding potential due to increase impervious areas and flat gradients.	Low	High	Medium	Drainage systems (including culverts, drainage networks, kerb and channel and open drains) shall cater for 1 in 5 Average Recurrence Interval (ARI) storm events, with a one in 100-year ARI storm event checked for overland flooding through flow paths. The system shall have sufficient capacity to accommodate the design drainage flow in accordance with the drainage requirements and without causing damage or nuisance to surrounding landowners and properties. Council requirement to provide detention to reduce post development flows to predevelopment level, which for Precinct 1 will be accommodated within the Stage 1 open channel construction as the volumes that can be contained within this system, which provides protection largely from the Gawler River flooding is significant.	Drainage network designed in accordance with Council standards.
B	Flooding - Gawler River	Flooding (large magnitude) of low-lying land due to overland flooding from floodwater breaking out of Gawler River.	Medium	High	High	Incorporate a network of regional drainage channels in design - elements to be designed to maximise stormwater interception of overland flooding with no flows to surrounding low lying areas. Regional drainage channels to be located and tested with flood plain modelling by Water Technologies. Regional channels to be hydraulically sized and modelled as part of the design.	
C	Flooding - Increase downstream flooding / exceeding capacity of Outfall channel	Flooding of low-lying land and erosion of channel and adjacent area.	Medium	High	High	Incorporate a network of regional drainage channels in design - elements to be designed to maximise stormwater interception of overland flooding with no flows to surrounding low lying areas. Detention to control rate of discharge to pre-development levels.	

1. DESIGN PHASE							
D	Erosion at outlets	Scouring and erosion associated with increase velocities, peak, volume of water.	Medium	High	High	Drainage outlets to incorporate rock pitching, energy dissipation and vegetation	
E	Shallow ponding / stagnant water conducive to mosquito breeding	Nuisance issues, health risks to community.	Medium	High	High	Minimise ponding to controlled areas Incorporate naturalistic design principles to create habit for natural predators in channels and pools Incorporate porous rock riffles that enable pools to drain out slowly after rainfall events Swales and drainage channels designed with longitudinal gradients to avoid stagnant and isolated pools	Regional channels incorporate a pool and riffle sequence for stormwater treatment. The pools are designed to drain out through porous rock riffles. The channel has been designed using naturalistic design principles and incorporates vegetation to create habitat and biodiversity which provides natural control of mosquito population.
F	Waterway function - Thompson Outfall channel	Decrease in waterway function due to changes to hydrological regimes, sedimentation, erosion, water quality.	Medium	Medium	Medium	The design and layout for stormwater treatment ponds will follow the rationale and design features associated with naturalistic water design, and wetland design. The treatment flow adopted in the design will be based on a three month to one-year ARI peak discharge rate from the local catchment. This will allow for 98 percent of all annual rainfall and daily runoff events from the local catchment will receive treatment to the WSUD standards. Any flows of a higher rate above the one-year ARI would still pass through a stormwater treatment system and receive some treatment. The regional channels are designed to slow the flow of stormwater through the local catchment. The regional channels will accommodate a large retention storage during the interim phase of the development which will hold back stormwater.	The regional channel will accommodate a large detention volume in the interim phase to hold back urban flows from Precinct 1 and 2 with the channel being extended to connect to Thompson' Creek. Ultimately a detention basin is proposed at the downstream end of the development where it connects to Thompson Outfall channel. This is modelled together with the future lakes in the Ultimate Development scenario.

1. DESIGN PHASE							
G	Acid Sulphate Soils	Long term impacts on infrastructure associated with acid (from the disturbance of acid sulphate soils).	Low	Medium	Low	Undertake geotechnical investigations to determine if these soils are present.	Acid sulphate soils have not been encountered within the Precinct 1 development site.
H	Water Sensitive Urban Design	Runoff quality leads to long term water quality impacts to receiving environments. **while impacts are operational, unless addressed during design, little chance of addressing impacts during operations.	Medium	Medium	Medium	Project based treatment design using treatment train approach. The design and layout for stormwater treatment ponds will follow the rationale and design features associated with artificial wetlands and naturalistic waterway design principles. The treatment flow adopted in the design will be based on a three month to one-year ARI peak discharge rate from the Local catchment. This will allow for 98% of all annual rainfall and daily runoff events from the Local catchment will receive treatment to the best practice standards. Any flows of a higher rate above the one-year ARI would still pass through a stormwater treatment pond and receive some treatment. Treatment will achieve reductions in total pollutant load from the contributing roadway catchment. The WSUD Guidelines for the Greater Adelaide Region (2013 seeks the following pollutant reduction targets. - 80% reduction of total suspended solids (TSS). - 60% reduction of total phosphorus (TP). - 45% reduction of total nitrogen (TN) - 90% reduction of gross pollutants, and retention of litter greater than 50mm for up to the 3-month ARI peak flow. - Oil and grease, no visible oils for flows up to the 3-month ARI peak flow.	**MUSIC modelling used to verify treatment systems adopted in design. Design demonstrates meets targets as specified Using best practice criteria for pollutant reduction targets and checked against EPA Water Quality Policy (2003)

1. DESIGN PHASE							
I	Groundwater	Increase in groundwater levels due to increased runoff from paved areas.	Medium	Medium	High	AGT had assessed the likelihood of increased groundwater levels due to the increase in impervious areas in their report titled. *Buckland Park Drain Model, AGT (2011)* and the report suggests there may be some local raising of water levels at the inverts of the open channel system, but that water levels will remain largely unchanged across the site. The open channel system will intercept shallow groundwater in some locations across the site, however, the flow rates of groundwater passing through the extensive open channel system are estimated to be of the order of 200l/s which is considered small given the scale of the network.	
J	Thompson's Creek in private ownership	Modification of the creek by private landowners increasing the risk of flooding.	Low	Medium	Medium	There is a section of Thompson's Creek that is outside the development boundary and is in private ownership. There is a risk that private landowners could fill or modify the creek, and impact on its capacity. Modifications to the creek would be a 'Water Affecting Activity' under the Natural Resource Management Act and would require a permit, so there are penalty measures in place should this occur notwithstanding there is still a risk. Ultimately the main channel will be constructed down to the Thompson's Outfall Channel, and the system will not rely on any part of the existing Thompson's Creek, and the risk will be removed. In the short term, the extent of storage provision within the main channel constructed down to Thompson's Creek will result in only very minor flow rates in Thompson's Creek.	

Table 3: Construction Phase Risk Management Process

2. CONSTRUCTION							
ID	**Issue**	**Potential Impact**	**Likelihood**	**Consequence**	**Level of Risk**	**Response/Management Measure**	**Notes**
A	Sedimentation	Sedimentation impacts on receiving water quality: - increase in turbidity / total suspended solids / total dissolved solids - to aquatic ecosystems by reducing light and smothering organisms.	High	Low	Medium	SEDMP	
B	Vegetative matter	Increase in natural organic matter impacts on receiving water quality including: - increase in Nitrogen / Phosphorus and reduced oxygen levels - algae outbreaks and eutrophication - visual / surface scum.	Low	Medium	Medium	SEDMP	
C	Gross pollution (litter)	Impacts on receiving waters: - visual / aesthetics - decreased water quality.	Medium	Low	Medium	Construction Environmental Management Plan (CEMP) Waste recycling and reuse.	
D	Accidental spills (including hazardous materials)	Impacts on receiving water quality: - increased toxicity - aquatic flora death / breakdown and increases in organic matter - aquatic fauna death / breakdown and increases in organic matter.	Low	Medium	Medium	CEMP	

2. CONSTRUCTION							
E	Hydrocarbons	Impacts to water quality including: - increased toxicity - algae outbreaks and eutrophication - visual / surface scum.	Low	Medium	Medium	CEMP	
F	Acid Sulphate Soils	Impacts on receiving water quality including: - decreases in pH - increases in heavy metals - increased toxicity to aquatic flora / fauna - soil contamination along flow lines.	Low	High	Medium	Site does not lie in the extent of Coastal acid sulphate soils.	
G	Interception of groundwater (<3m unconfined saline aquifer)	Impacts on receiving water quality (associated with dewatering activities).	Low	Low	Medium	CEMP	
H	Accidental spills and/or release of contaminated soil into groundwater systems	Contamination of groundwater.	Low	High	Medium	CEMP	
I	Temporary changes in direction and flow of surface water and groundwater	Pooling in undesirable areas, including excavations.	Medium	Low	Low	CEMP	
J	Increased volume of surface water flow	Increased turbidity levels in receiving channels for excessive sediment accumulation within the bed of channel.	Medium	Medium	Medium	CEMP Temporary drainage systems required during the construction of the works	Regional channel will retain stormwater without direct discharge to Thompson Outfall channel.

Table 4: Operations (Post Construction) Phase Risk Management Process

3. OPERATIONAL - POST CONSTRUCTION							
ID	**Issue**	**Potential Impact**	**Likelihood**	**Consequence**	**Level of Risk**	**Response/Management Measure**	**Notes**
A	Urban stormwater pollution	Impacts to water quality including: - increased toxicity - accumulation in aquatic sediments.	High	Medium	High	Project based treatment design e.g. drains, wetlands, detention basins (interchanges), treatment train approach. Maintenance and monitoring of system to achieve design outcomes.	
B	Hydrocarbons	Impacts to water quality including: - increased toxicity - algae outbreaks and eutrophication - visual / surface scum.	High	Medium	High	No runoff from any part of the project shall be discharged out of the road corridor unless it is in an underground or surface drainage system that is intercepted by a treatment wetland prior to entering a watercourse.	
C	Sediment	Impacts on receiving water quality: - increase in turbidity / total suspended solids / total dissolved solids - to aquatic ecosystems by reducing light and smothering organisms - release of associated metals and nutrients.	Medium	Medium	Medium	Project based treatment design e.g. sediment ponds. Treatment train response. Existing regional drainage catchments and flow patterns should be maintained where practicable and drainage flows shall not cause scour, damage or nuisance to surrounding landowners and properties.	
D	Nutrients	Impacts on receiving water quality: - increase in Nitrogen / Phosphorus and reduced oxygen levels - aquatic flora death / breakdown and increases in organic matter - aquatic fauna death / breakdown and increases in organic matter.	Low	Medium	Low	Design response. Treatment train response (primary treatment).	

3. OPERATIONAL - POST CONSTRUCTION							
E	Vegetative matter	Increase in natural organic matter impacts on receiving water quality including: - increase in Nitrogen / Phosphorus and reduced oxygen levels - algae outbreaks and eutrophication - visual / surface scum.	Low	Medium	Low		
F	Gross pollution (litter)	Impacts on receiving waters: - visual / aesthetics - decreased water quality.	Medium	Low	Low	Maintenance Provision of gross pollutant traps at stormwater outlets.	
G	Increased runoff volumes due to increased impermeable surfaces	Impact to flow regimes and function of receiving waters.	High	Medium	High	Using WSUD techniques to slow rate of runoff through swales, soakage systems and pool and riffle sequence in regional channel Revegetate regional channels with indigenous plant species to slow surface water flow, protect from erosion, and restore habitat and environmental values.	
H	Rising groundwater levels due to irrigation of playing field and residential properties	Impact on infrastructure, vegetation due to rising saline groundwater.	Low	High	Medium	Regional channel intercepts groundwater and therefore water levels remain unchanged.	Study report by Australian Groundwater Technology suggests that this is unlikely.

3.3 Construction Environment Management Plan (CEMP)

The CEMP is expected to be developed to mitigate the risks associated with construction and to address risks appropriate to avoid impacts to the downstream waterways. The CEMP is expected to have contents similar to that listed as follows:

Overview

Introduction

- Project Scope
- Purpose
- Roles and Responsibilities
- Project Environmental Process
- Environmental Management System
- Induction and Training
- Contractor and Subcontractor Management
- Communication
- Feedback and Enquiries
- Document Control
- Monitoring, Inspection and Audits
- Emergency Preparedness and Response
- Incidents/non-Compliance Reporting
- Reporting and Review
- Environmental Control Planning

Project Environmental Objectives

Key Environmental Risks and Controls

- Noise and Vibration
- Air Quality
- Water Quality – Sediment, Erosion and Drainage Management
- Waste Management
- Dangerous Goods Storage
- Energy Use and Greenhouse Gas Emission/Sustainability

Conclusion

The Construction Environment Management Plan will be prepared by the Construction Contractors (for each stage of the development) and will be submitted to Council for approval prior to construction. The CEMP will incorporate a SEDMP, which will form an important part of the site management during the construction phase. It is expected that the SEDMP will be developed using a risk-based approach that considers all contributing site physical factors that contribute soil erosion. The CEMP will be prepared by the Construction Contractor and therefore not covered in this report. These stages will follow the principles as outlined in this report.

4 STORMWATER MANAGEMENT OBJECTIVES AND STRATEGIES

4.1 Objectives

The key aspects to achieve in the strategy for the management of stormwater runoff from the development relate to the following:

- Flooding
- Water Quality
- Water Use
- Environmental Protection and Enhancement

From these key aspects, broad objectives for management of stormwater runoff can be developed and are identified as follows:

Objective 1: Flood Management - Provide and maintain flood protection to Precinct 1 and parts of Precinct 2 and future development based on local catchment (Development) and flooding arising from the broader Gawler River system (Regional).

Objective 2: Water Quality Improvement – Treat stormwater to meet the requirements for protection of the receiving environment to EPA and WSUD standards. Use green infrastructure to manage water quality and to integrate with Objective 4.

Objective 3: Water Use – Capture and use of stormwater runoff for beneficial purposes.

Objective 4: Amenity, Recreation & Environmental Enhancement and Protection - Where possible, develop land used for stormwater management purposes to facilitate recreation use, amenity & environmental enhancement.

The development of the stormwater strategy for Precinct 1 and Precinct 2 requires these broad objectives to be further refined to identify specific management objectives. These specific objectives are outlined in the following Sections and will then enable targeted management strategies to be identified, assessed, and implemented.

4.2 Flooding

A number of strategies have been implemented to achieve the objectives for flood management set out in Section 5. These strategies are briefly set out below.

Strategy 1: Primary Drainage Infrastructure

The inclusion of a drainage network designed to manage the minor/major principles for Precinct 1 and Precinct 2. The standards are described in Section 5 have been applied to the detailed design of all current stages and will be applicable for the remainder of Precinct 1 and Precinct 2 and the entire development.

Strategy 2: Regional Flood Management

The inclusion of a network of channels designed to intercept overland flooding from Gawler River. Refer to Section 5 for further detail. This has been updated to include an extended length of open channel network to connect the drainage system to Thompson's Creek in the interim to allow for an outfall connection to Thompson's Outfall channel. The initial SMP used stormwater retention in the open channel network to control outflows from the site, however, this did not allow for a free draining channel, which has resulted in difficulty being able to undertake the proposed channel planting which is part of the stormwater quality treatment needs.

The flood modelling conditions were based off the modelling of the floodplain carried out by Water Technology (refer to Appendix C). Pre-development, current and future development conditions were considered to ensure flood management objectives were met.

4.3 Stormwater Quality

Strategy 1: Green Infrastructure (WSUD)

The provision of WSUD elements is to be incorporated at key locations in the development for management and treatment of stormwater. The construction of regional drainage channel system for the management of flood flows will provide the opportunity to incorporate linear ephemeral wetland pools for water quality improvement. Based on the significant length of channel and based on their widths, several potential sites are highlighted in Section 6.

Other WSUD opportunities are to be pursued within the development include the use of:

- Vegetative swales
- Ephemeral wetland pools along the regional channel network
- Ephemeral wetland ponds will also be included where pipe outfalls are in close proximity to the proposed saltwater lakes to achieve nutrient reductions prior to discharge to the lakes

The ephemeral wetlands will be based on a shallow, densely vegetated basins that will incorporate a temporary average pool depth of 300 mm (the pool depth will vary from 200 mm to 600 mm). The residence time will be controlled using a discharge control pit to release treated stormwater over a period of 60 - 72 hours. Treatment will occur using settling, absorption, and uptake of nutrients through wetland processes.

The ephemeral wetland ponds will accommodate a rainfall runoff volume from a 20 mm rain event to temporarily fill the ephemeral wetland. This pond will slowly drain down over a two- to three-day period to a dry condition. It is envisaged that the ephemeral wetland pond will exhibit strong environmental value through biodiversity, habitat, and sustainability

Strategy 2: Interception of Gross Pollutants

The development drains within Precinct 1 and 2 include a number of outfalls into the regional channels which will ultimately drain out to the Gulf St Vincent. The outfalls will each accommodate a GPT using Continuous Deflection Separation (CDS) technology to intercept gross pollutants, as will any other outlets to the open channel system that are required for the balance of Precinct 1 and Precinct 2.

4.4 Stormwater Reuse

Strategy 1: Implement Aquifer Storage and Recovery Scheme

Provision of a stormwater harvesting scheme within Precinct 1 and Precinct 2 is not considered viable at this early phase of development due to the lack of development and runoff to generate sufficient water.

Walker Corporation are negotiating with SA Water to have a Northern Adelaide Irrigation Scheme (NAIS) water brought into the development to supply irrigation water for streetscapes and reserves. The need therefore for consideration of an ASR scheme is no longer warranted.

5 STORMWATER DESIGN

5.1 Regional Flooding

The regional flooding within the development area is a result of breakout flow from the Gawler River. Extensive flood plain hydraulic modelling was undertaken to inform the extent and risks for pre and post development flooding scenarios. A network of regional flood conveyance channels was developed to manage and convey flood waters safely through the development. These channels not only provide protection to the development from regional flooding (Gawler River), they also form part of the development’s flood conveyance from short duration storm events.

Flood mapping was undertaken by Water Technology to inform the extent of regional flooding for pre-development, current and post-development conditions (refer to Appendix C Further discussion and flood mapping is outlined in the following Sections. The map in Appendix C provide water surface elevations for flooding from the Gawler River in the 100-year ARI event.

5.2 Design Basis – Minor and Major

The following section describes the general design basis to be adopted for the major and minor storm systems.

Design Basis

The internal stormwater system is designed for the following average recurrence intervals (ARI’s):

Minor storms (internal underground drainage)	20%AEP, 5-year ARI
Major storms (overland flow)	1%AEP, 100-year ARI

Internal Drainage Calculations and Design

Design Parameters

A minimum grade of 0.50% for the internal drainage system should be achieved where possible. Where a 0.50% grade could not be achieved due to constraints, the following minimum grades for the relevant pipe sizes have been decided upon as per discussions with Council:

- 375 mm 0.50%
- 450 mm – 600 mm 0.40%
- 600 mm and above 0.30%

The minimum grade at all road crossings shall remain at 0.50%. In addition, the minimum grade for the upper reaches of a system shall also remain at 0.50% so as to achieve sufficient velocity prior to joining the larger network.

The following criteria are used for the minimum allowable pipe size:

- Reinforced concrete pipe 375 mm
- Minimum freeboard (minor storm) 150 mm

Minimum pipe size:

- Reinforced concrete pipe 375 mm dia
- uPVC pipe (allotment connections) 150 mm dia
- Minimum freeboard (minor storm) 150 mm

The underground internal drainage system will be designed to accommodate flows from a 20% AEP storm event with no surcharging. A minimum freeboard at pits for minor storms of 150 mm will be adopted so that the hydraulic grade line (HGL) is at least 150 mm beneath all pit openings.

Overland flow paths were defined for the 1%AEP storm event.

The minimum floor level for dwellings is also required to be 150 mm higher than the top of kerb.

Internal stormwater runoff from catchments will be discharged at a number of locations into the regional stormwater channel system. Each outlet is proposed to be fitted with a gross pollutant trap (GPT) in order to satisfy primary stormwater treatment requirements, so that stormwater runoff is improved and pollutant transfer to receiving waters is minimised. The treatment flow for each GPT was calculated using the 4EY (3-month ARI) storm event and they have been sized on this basis.

5.3 Interim and Ultimate Development Scenarios

General

A system of regional channels has been proposed throughout the Buckland Park Development in order to manage and convey breakout flows from Gawler River for long duration flooding events, in addition to managing stormwater outflows from the development during short duration events. The regional channel network will protect the development from flooding both regional and localised flood events. The basis on which the channels were designed is the flood modelling undertaken by Water Technology (formerly Australian Water Environments).

In the Ultimate Development scenario 3 saltwater lakes are proposed which will provide for stormwater detention above the permanent lake level. Outflows from the lakes will be conveyed to Thompson's Outfall channel via a gravity pipe network so that salt water flows are prevented from entering the open channel network and therefore risk infiltration into the shallow groundwater systems.

Appendix C shows flood modelling results provided in Water Technology floodplain maps for the 100-year ARI flood event in the context of Riverlea Precinct 1 and Precinct 2. This demonstrates that the extent of channel systems proposed to be constructed within Precinct 1 and 2 will provide protection to those stages. The channel network will need to be extended in the future as further development occurs, but the extent of channel network required will be dependent on the location of the next precinct.

The Ultimate regional channel solution is illustrated in schematic purposes in Figure 6. Council's requirement for the Buckland Park Development is that post development outflow does not exceed the pre-development level. The need for an ultimate major detention basin to service the entire development and the basis of its design are discussed in detail in 'Stormwater Management, Water, Wastewater and Recycled Water- Technical Paper,' prepared by Wallbridge & Gilbert, 2022. The following is a summary of key outcomes from the stated technical paper relating to stormwater detention requirements:

Pre-development peak 100-year ARI flow rate was calculated to be approximately 10 m^3/s.

Detention will be incorporated above the proposed salt water lakes for those catchments draining to the lakes. For those catchments that do not drain to the lakes, a large detention basin is proposed in the south-western corner of the site and will reduce the peak flows from the site to a maximum of 6.1m^3/s in the Ultimate Development state, combined with the proposed saltwater lakes.

5.3.1 Ultimate Development

A TUFLOW model was used to determine that a detention basin of the order of 250,000 m^3 would be required to attenuate the 1 in 100-year ARI peak flows to a maximum outflow of 6.12 m^3/s, with the critical duration storm the 12 hour event. The peak outflow from the 3 salt water lakes is 0.16m^3/s and the critical duration storm is the 30 hour event.

The location for the detention basin is indicatively shown in Figure 6 and was chosen for the following reasons:

- Lowest point on the site
- Low possibility of encountering acid sulphate soils
- Limited development potential of this area as the site elevations are low
- Site can be used to generate fill for the development

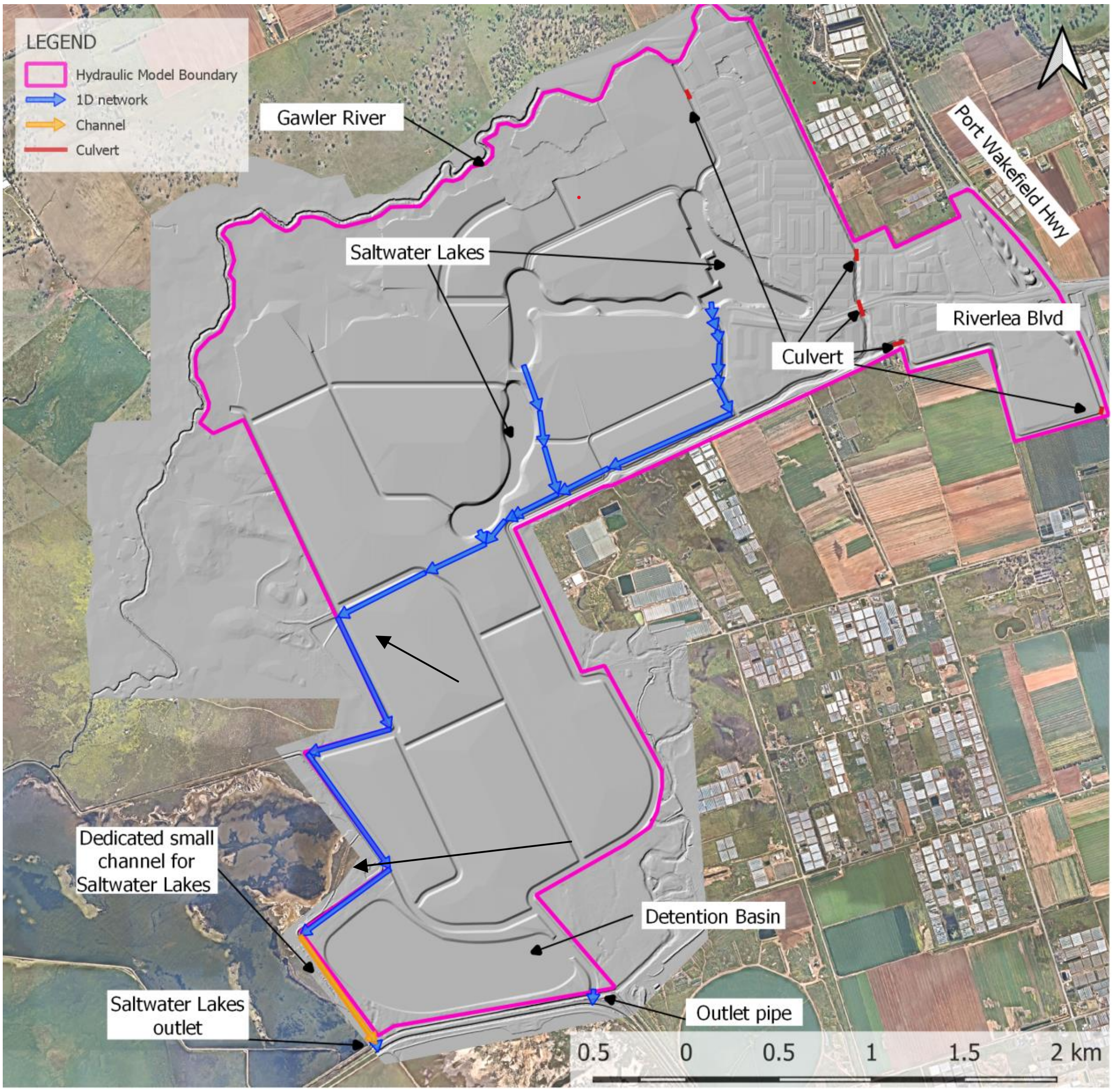


Figure 6: Proposed Ultimate Channel System including Saltwater Lakes

Methodology

A 1D/2D TUFLOW model has been developed in accordance with AR&R 2019 guidelines. The latest design surface for the development site has been used. The modelling has been undertaken for 1% AEP event.

The model shown in Figure 6 and covers about 10.2 km^2.

A range of storm durations was selected and for each duration 10 temporal patterns were modelled. The median of all 10 temporal patterns for each duration was processed and the maximum of the medians were then extracted to form the critical results. This approach ensures only the critical results are presented for each modelling cell. The results have been checked for all the modelled durations to ensure the peak results have been captured.

Hydrological data including rainfall and losses has been entered directly into the model using the Rain on Grid (RoG) approach, which directly applies rainfall to the modelling area. By using this approach, both hydrologic and hydraulic modelling can be simulated together in TUFLOW rather than separately.

Digital Elevation Model (DEM)

The latest development site design DEM has been used. Minor modifications have been undertaken to correct identified DEM generated anomalies.

Durations and Temporal Patterns

A wide range of short and long rainfall durations were modelled to ensure peak flood elevations for the development site were captured. Durations modelled included 15 min, 30 min, 60 min, 120 min, 180 min, 360 min, 540 min, 720 min, 1,080 min, 1,440 min, 1,800 min, 2,160 min and 2,880 min. For each duration 10 temporal patterns were modelled.

Rainfall Data

Rainfall depths and temporal patterns have been sourced from the AR&R 2019 data hub and the Bureau of Meteorology (BOM). The design rainfall inputs adopted, used the coordinates below, which is the centroid of the modelling area:

- Latitude : -34.663200
- Longitude : 138.507350

Loss Estimation

The initial and continuing loss method has been used for the modelling. The losses have been sourced from the AR&R 2019 data hub. The initial and continuing loss adopted was 29 mm and 4 mm/hr respectively. The initial loss has been adjusted to model the pre-burst rainfall. The pre-burst rainfall depths have been deducted from the initial losses.

Surface Materials and Manning's n Value

The development site has several different surfaces and terrains to account for with the flood modelling. The surfaces have different loss and roughness coefficients (manning's n value). To model this, the modelling area was classified based on the different land use that will be present with completion of the development site. The surface material classification assigned for the site are shown in Figure 7.

The following surface material categories were used in the model:

- Saltwater lakes (standing water)
- Open channel, straight banks, and well-maintained channel
- Roads
- Park reserves, containing light shrub and tree planting and grass lands
- Lots, block of lands containing high density of impervious area such as roofs, concretes and it was assumed 70% of the area was impervious
- Water surface, which covers tall shrubs and average depth of flow

The Manning's n value used for the modelled land uses are presented in Table 5.

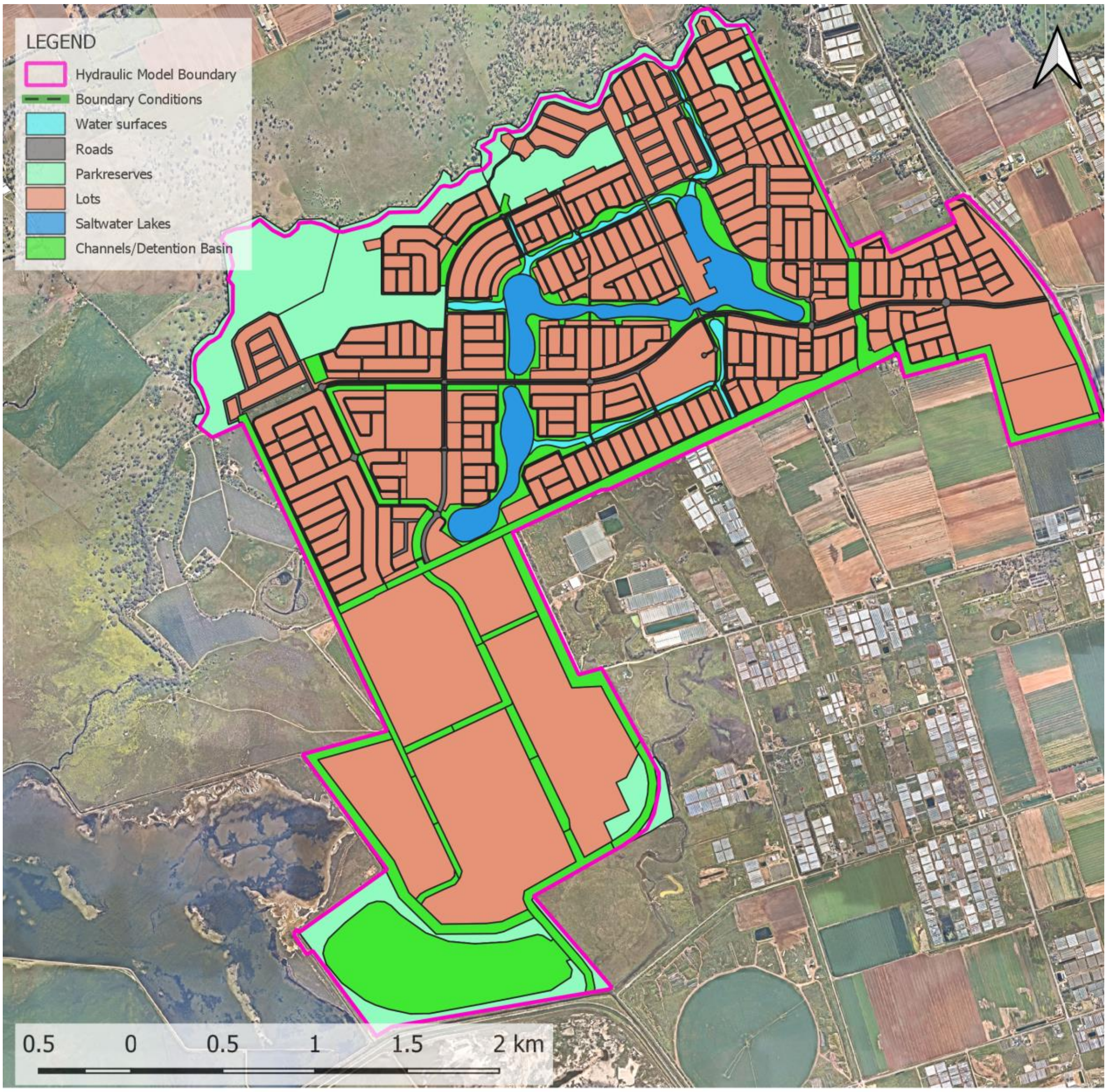


Figure 7: TUFLOW MODEL – Surface Condition Assumptions

Table 5: Manning's n Value

LAND USE	MANNING'S N VALUE
Saltwater lakes	0.03
Park reserve	0.04
Open space/channel	0.03
Water surface	0.05
Lots	0.30
Roads	0.02

Flood Depths

Figure 8 shows the 1%AEP flood depths across the development.

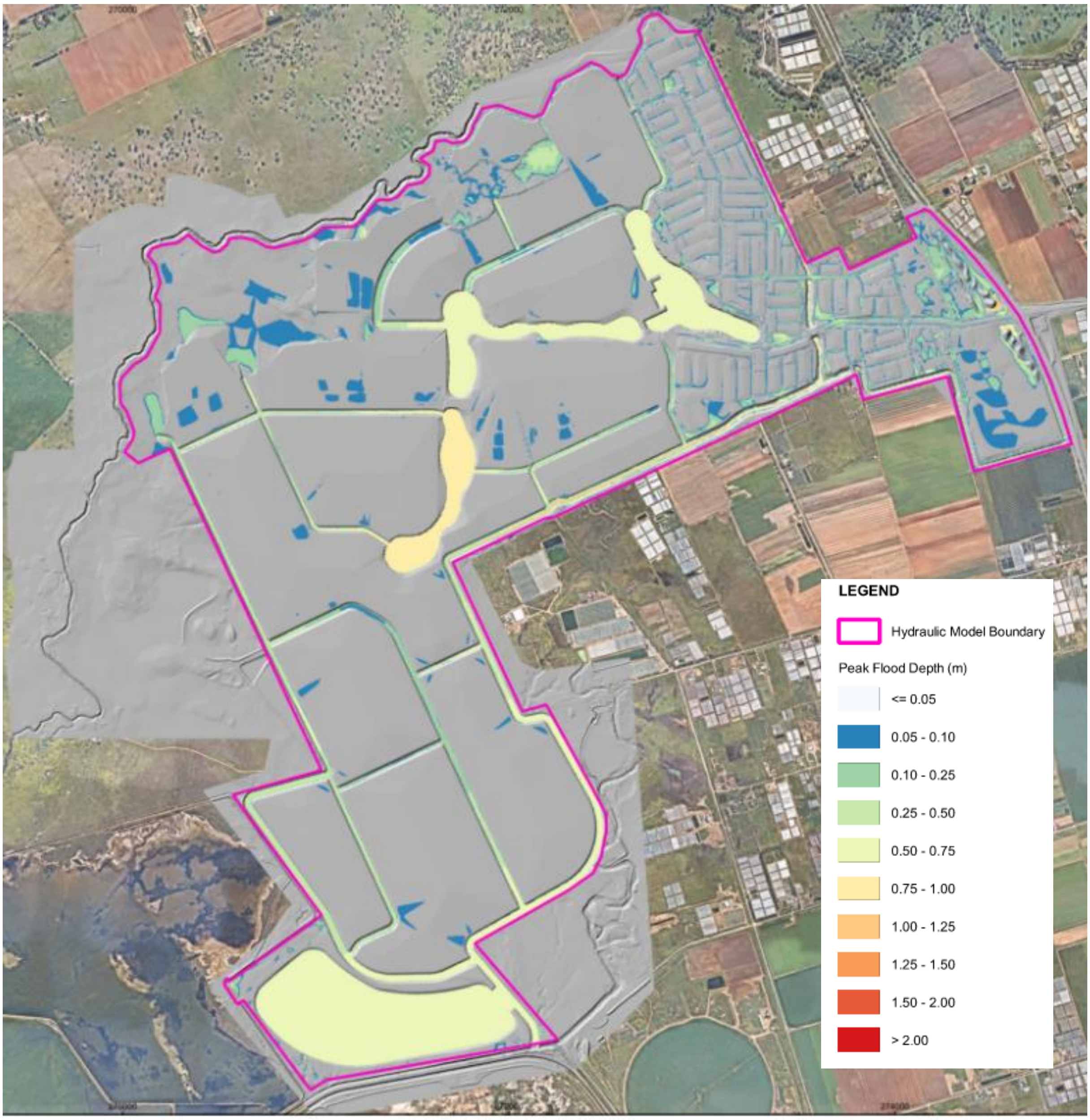


Figure 8: 1%AEP Flood Depths – Ultimate Development

Flood Levels

Figure 9 shows the predicted flood levels across the site in the 1%AEP event to Australian Height Datum (AHD)

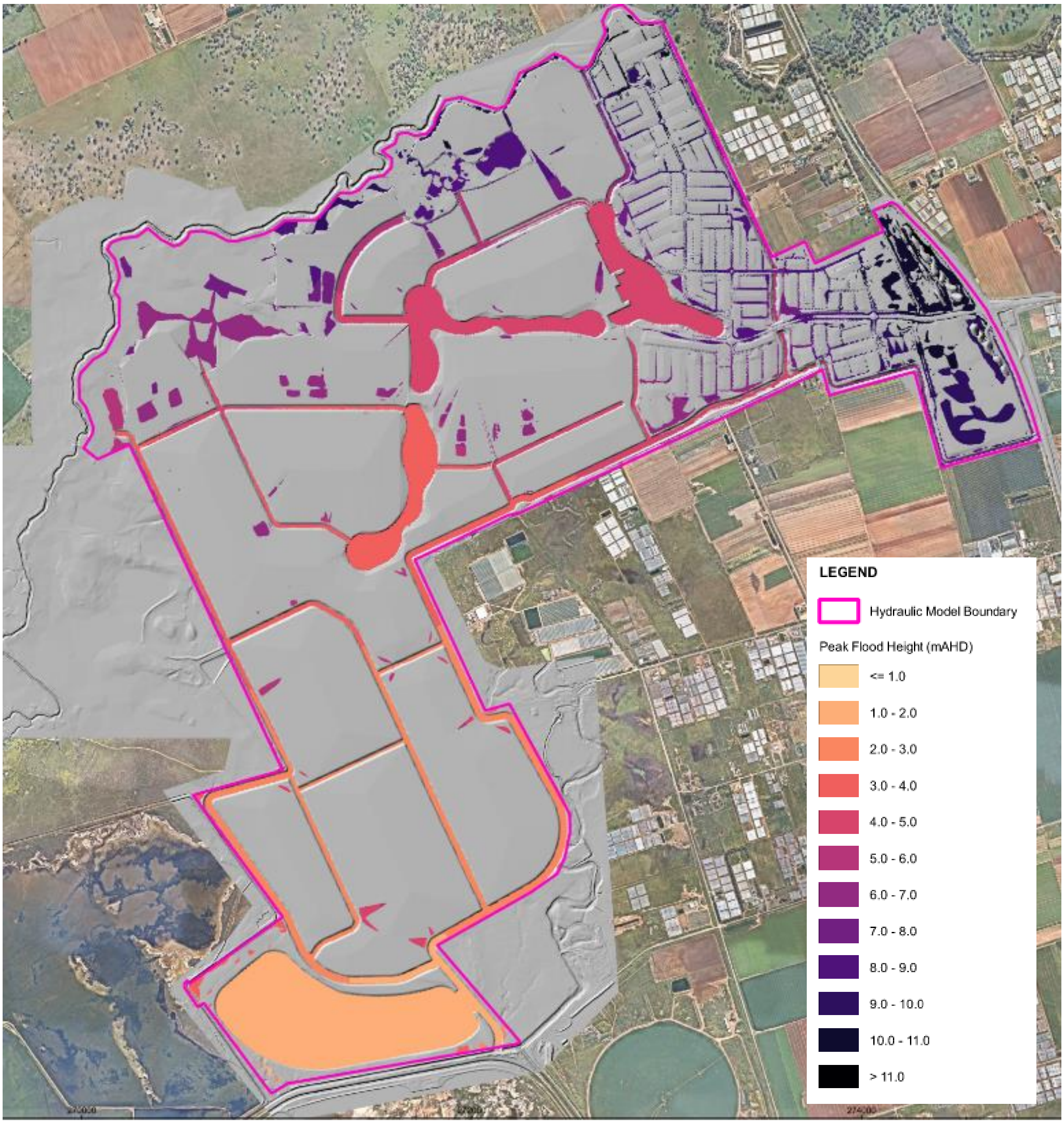


Figure 9: 1%AEP Flood Levels (AHD) – Ultimate Development

5.3.2 Interim Solution – Prior to Salt Water Lake 1 Construction

For the purpose of Precinct 1 and Precinct 2, it is suggested that construction of the ultimate detention basin is not required at that stage, and an interim solution requiring a lesser proportion of channel construction is more appropriate including a smaller 75,000m^3 interim basin. Figure 10 shows the proposed channel layout for Precinct 1 and 2.

Figure 10: Proposed Extent of Channel Construction for Precincts 1 and 2

The open channel network is outlined in green, and includes some temporary channels aligned along the future salt water lakes until such times as the proposed lakes are constructed.

Methodology

For the Interim development stage comprising Precinct 1 and 2, a DRAINS Model was established which included the channel cross sections, so that it could be run in the Unsteady State mode to model the effect of the channel storage. The outputs from the DRAINS model were also then input into a HEC-RAS model to determine the peak water levels for the Interim development stage, and to demonstrate that the channel system has sufficient capacity to cope with the 1% AEP flood levels.

Loss Estimation

The following parameters were adopted for the DRAINS model, to be consistent with the TUFLOW assumptions obtained from the ARR Data Hub:

- Initial Loss of 30mm
- Continuing Loss of 4mm/hr
- Paved Area Depression Loss of 1mm

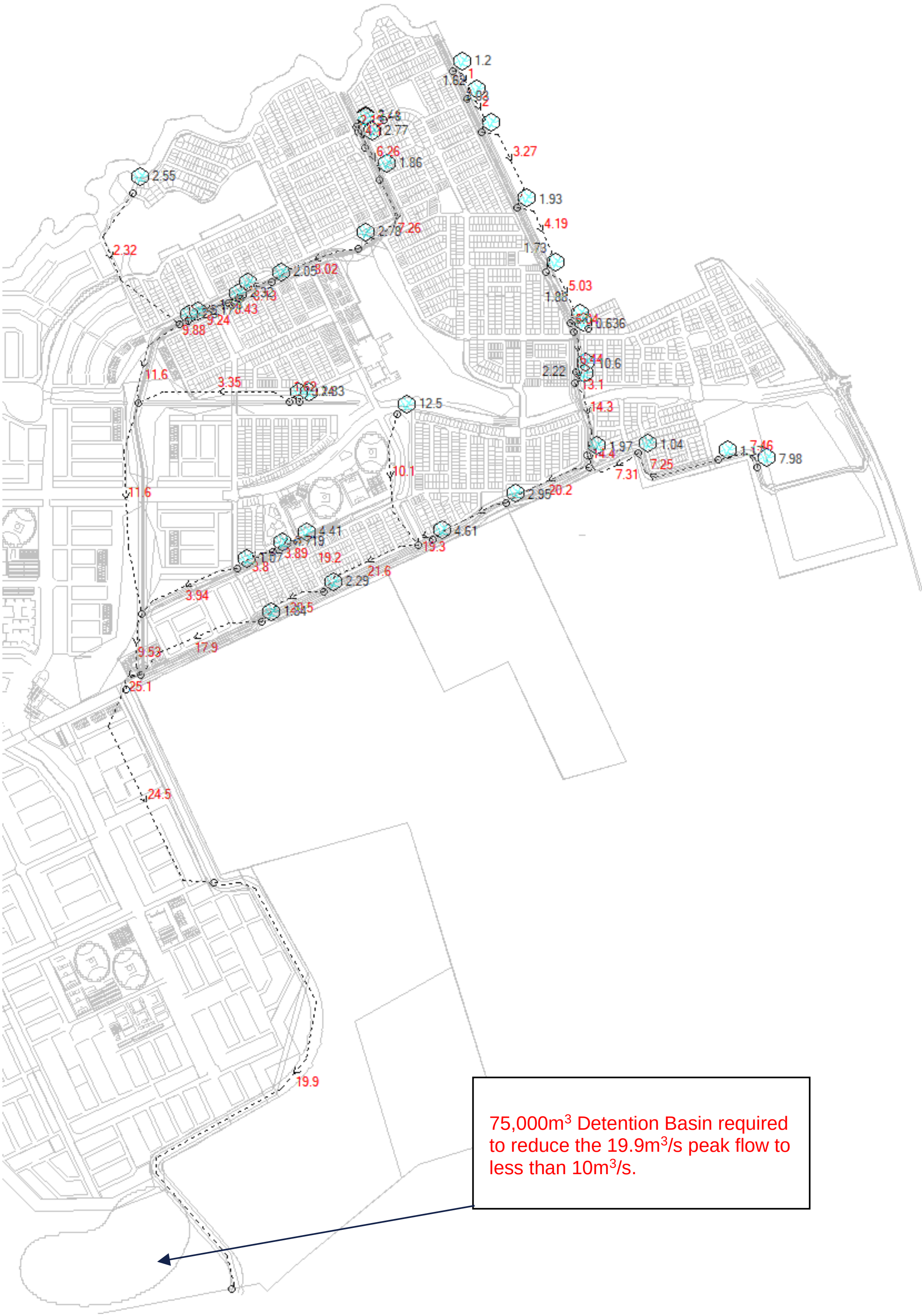


Figure 11: DRAINS Model – Interim Solution – Shows Peak Flows in 1%AEP Event

Restriction of Post Development Outflows

A 75,000m^3 interim detention basin is required to be constructed when the channel system is extended to Thompson's Outfall Channel to reduce the peak flows to less than predevelopment levels. This basin can be augmented in the future to a minimum of 250,000m^3 to service the ultimate development.

DRAINS outputs for the 1%AEP, 20%AEP and 4EY are provided in Appendix B.

HEC-RAS outputs for the Interim Channel system are provided in Appendix F for the same events.

A summary of the actual flows for each event at locations within the channel network is provided in Figure 11.

Internal stormwater runoff from Precinct 1 and 2 is discharged at a number of locations into the regional stormwater channel system as indicated in Appendix F. Each outlet is proposed to be fitted with a gross pollutant trap (GPT) in order to satisfy primary stormwater treatment requirements, so that stormwater runoff is improved and pollutant transfer to receiving waters is minimised. The treatment flow for each GPT was calculated using the 3-month ARI storm event and they have been sized on this basis.

5.3.3 Interim Solution – Post Salt Water Lake 1

Figure 12 shows the proposed solution post construction of Salt Water Lake 1. Salt Water Lake 1 will include a 750mm outlet pipe that will discharge directly to Thompson's Outfall Channel to avoid salt water discharging directly to the Riverlea open channel system. The Salt Water lake will provide stormwater detention above lake level for the localised catchments draining to it. The detention depth above the lake will be a maximum of 500mm. The northern most section of Channel 5 as shown in Figure 10 will be directed to Salt Water Lake 1 post construction and commissioning of the lake infrastructure. The peak outflow from the lake in the 1% AEP event is estimated to be 425L/s with a combined peak detention depth of 500mm. The critical duration storm for the lake is the 24 hour event.

Figure 12: Interim Solution – Post construction of Salt Water Lake 1

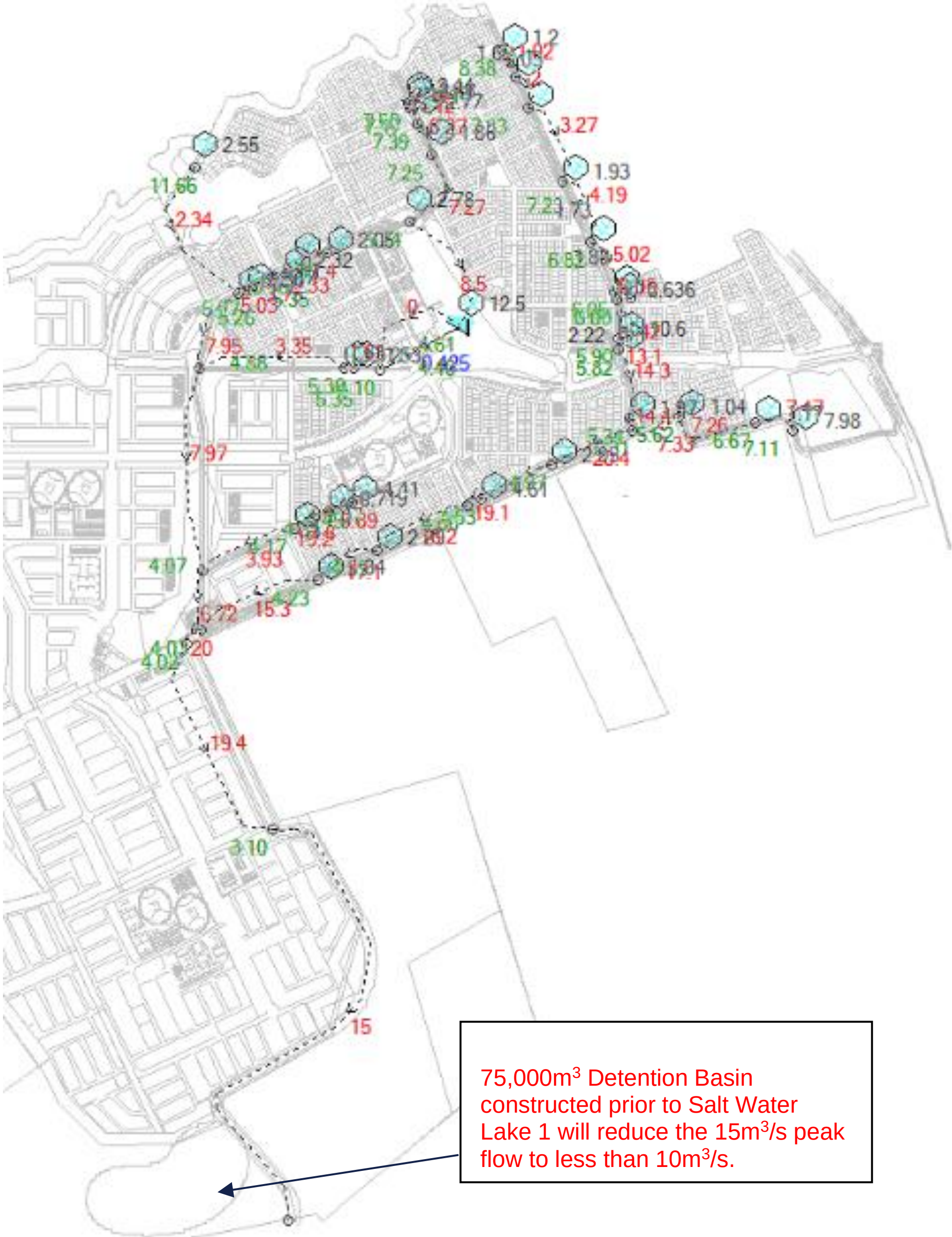


Figure 13: Interim Solution – DRAINS Model - Post construction of Salt Water Lake 1

6 WATER SENSITIVE URBAN DESIGN

6.1 Strategy

The implementation of a water sensitive urban design (WSUD) strategy is based on the following considerations:

- Selection of techniques that suit the site's physical, climatic and environmental setting.
- Selecting techniques that are robust and sustainable, and therefore will suit the water regimes.
- Locating techniques such that they are maintainable.
- Development of a strategy that is integrated within the site, and contributes to deliver multi-objective outcomes for the development.

Further discussion about the WSUD is outlined below and in this Section.

The overall WSUD and water quality management strategy has been based on the inclusion of the following key elements into Precinct 1 of the development, noting that detailed design has been progressed for Stages 1 to 12 of Precinct 1:

- Gross pollutant traps at major stormwater outlets.
- Integration of vegetated swales for localised sub catchments.
- Linear ephemeral wetland pools which have been incorporated into pool and riffle sequences within the low flow channels of the larger regional drainage channels.
- Design the regional channels to incorporate naturalistic waterway design principles. (See further information below with regards to the multi objective approach).

The key WSUD design features for the development is the design of the regional drainage channels. Their design adopts a multi-objective approach within the development to incorporate functions that go beyond flood conveyance. These are summarised in the following points:

- The design adopts a landscape design approach that aims to enhance existing environmental values while adding to create new habitat opportunities through restoration and revegetation using local indigenous species.
- Development of wetland habitat pools into the low flow channels and riparian areas along the regional drainage channels to enhance their function as habitat, biodiversity and ecological service corridors.
- The integration of the above features into passive recreation uses for the community through the inclusion of share path networks and linkages.
- Avoiding the direct connection of stormwater drainage systems into existing waterways downstream of the development by limiting the number of outlets and locating these at treatment pools within the regional channel. These outlets have been designed with rock and plantings to reduce their visual impact and prevent erosion.
- The regional drainage channels have been designed to operate as living ephemeral streams through the incorporation of design features that mimic natural waterways. Such design features include:
  - Incorporation of pool and riffle sequences within the low flow channels which facilitate stormwater treatment from the development.
  - Creating batters of varying slopes.
  - Ensuring velocities are managed appropriately to prevent bed and bank erosion.
  - Revegetation to facilitate filtering, sediment deposition, nutrient uptake and while also providing opportunities for habitat and visual amenity.
  - Inclusion of porous rock riffles which aim to allow stormwater to be released from the online wetland pools at a slow rate in order to facilitate treatment while reducing risks associated with mosquito breeding.

The functionality of the online wetland pools is discussed in detail in Section 5.2. The treatment performance of the online wetland pools and other associated WSUD elements are presented in Section 5.4. A general layout plan showing the location of the treatment wetland pools together with the WSUD strategy is provided in Appendix E.

Ephemeral Wetland Treatment Pools

A series of online ephemeral wetland pools have been designed and integrated as part of the low flow channels which are within the regional drainage channels. These pools are densely vegetated shallow water bodies of 200 to 300 mm depth that provide treatment of urban stormwater from the development. Their treatment function provides enhanced sedimentation, fine filtration, adhesion and biological uptake, and chemical processes to remove pollutants from urban stormwater.

The online pools consist of a macrophyte zone which is a shallow densely vegetated (reed bed) which is wide and shallow. The pools are controlled by a porous rock riffle which allows water to be held within the pond for a sufficient duration to facilitate treatment. These riffles are porous, in that they have been designed to incorporate an open rock structure to allow seepage through the voids, which provides a detention time of approximately 4 to 10 hours for each pool. The pools lie in succession along the channel and therefore a total detention time of approximately 2 to 3 days is provided which follows the principles of wetland design. It is expected that the pools will dry out following the emptying time.

The porous rock riffle designs offer an effective and sustainable means of controlling water levels within the pools using an informal approach. The riffles are of a robust design comprising of an open graded rock matrix along the crest to facilitate seepage, while the base or apron will comprise of a densely well graded matrix of rock which is held into position by a row of toe rock (rock key which anchors the riffle) to prevent downstream migration of rock.

The wetland systems will dry out seasonally which mimics natural flood plains. Such systems are considered to be highly biologically productive that provide habitat and ecological value within an urban setting.

As the wetland pools are located online, treatment effectiveness is limited by the ability of the pools and vegetation to entrain pollutants and assimilate them to prevent transfer downstream. In this regard it is necessary to ensure that the 100-year storm flow velocity through the regional drainage channel resulting from a major flood within the Gawler River catchment is not in excess of 0.5 m/s. This follows the recommendations contained in the “Constructed Wetland Guidelines – Melbourne Water, April 2010”. The guidelines suggest that the flow velocity during the major storm flow should not exceed 0.5 m/s for online systems to avoid the removal of trapped pollutants to downstream environments. This design requirement has been checked using Mannings equation for normal flow and Hec ras hydraulic river model, and it has been confirmed that the requirement is met. Further to this point, given that the maximum velocity does not exceed 0.5 m/s, there is no risk associated with erosion along the channel and loss of plantings.

Sedimentation processes associated with coarse particles within the low flow channel/online pools is expected to occur upstream of the treatment systems. Coarse sediments that may enter the regional channel at the upstream of the development from the broader Gawler River catchment are expected to drop out of suspension quickly as a result of deep flow and low velocity. Coarse sediments require velocities not exceeding approximately 0.8 m/s to settle out of suspension. Once they are entrained into the bottom of the main channel, it is expected that they cannot be re-entrained into the flow due to the low velocities of less than 0.5 m/s. As is the case with similar regional channels and constructed urban wetland systems, it is envisaged that the channel and online pools will require dredging of sediments and removal of decayed vegetation at approximately 20-year frequencies. This process is not uncommon for vegetative stormwater treatment systems within an urban setting.

It is noted that there are two groups of pools that are located on the upstream and downstream side of the main road bridge crossing. These pools have been designed using similar principles as per other ephemeral wetland pools, however they differ in that they incorporate a pool storage volume that is semi-permanent. Council have raised a concern with regards to the potential for these pools to create favourable conditions for mosquito breeding.

It is expected that these pools will dry out, however as the water level drops, it is expected that groundwater intrusion will replace the stormwater and hence maintain aquatic fauna. Mosquito control is reliant upon maintaining a healthy population of aquatic fauna. Hence it is concluded that a permanent water body that is maintained by groundwater and stormwater can provide an environment whereby aquatic fauna can survive and provide a natural means of control.

Gross Pollutant Traps

There are a number of gross pollutant traps (GPT) proposed, located at each of each of the outlets for to the open channel system. This methodology will be applied for all future outlets into the open channel system. These GPTs will provide an effective means of pre-treatment to trap debris and coarse sediments prior to entering the downstream system.

6.2 Modelling and Results

In preparing this stormwater management plan, we have developed MUSIC models for both the Ultimate scenario where the full saltwater lake scheme has been implemented, and the Interim stage where temporary channel system is used to capture and treat flows from Precinct 1 and 2. The interim solution relies on the channel being constructed all the way to Thompson's Outfall channel, which will then provide for a free draining channel solution which will allow the low flow channel inverts to be suitably planted to achieve the required water quality outcomes.

Figure 14 outlines the MUSIC model catchments for the Ultimate Development scenario and Figure 15 outlines the catchments for the Interim Scenario.

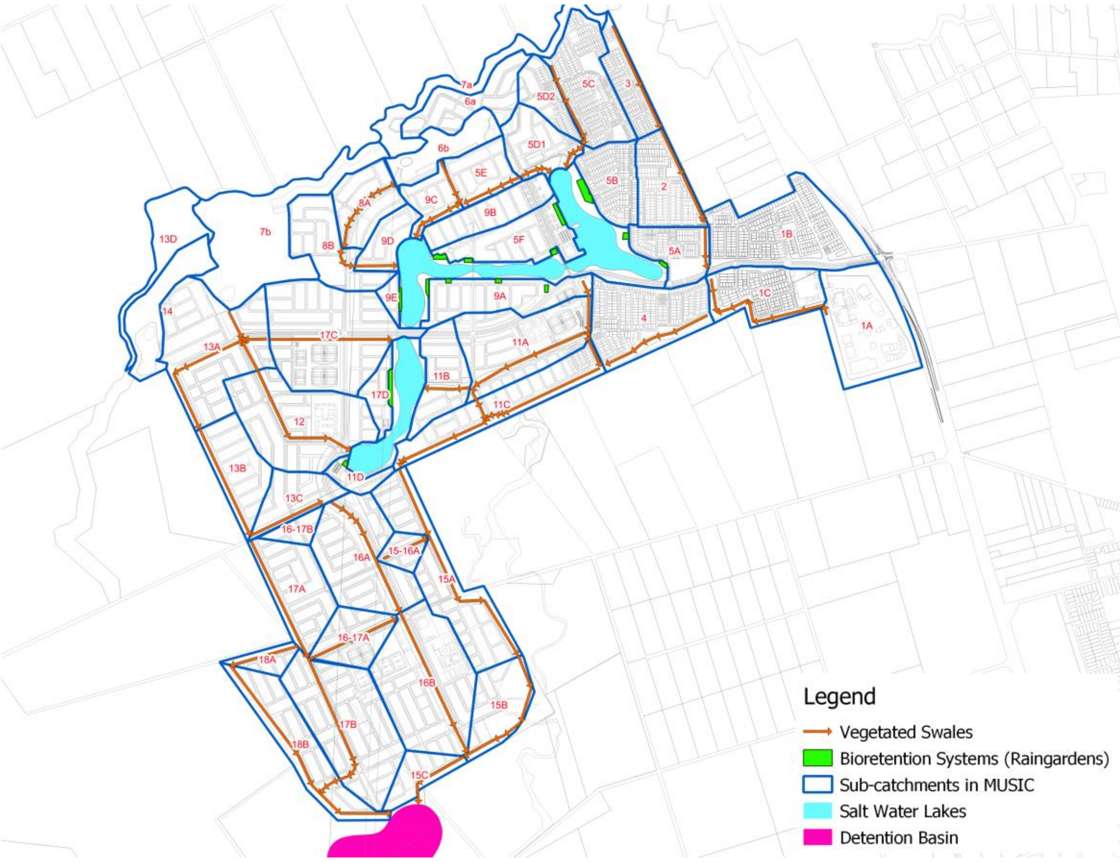


Figure 14: MUSIC Model Catchment Plan and WSUD Assets locations with indicative proposed layouts for the Ultimate Development

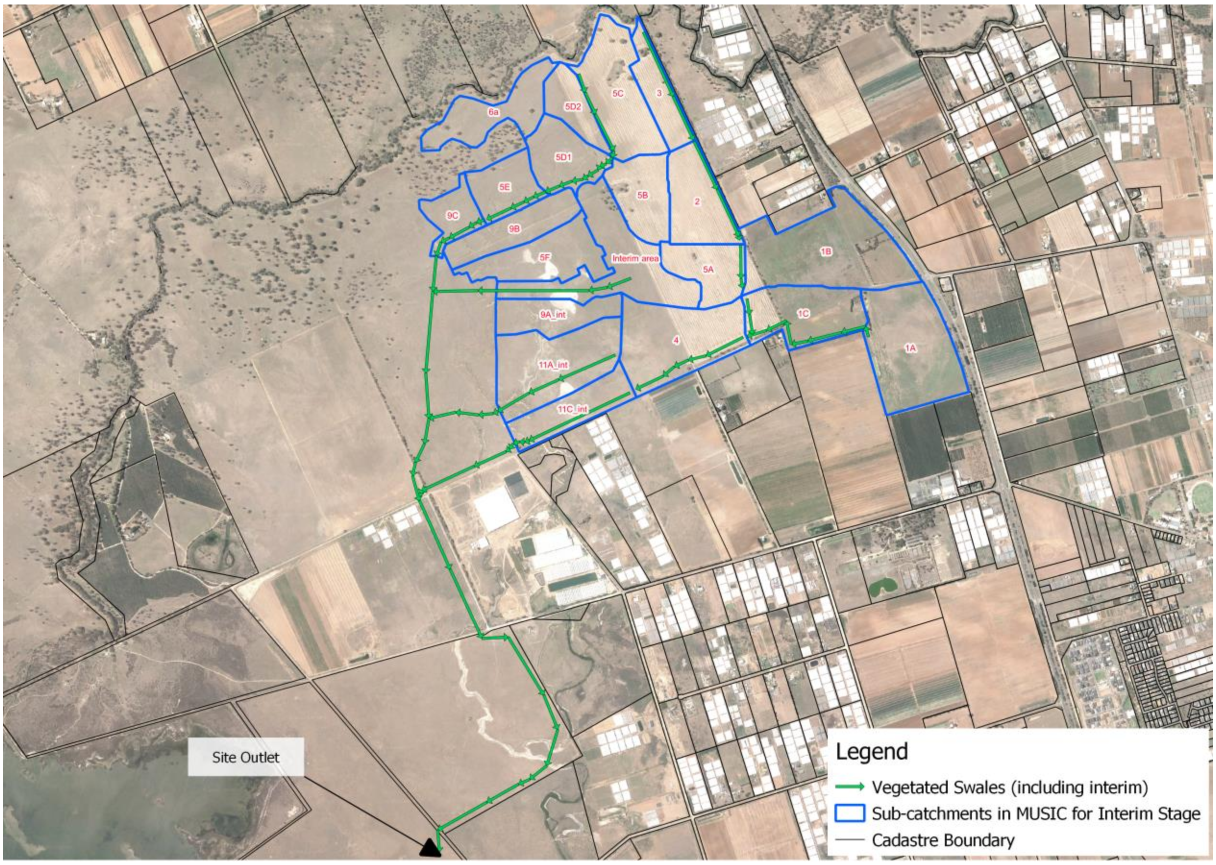


Figure 15: MUSIC Model Catchment Plan and WSUD Assets locations with indicative proposed Layouts for the Interim Scenario for Precinct 1 and 2

This section summarises the water quality simulation carried out using MUSIC software and compares the outcomes to the EPA Water Policy and WSUD treatment guidelines for pollutant reduction targets as defined in the WSUD Guidelines for the Greater Adelaide Region (2013).

MUSIC modelling is utilised to conceptually confirm the required surface areas of the wetland treatment pools to ensure that the treatment requirements can be met from for the development of Precinct 1. Refer to Appendix D showing the extent of the modelled catchment that is covered within the MUSIC model. The extent of modelling includes future stages beyond Stage 1A and 6A which ensures that this strategy considers the ultimate development of Precinct 1 and parts of Precinct 2.

MUSIC version 6 has been used to assess the performance of the design. The model layout has been included in Appendix D and shows that adjacent/future catchments have been included in the model to provide proof of concept that the treatment strategy will accommodate the immediate adjacent future stages of development.

MUSIC Software

MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the CRC for Catchment Hydrology in Victoria. MUSIC provides the ability to simulate both quantity and quality of runoff from catchments ranging from a single house block and urban areas up to many square kilometres, and the effect of a wide range of treatment facilities on the quantity and quality of runoff downstream. MUSIC predicts the performance of the stormwater quality management systems.

This simulation is based on an assessment of the treatment systems required for the development of Stages 1 to 12. Preliminary sizes were developed using first design principles for wetland design, and this formed the basis for testing and modelling in MUSIC to ensure that the space requirement for treatment can be met for the development.

MUSIC Modelling

Stages 1 to 12 development characteristics and parameters have been entered into the MUSIC model based on the sub-catchments. Refer to Appendix D for screen output of the model showing catchment nodes and treatment systems graphically displayed. The treatment elements of the system, including gross pollutant traps and vegetated swales are all included in the model as per their adopted design configurations shown on the design drawings. MUSIC model uses climatic data comprising of daily rainfall interval and evaporation data from Edinburgh RAAF from 1979 to 2010. This data is used to simulate the rainfall runoff on site and the subsequent treatment performance for the development. The results and outcomes are in this Section.

The parameters entered into MUSIC model for the source and treatment nodes are summarised in Table 6. The table is not intended to provide details of each node within the model, instead it provides a general overview of the typical parameters used for the source and treatment nodes. It this case the source nodes are represented by "urban nodes", and the treatment nodes are represented by, gross pollutant trap and vegetated swales.

Table 6: MUSIC Modelling Parameters

NODE TYPES	PARAMETERS				
Urban	Soil storage capacity 40 mm	1 mm depression storage	Typical impervious fraction 65%	Stochastically generated pollutants	Initial storage capacity of 25%
Treatment	**Parameters**				
Low Flow Swale	Gradient 0.2%	Vegetation height 250 mm	Base width 15 m	Infiltration loss 0.70 mm/hr	Batter 1 in 3 Depth 2.0 m
GPT	Treatment flow to the 3-month ARI	TSS removal rate 70%	TP removal rate ZERO	TN removal rate ZERO	Gross pollutant removal rate 90%

Treatment Requirements

The design of the site treatment system aims to treat stormwater in accordance with the standards as defined by:

The South Australian EPA water quality policy WSUD targets.

WSUD best management practice pollutant reduction targets as defined in the WSUD Guidelines for the Greater Adelaide Region.

The pollutant treatment criteria are presented in Table 7 which have been compared to the simulated results using MUSIC.

Stormwater Quality Simulation Results – Ultimate Development

The results presented in this section demonstrate water quality compliance in accordance with the target values specified. These are assessed against the standards defined in the tables below. These standards were entered into the model to enable a direct comparison to be made. The results have been reported at the downstream node located at the development stage boundary.

Based on the EPP Water Quality limiting concentrations, the model results are presented in Table 7 and compared to the target values.

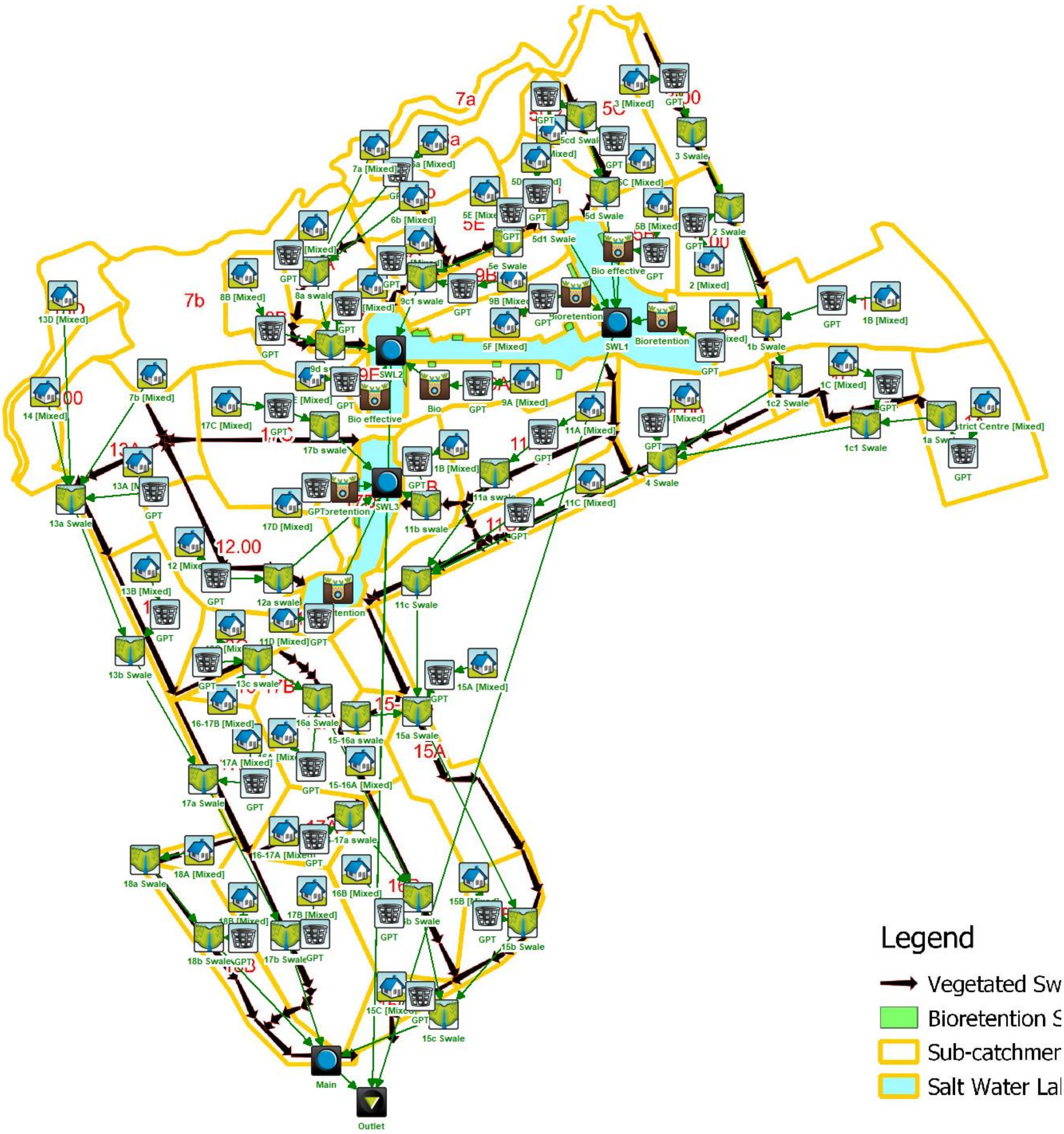


Figure 16: MUSIC Model Schematic - Ultimate Development

The results were also compared to the WSUD Guidelines for the Greater Adelaide Region, which are based on recognised Australian best practice. These are presented in Table 7 along with the results achieved.

Table 7: Water Quality Results Compared to Best Practice Standards – Ultimate Development

POLLUTANT TYPE	TSS	TP	TN	GROSS POLLUTANTS/LITTER
Target percentage reduction (%)	80	60	45	>50 mm and retention in 3-month ARI
Reduction achieved at SWL1 (%)	94.8	70.2	49.6	100% trapped (averaged over the simulated period)
Reduction achieved at SWL2 (%)	96.5	79.8	61.0	100% trapped (averaged over the simulated period)
Reduction achieved at SWL3 (%)	95.2	70.1	45.4	100% trapped (averaged over the simulated period)
Reduction achieved at Site Overall (%)	96.6	82.0	63.1	100% trapped (averaged over the simulated period)

The results summarised in Table 7 demonstrate that the suspended solids, TP and TN reductions will meet the required performance criteria. Whilst other pollutant loads are not considered due to the limitations of MUSIC, the software assumes that other pollutants would be effectively removed and or treated. The rationale is based on the premise that very fine pollutants are attached to other particulate pollutants such as phosphorous (TP) and total suspended solids (TSS). Therefore, while targeting TP and TSS, it is reasonable to expect that many more pollutants are in fact being removed, trapped and or treated.

In summary, the resultant pollutant concentrations attained from the simulations revealed that each fall within the average (mean) limits set by the EPA in South Australia in addition to complying with the best management performance targets set in the referenced codes and guidelines Therefore the design of the site treatment system is satisfactory in terms of meeting the required performance limits of pollutant concentrations.

Stormwater Quality Simulation Results – Interim Solution Precinct 1 and 2

The results presented in this section demonstrate water quality compliance in accordance with the target values specified for the Interim development stage. These are assessed against the standards defined in the tables below. The results have been reported at the downstream node located at the development stage boundary.

Based on the EPP Water Quality limiting concentrations, the model results are presented in Table 8 and compared to the target values

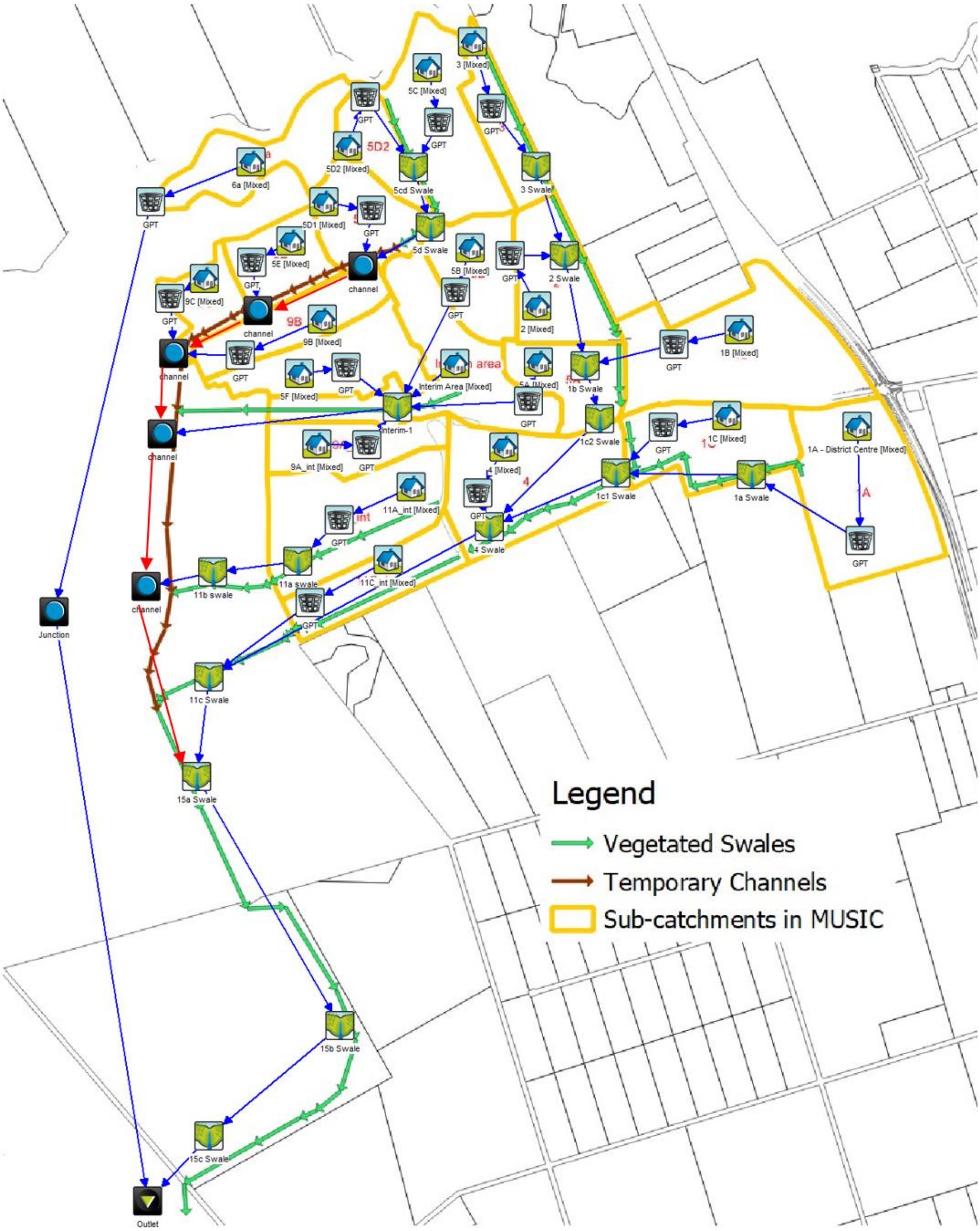


Figure 17: MUSIC Model Schematic – Interim – Precinct 1 and 2

Table 8: Water Quality Results Compared to Best Practice Standards – Interim Scenario

POLLUTANT TYPE	REDUCTION ACHIEVED AT INTERIM STAGE (%)	TARGET REDUCTION (%)
TSS	95.30	80
TP	79.80	60
TN	59.90	45
Gross Pollutants/ Litter	99.5% trapped (averaged over the simulated period)	> 50 mm and retention in 3-month ARI

The permanent channels are intended to be fully planted out, however, the temporary channels will be topsoiled and just grassed and are not intended to contribute to water quality improvements. The MUSIC model does not include any contribution to water quality improvements from the temporary channels.

The results summarised in Table 8 demonstrate that the suspended solids, TP and TN reductions will meet the required performance criteria for the Interim development scenario where there is a combination of temporary and permanent open channels. Whilst other pollutant loads are not considered due to the limitations of MUSIC, the software assumes that other pollutants would be effectively removed and or treated. The rationale is based on the premise that very fine pollutants are attached to other particulate pollutants such as phosphorous (TP) and total suspended solids (TSS). Therefore, while targeting TP and TSS, it is reasonable to expect that many more pollutants are in fact being removed, trapped and or treated.

In summary, the resultant pollutant concentrations attained from the simulations revealed that each fall within the average (mean) limits set by the EPA in South Australia in addition to complying with the best management performance targets set in the referenced codes and guidelines Therefore the design of the site treatment system is satisfactory in terms of meeting the required performance limits of pollutant concentrations.

6.3 Management of Sediment Loads

Land Division Construction Phase SEDMP

During the construction phase of the development a Stormwater, Erosion and Drainage Management Plan (SEDMP) shall be implemented in accordance with the Environment Protection Act 1993. The SEDMPs for all stages will be prepared to meet the requirements in accordance with the Code of Practice for the Construction and Building Industry (1999). The SEDMPs will be developed for each design stage during the detailed design process. These plans are submitted as part of the Engineering approval process attached to this report. SEDMPs for future stages will be undertaken as part of the engineering design and will be submitted via a separate engineering design report for those stages. It is noted that these will follow the principles as outlined in this report.

The SEDMP encompasses surface stormwater management practices that shall be implemented during the construction phase by the constructor. The SEDMP provides a guide to the constructor to plan site management measures that should be implemented in order to prevent sediment and pollutant exports during the construction stages. Whilst the site's conditions will change as the construction progresses, it is the environmental duty of the constructor to ensure that the site SEDMP is progressively maintained and upgraded to suit changing site conditions and stages of construction.

The SEDMP has been prepared to include several techniques to be implemented during the land division construction phase. Typical techniques include (but are not limited to), sediment traps/basins, silt fences, diversion swales to control site flow, single site access point with shaker pad and other measures as deemed necessary. It is noted that the SEDMP will not be limited to the adoption of sediment basins within the regional channels, the SEDMP will require a sequence of management techniques to work collectively. The Contractor shall consider other techniques that form part of the strategy within the SEDMP. This includes:

- The minimisation of cleared land to minimised exposure to wind and rain
- Focussing efforts on minimising soil loss through erosion
- Techniques to minimise the generation of airborne dust

It should be noted that the proposed in-line pools within the channels will be constructed during the early phase of construction and can function as a sediment capture basin during the major earthworks and roadwork construction phases. In this regard these will ensure that all site generated runoff will pass through the pools prior to discharge downstream from the development. Upon completion of the development works, these pools will be reinstated in accordance with the design documentation to ensure that their ultimate design function of stormwater treatment is restored in accordance with the design intent.

The SEDMP will form a key component of the constructor's environmental management plan (CEMP) that will be developed prior to construction.

Post Land Division Construction Phase SEDMP (Private House Building Phase)

It is widely acknowledged and understood that sediment loads and debris resulting from individual house building can be quickly conveyed via the stormwater network. These pollutant loads can be significant. However, the amount of pollution generated by individual house builders is highly dependent upon their level of compliance to the EPA Codes of Practice for building sites.

The SEDMP has been developed to provide provisions to manage this issue to ensure that the impacts during the house building phase are appropriately addressed to prevent downstream impacts. In this regard, the provisions include:

- Gross pollutant traps are located on all major stormwater outlets into the regional channel. These will trap debris and coarse sediment.
- Sedimentation traps located at each of the stormwater outlets into the regional channels. These will trap medium to finer sediment.

The sediment traps should remain functional for a period of time not less than to the equivalent of 70% of the houses completed or as advised by Council. Upon this timeframe, the sediment traps should be removed, and the channel should be reinstated in accordance with the design documentation.

Dust Control

During the land division construction phase of the development an Environmental Management Plan (EMP) will be prepared by the constructor and implemented in accordance with the Environment Protection Act 1993 and its associated regulations (2009). The plan shall also be prepared to meet the requirements in accordance with the Code of Practice for the Construction and Building Industry (1999).

The contractor shall implement measures to minimise and manage nuisance issues associated with the mobilisation of dust resulting from earthworks and construction activities undertaken on site as part of the land division construction phase. Measures to control dust shall be implemented and maintained at all times. Measures will include but not be limited to the following:

- Minimise the area of land that is cleared and exposed to wind any given time during the construction phase.
- Perimeter dust filter screen attached to fencing.
- Covering stockpiles with mulch.
- Maintain adequate moisture levels to all site access tracks and earthworks areas.
- Adopting a proactive approach to dust control by remaining informed of forecast weather conditions and preparing strategies in advance of high-risk days.
- Hydro seeding areas left exposed for periods of time.

Post Land Division Construction Phase Sediment Loading

In consultation with approval authorities, concerns have been raised in relation to the absence of a sedimentation basin to trap sediments from the local catchment (Buckland Park development). Sediment loads have been estimated and used to assess the potential depth of sediment expected to accumulate within the ephemeral wetland pools over time.

Sediment loads from developing and established catchments can vary significantly depending upon a number of factors. According to the widely adopted text “Managing Urban Stormwater, Soils and Construction, Landcom NSW (2006), a developing catchment can be expected to discharge between 50 m^3/ha and 200 m^3/ha of sediment each year. In a developed catchment, the annual sediment export is generally one to two orders of magnitude lower with an expected mean annual rate of 1.60 m^3/ha. These rates are adopted as standard practice in NSW.

Therefore, it is acknowledged that these loading rates are based on the climatic conditions experienced along the east coast of Australia where higher rainfall intensity and annual totals vary considerably from local conditions in Buckland Park. It is envisaged that these rates would be lower for South Australian conditions.

For the purpose of this exercise, we have adopted a loading rate of 1.60 m^3/ha, while acknowledging that this rate is based on conditions experienced along the east coast of Australia and is therefore expected to provide a conservative estimate. The calculation of estimated potential sediment load and depth along the regional channels is outlined below.

Catchment area = 170 Ha

Sediment loading rate = 1.60 m^3/ha/a

Volume of sediment / annum = 270 m^3

Length of channel in Stages 1 to 12 = 5000 m

Annual depth of sediment accumulation (assuming uniform distribution) = 5 mm

Estimated depth accumulation in 5 years = 25 mm

These estimates are only intended to provide a guide only.

6.4 Revegetation Guide - Planting List

A study report prepared by EBS Ecology titled “Buckland Park Significant Environmental Benefit (SEB) 5 Revegetation Management Plan, September 2012” has been prepared to define the vegetation communities to be incorporated into the regional drainage network. The aim is to establish a functioning ecosystem while also meeting the requirements of the Native Vegetation Council to provide SEB offset areas associated with the residential development. The Development open space areas will be subsequently revegetated with a range of indigenous flora species that will contribute to improvement of biodiversity values in the regional landscape.

The revegetation of the regional channels and ephemeral pools are intended to provide a vegetation community of native vegetation that aims to restore pre-European ecosystems and biodiversity. The revegetation management plan sets out the vegetation communities for each zone associated with the regional channels. These zones generally correspond to the water regimes and aspect associated with the channels.

The following species lists in Table 9 to Table 12

Table 12 have been provided by EBS Ecology for each vegetation zone. These are intended to provide general information only.

Table 9: Revegetation Species Aquatic Zone

STRATUM	SPECIES NAME	COMMON NAME
Understorey <1m	*Bulboschoenus caldwellii*	Salt Club Rush
	Cyperus gymnocaulos	Spike rush
	Cyperus vaginatus	Stiff Flat-sedge
	Juncus kraussii	Sea Rush
	Juncus subsecundus	Finger Rush
	Muehlenbeckia florulenta	Lignum
	Phragmites australis	Common Reed

Revegetation within the aquatic zone has been designed to re-establish reed bed/sedgeland vegetation within the aquatic and riparian zones. These zones will become self-regulating over time based on seasonal variation.

Table 10: Revegetation Species for the Riparian Zone

STRATUM	SPECIES NAME	COMMON NAME
Understorey <1m	*Atriplex paludosa* ssp. *cordata*	Marsh Saltbush
	Atriplex semibaccata	Berry Saltbush
	Chenopodium pumilio	Small Crumbweed
	Disphyma crassifolium ssp. *clavellatum*	Round-leaf Pig-face
	Einadia nutans	Climbing Saltbush
	Enchylaena tomentosa var. tomentosa	Ruby Saltbush
	Maireana aphylla	Leafless Cotton-bush
	Maireana brevifolia	Short-leaf Bluebush
	Rhagodia candolleana	Sea-berry Saltbush
	Suaeda australis	Austral Sea-blight
	Threlkeldia diffusa	Coast Bone-fruit
	Vittadinia cuneata	Fuzzy New Holland Daisy

Riparian - is intended to provide a buffer of 1-2 m around the aquatic zone which will allow some self-transitioning of the vegetation dependent on seasonal flows and storm events. These will not significantly reduce flow rates of the drainage network. These shrubs will provide increased habitat values for small birds and reptiles while also outcompeting alien species which are expected to invade from storm water transport and upstream run-off flows.

Table 11: Revegetation Species List for Upper Slope Zone

STRATUM	SPECIES NAME	COMMON NAME
Understorey <1m	*Austrostipa scabra*	Spear Grass
	Themeda triandra	Kangaroo Grass
	Aristida behriana	Brush Wire grass
	Chloris truncata	Windmill Grass
	Rhytidosperma setacea	Wallaby Grass
	Rhytidosperma caespitosa	Wallaby Grass

Upper Slopes - include the banks from the riparian zone to the top of the bank.

Table 12: Revegetation Species for Buffer Zone

STRATUM	SPECIES NAME	COMMON NAME
Overstorey	*E. camaldulensis* var. *camaldulensis*	River Red Gum
Small trees / large shrubs >1m	*Acacia pycnantha*	Golden Wattle
	Pittosporum angustifolium	Native Apricot
	Callitris gracilis	Southern Cypress Pine
	Dodonaea viscosa ssp. *spatulata*	Sticky Hop-bush
Understorey <1m	*Aristida behriana*	Brush Wire-grass
	Atriplex semibaccata	Berry Saltbush
	Rhytidosperma setacea	Small-flower Wallaby-grass
	Chloris truncata	Windmill Grass
	Convolvulus remotus	Grassy Bindweed
	Dianella brevifolia	Black-anther Flax-lily
	Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush
	Maireana brevifolia	Short-leaf Bluebush
	Rhagodia parabolica	Mealy Saltbush
	Themeda triandra	Kangaroo Grass

Buffers- will serve important ecological functions in the drainage network. Primarily, it will act as an amenity for the drains with this section providing a break in the flat landscape and greening the site significantly. It will also serve as a buffer for weed invasion with the natural mulched surface being readily maintainable for weed management.

7 CLIMATE CHANGE

The CSIRO report titled "Climate Change in South Australia" is one of a number of publications that considers change to rainfall patterns. It presents a view that the average rainfall is likely to reduce but intensities of individual storms increase only marginally. These effects have been considered in the planning and design phases of the development.

The effect of climate change will have two potential impacts on the SMP, as follows:

- Sea level rise will influence the water levels in the regional flood conveyance channels and accordingly the hydraulic design for new infrastructure. The design has taken this into account by adopting higher ‘tail’ water conditions at the coastal outfall as adopted in the Gawler River Floodplain Mapping Study undertaken by Australian Water Environments.
- Rainfall (temporal) pattern variations will impact on regional hydrology and consequently stormwater harvesting. However, it was noted that the rainfall intensities are not expected to increase significantly, whereas the frequency of large events may do so.
- General allowance for a rise in groundwater levels as Sea level rises.

8 IMPLEMENTING THE STRATEGY

8.1 Priorities and Timeframes

The staging of the works will depend on the timing of land releases into the future. It is anticipated that the overall development will have a completion timeframe in the order of 20 to 30 years.

The key priorities for Precinct 1 and Precinct 2, are based on achieving the key objectives outlined in Section 4 of this report. In this regard these are:

- Flood protection from local catchment and regional catchment (Gawler River). The release of stormwater to pre-development flow rates to the Thompson Creek outfall channel.
- Water Quality management from the current land release to meet the required standards defined in Section 6.
- Environmental Protection and Enhancement by using a multi-objective approach to stormwater management such that it contributes to the delivery of this objective.

The scope outlined in this report sets out to deliver these priorities. It is intended that all subsequent land releases will set to deliver the same objectives.

Assuming that the timing of future land releases is not a limiting factor, we would anticipate the following key stormwater infrastructure elements could be implemented within the sequence and timeframes as outlined below:

- Year 2024/2025
  - Open Channel network and 75,000m3 basin to protect Precincts 1 and 2 are implemented.
- Years 2025 to 2035 – Extensions to the network of regional flood conveyance channels with integrated online treatment systems and development of the salt water lake network.
- Year 2035 – Detention basin and wetland downstream of Buckland Park at connection with Thomson Creek outfall channel. Further modelling work is required to determine the likely timing for this basin which will largely depend on the rate of development.

These works are discussed in more detail in Sections 8.2 and 8.3.

8.2 Interim Works

The interim works relate to permanent stormwater infrastructure elements that will be constructed as part of Precinct 2. These works include:

- Stormwater drainage infrastructure associated with the road network to collect and convey runoff to the regional channel at two outlet points.
- Regional drainage channels required to protect Precinct 1 and 2 which include some temporary channel sections. Refer to Appendix G.
- When Salt Water Lake 1 is constructed a new 750mm outlet pipe will need to be constructed as the outfall from the lake. The pipe will serve two purposes, one to provide circulation to the salt water lakes, and secondly to provide an outfall for stormwater discharging to the lake.
- Stormwater treatment systems integrated into channels as discussed in Section 6 of this report.

8.3 Future Works

Ultimately the full extent of regional channels and the future salt water lakes proposed will provide flood protection to all subsequent developed stages of Buckland Park. Further studies will be required to determine the staging of future drainage requirements and their timing.

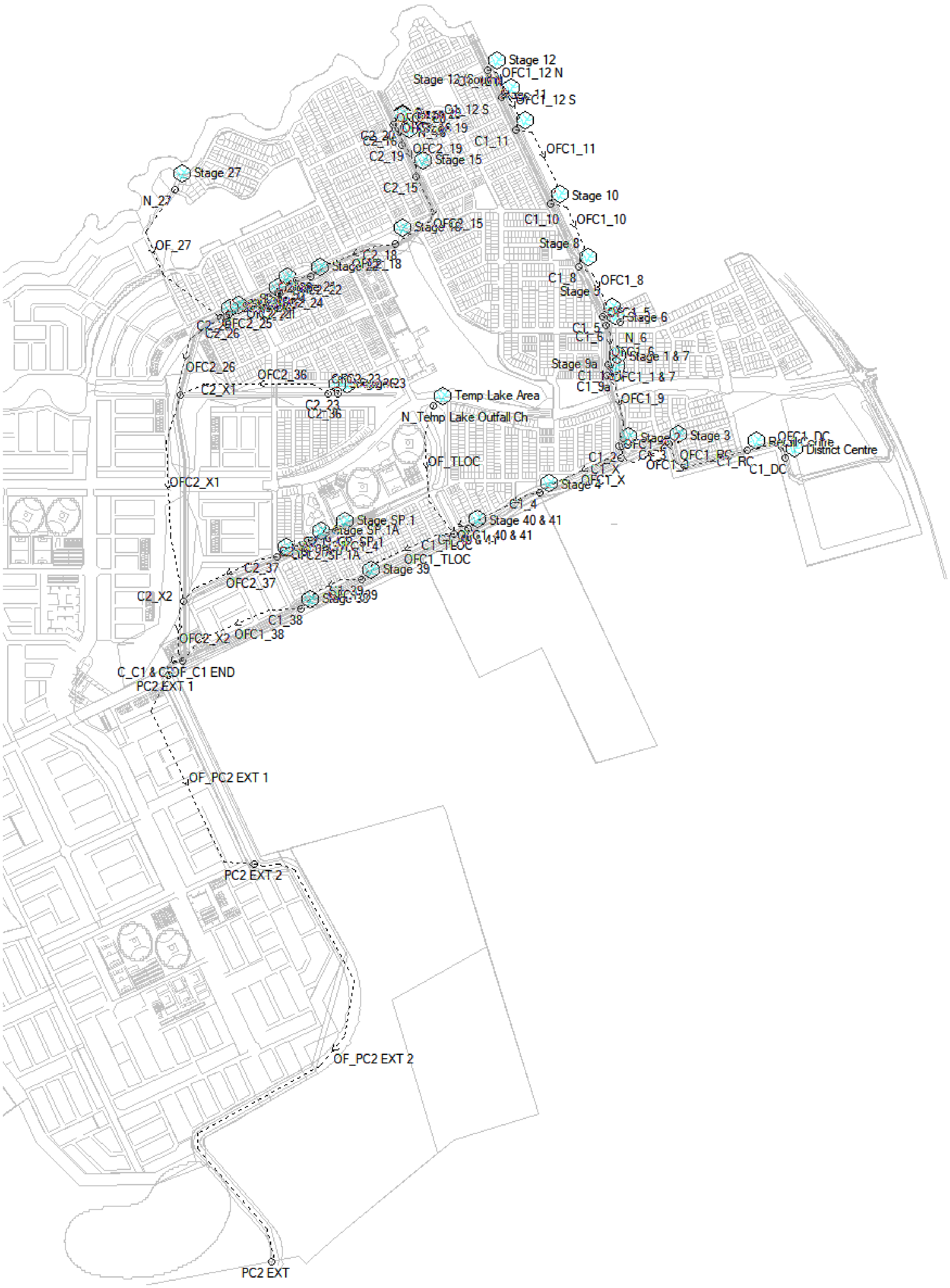
APPENDIX A
CATCHMENT PLAN


STAGE 12 (N)
4.33 ha
STAGE 16
8.78 ha
STAGE 20
8.94 ha
STAGE 12 (S)
3.75 ha
STAGE 27
9.19 ha
STAGE 19
9.97 ha
STAGE 15
6.69 ha
STAGE 11
7.32 ha
STAGE 18
10.02 ha
STAGE 14B
8.17 ha
STAGE 10
6.97 ha
STAGE 21
8.35 ha
STAGE 8
6.25 ha
STAGE 26
8.19 ha
STAGE 17
4.04 ha
STAGE 14A
5.02 ha
STAGE 22
7.4 ha
STAGE 5
6.77 ha
STAGE 7
23.09 ha
Temporary Lake Area
45.07 ha
STAGE 25
7.82 ha
STAGE 24
5.68 ha
STAGE 23
6.59 ha
NC.1
3.11 ha
STAGE 9B
3.83 ha
STAGE 1
15.16 ha
STAGE 9A
8.01 ha
STAGE 2
7.1 ha
RETAIL CENTRE
4.22 ha
STAGE 36
11.69 ha
STAGE 4
10.61 ha
STAGE 3
3.75 ha
STAGE 40 & 41
16.61 ha
SP.1
15.88 ha
DISTRICT CENTRE
28.74 ha
SP.1A
2.59 ha
STAGE 37
3.86 ha
STAGE 39
8.24 ha
STAGE 38
6.63 ha

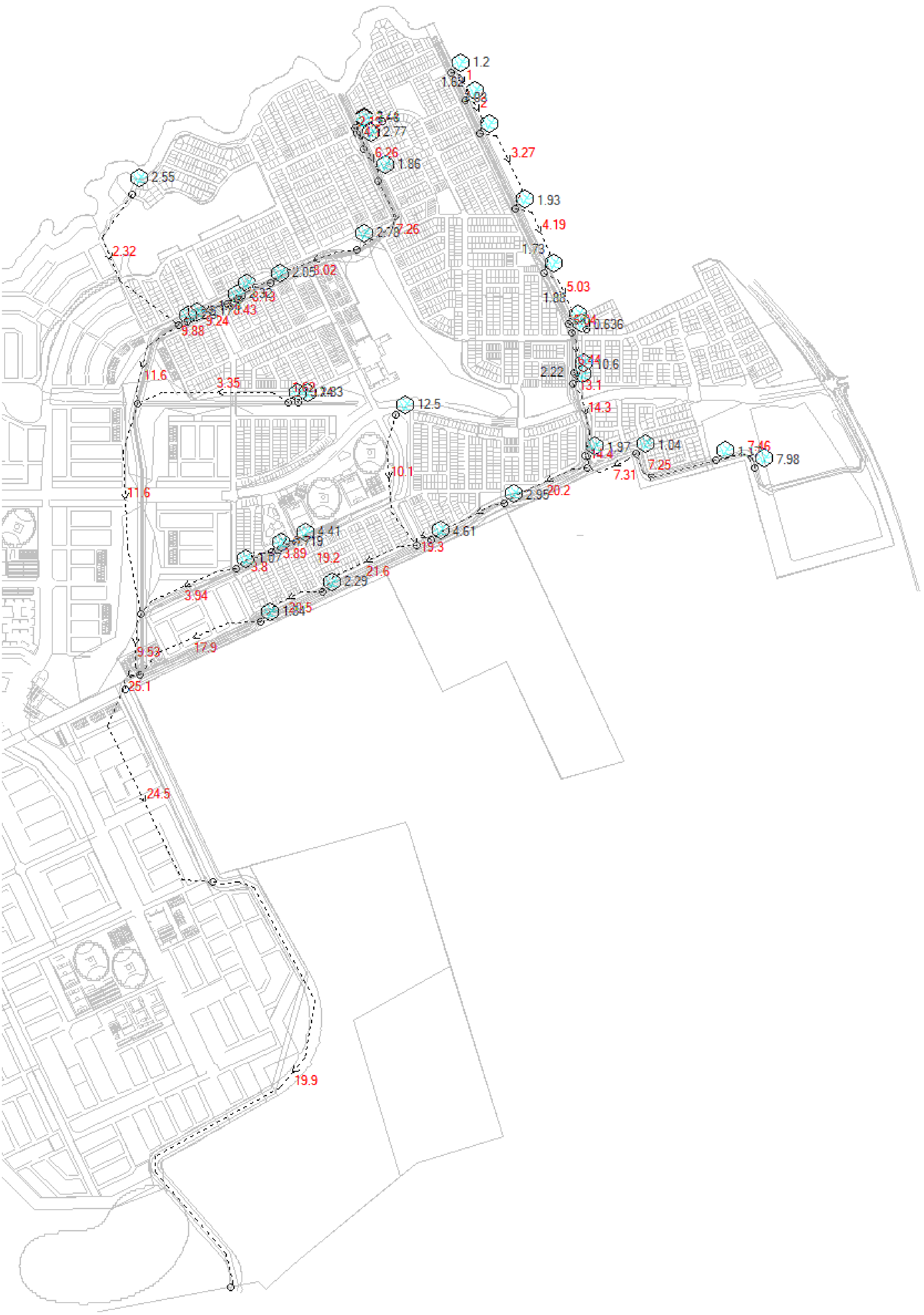
APPENDIX B
TUFLOW & DRAINS RESULTS

INTERIM CHANNEL DESIGN - DRAINS RESULTS

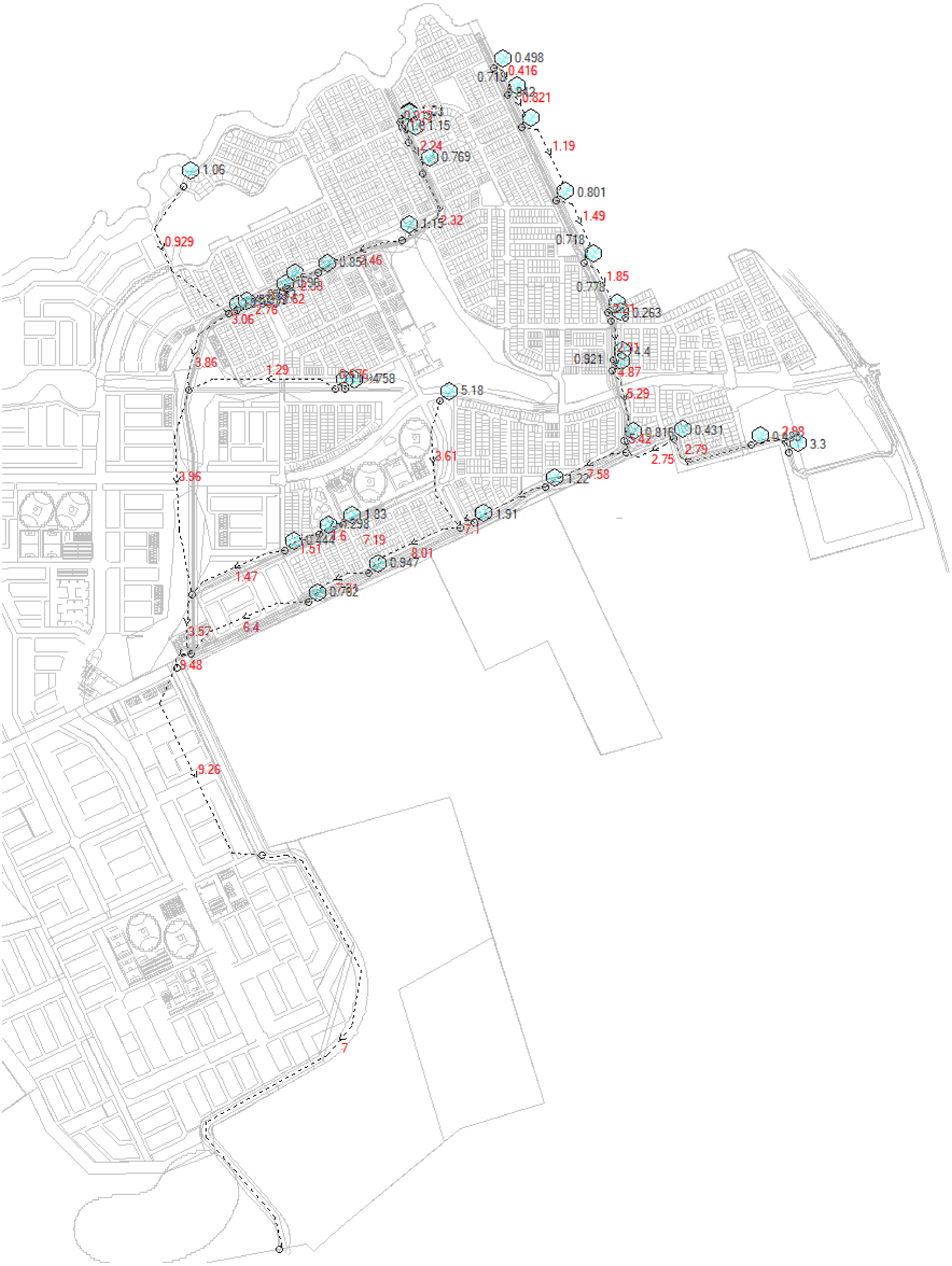
DRAINS MODEL OVERALL LAYOUT - INTERIM CHANNEL DESIGN



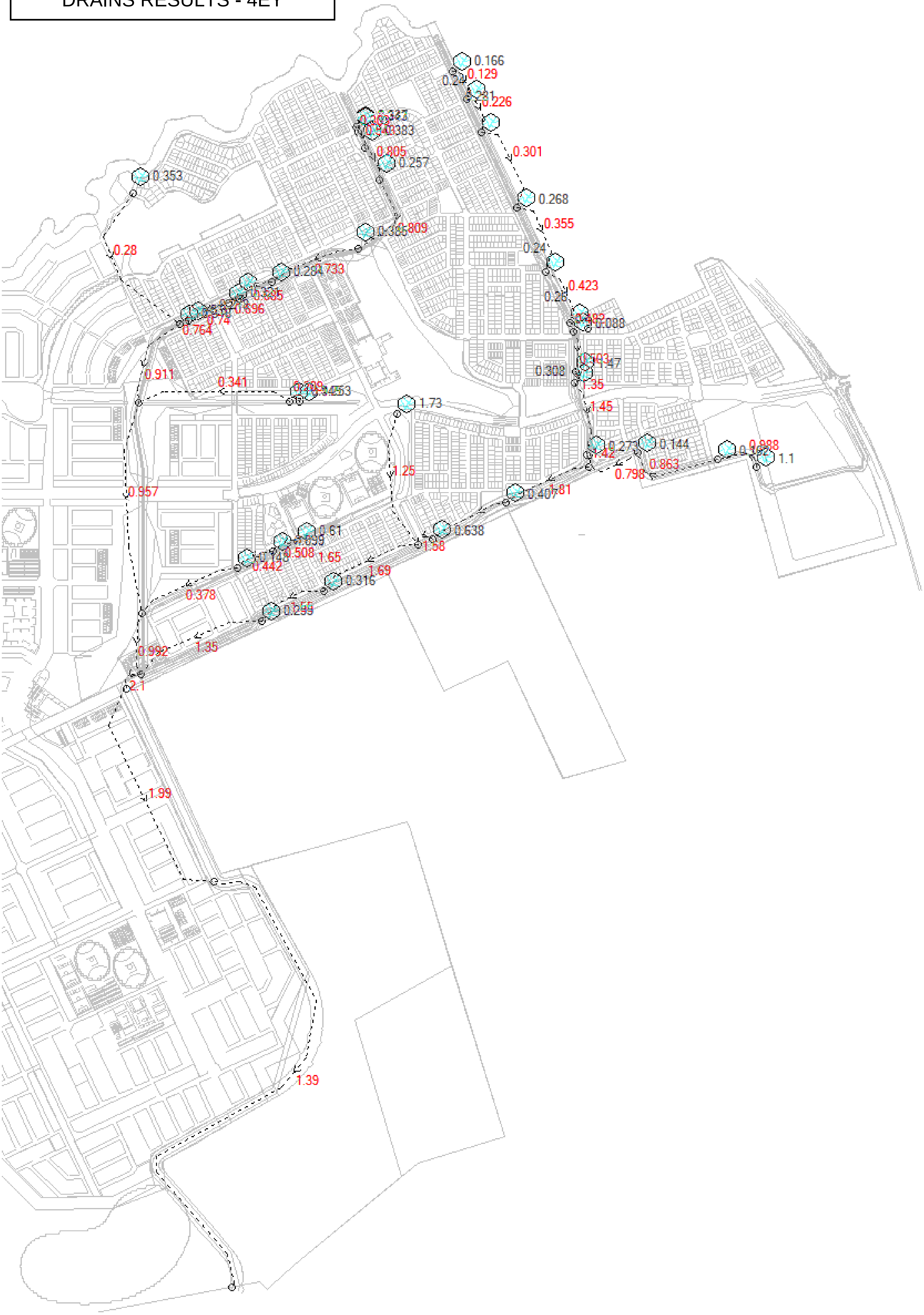
DRAINS RESULTS - 1% AEP



DRAINS RESULTS - 20% AEP

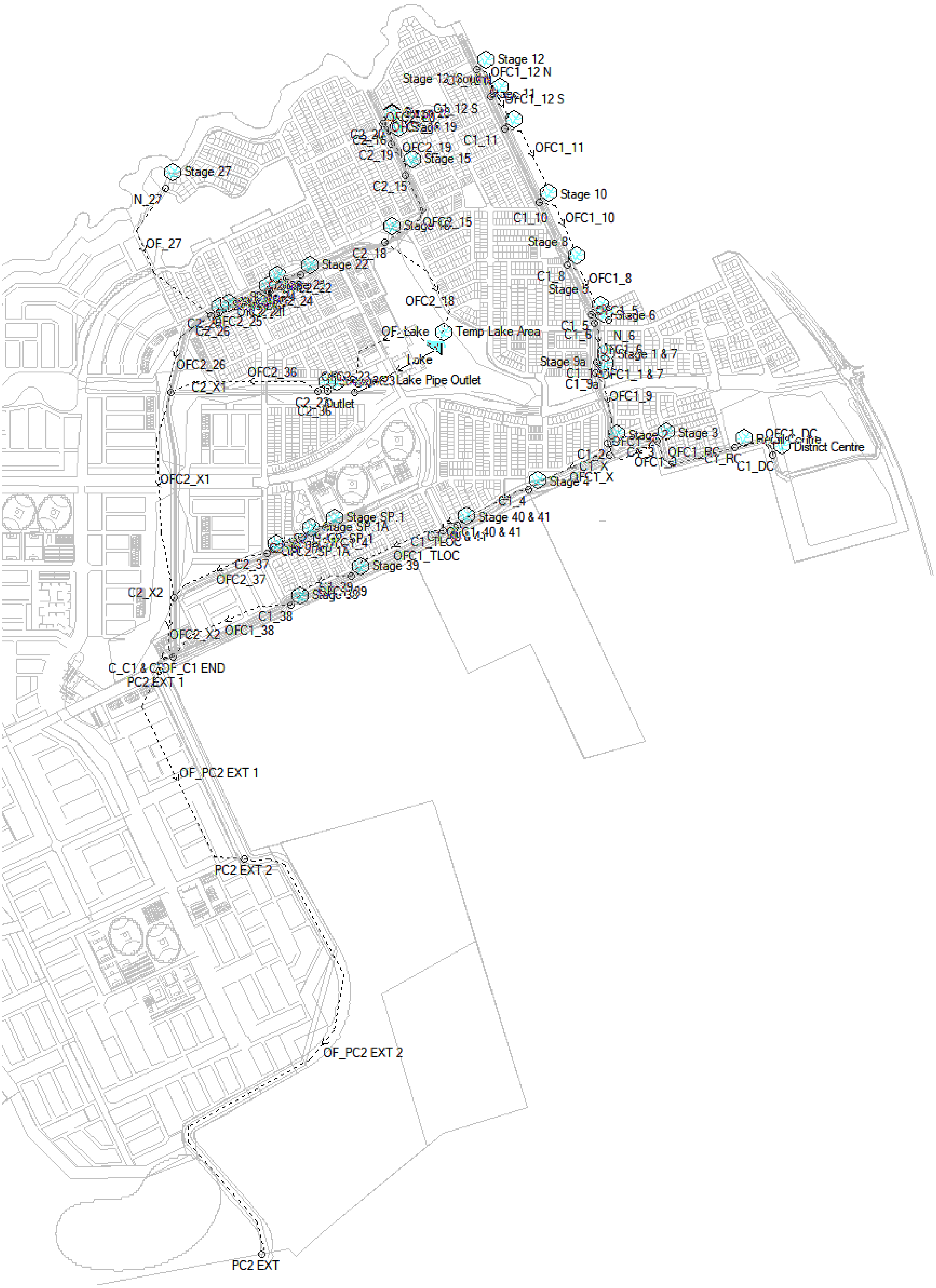


DRAINS RESULTS - 4EY

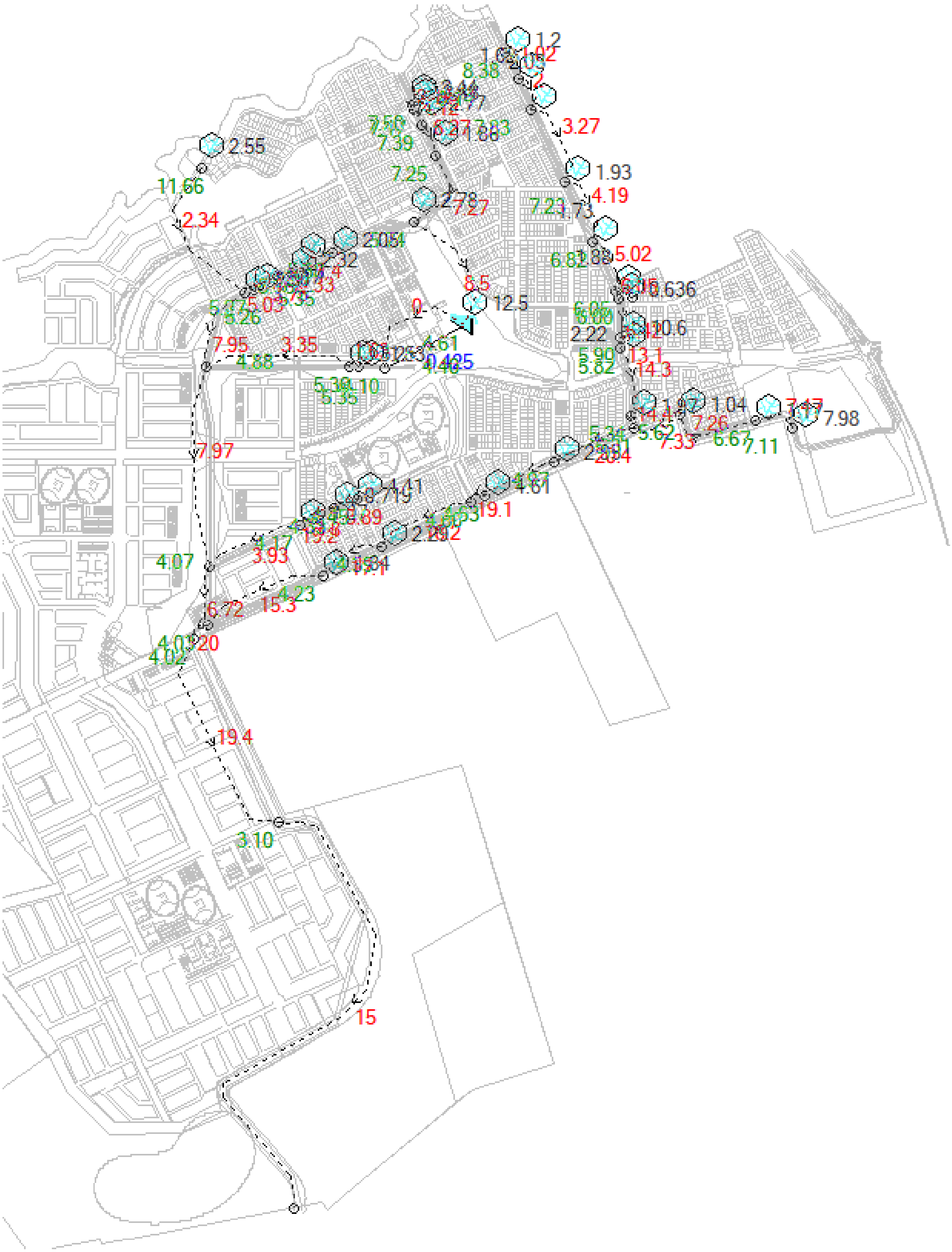


INTERIM CHANNEL DESIGN LAKE DISCHARGE OPTION - DRAINS RESULTS

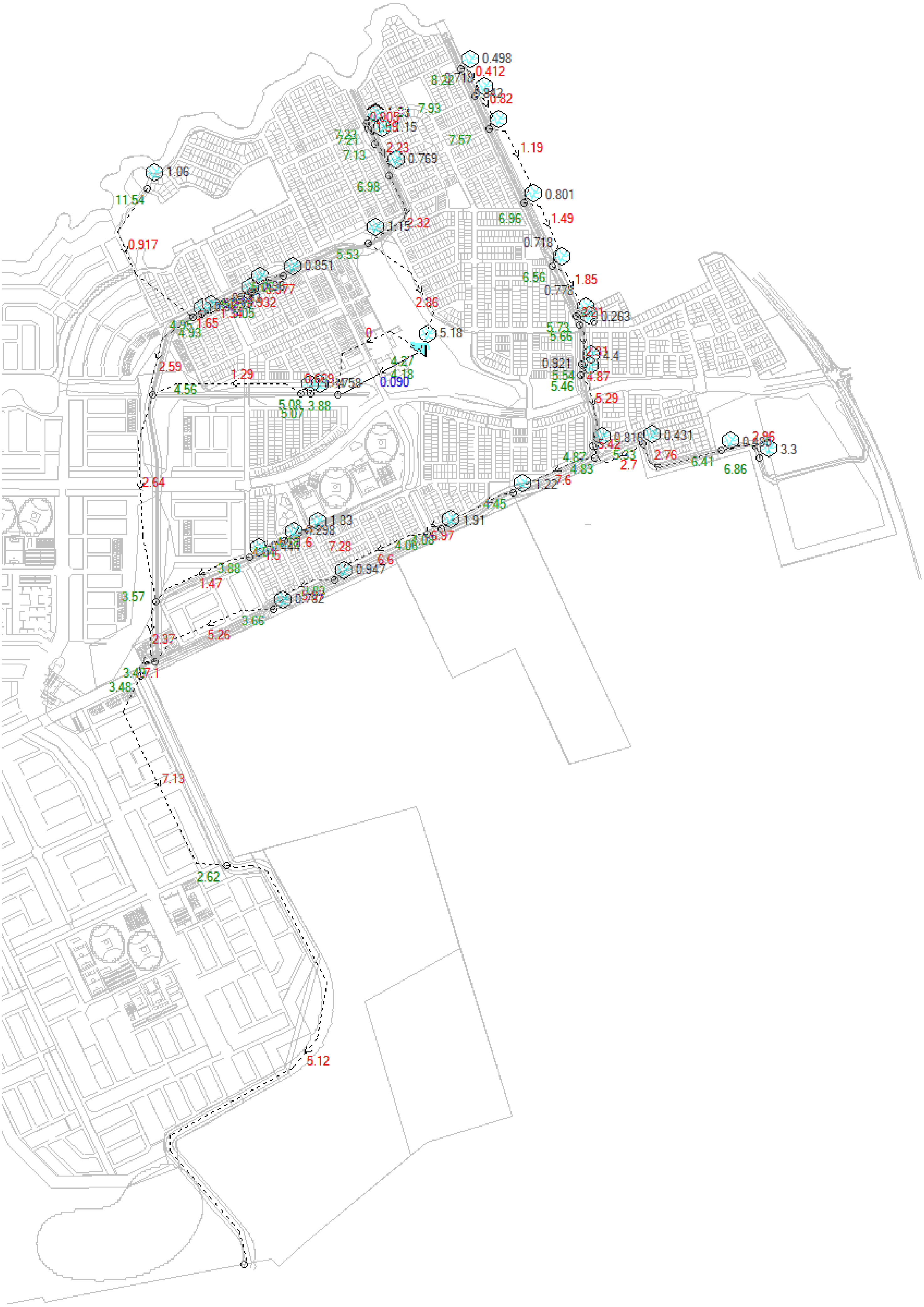
DRAINS MODEL OVERALL LAYOUT - INTERIM ARRANGEMENT WITH LAKE DISCHARGE



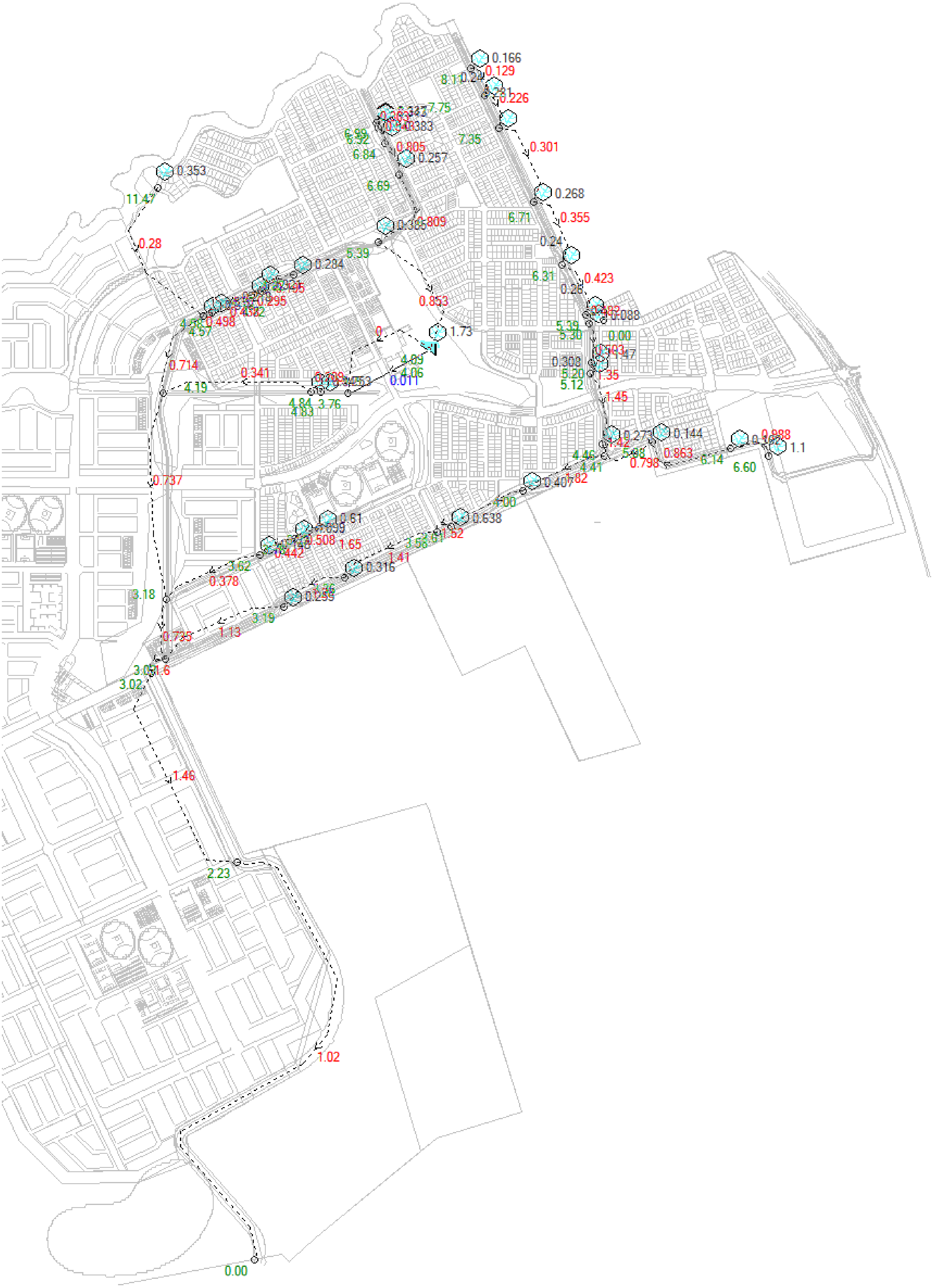
DRAINS RESULTS - 1% AEP

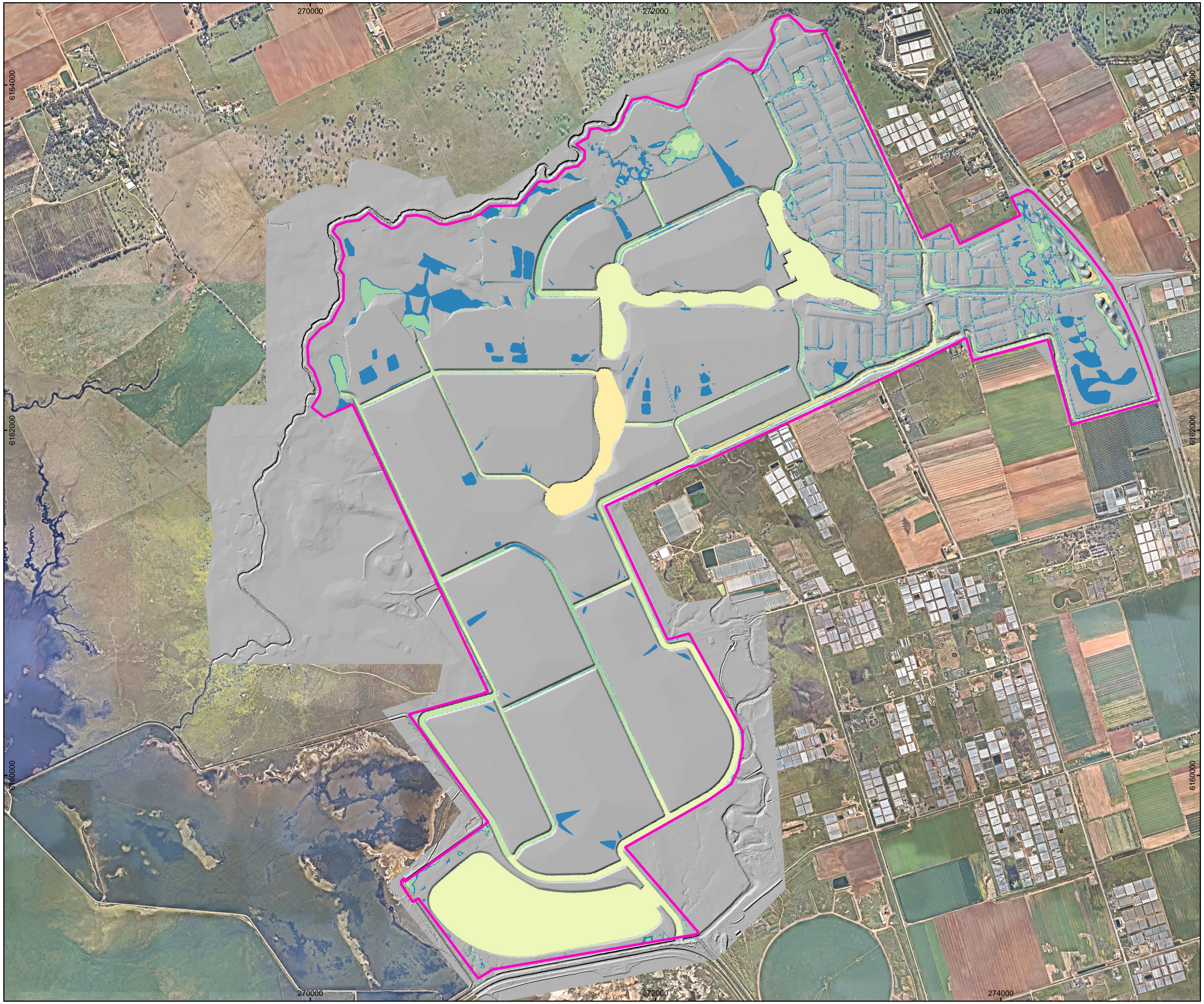


DRAINS RESULTS - 20% AEP



DRAINS RESULTS - 4EY





LEGEND

Hydraulic Model Boundary

Peak Flood Depth (m)

- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- > 2.00

200 0 200 400 600 800 m

Scale 1:21,000 on A3

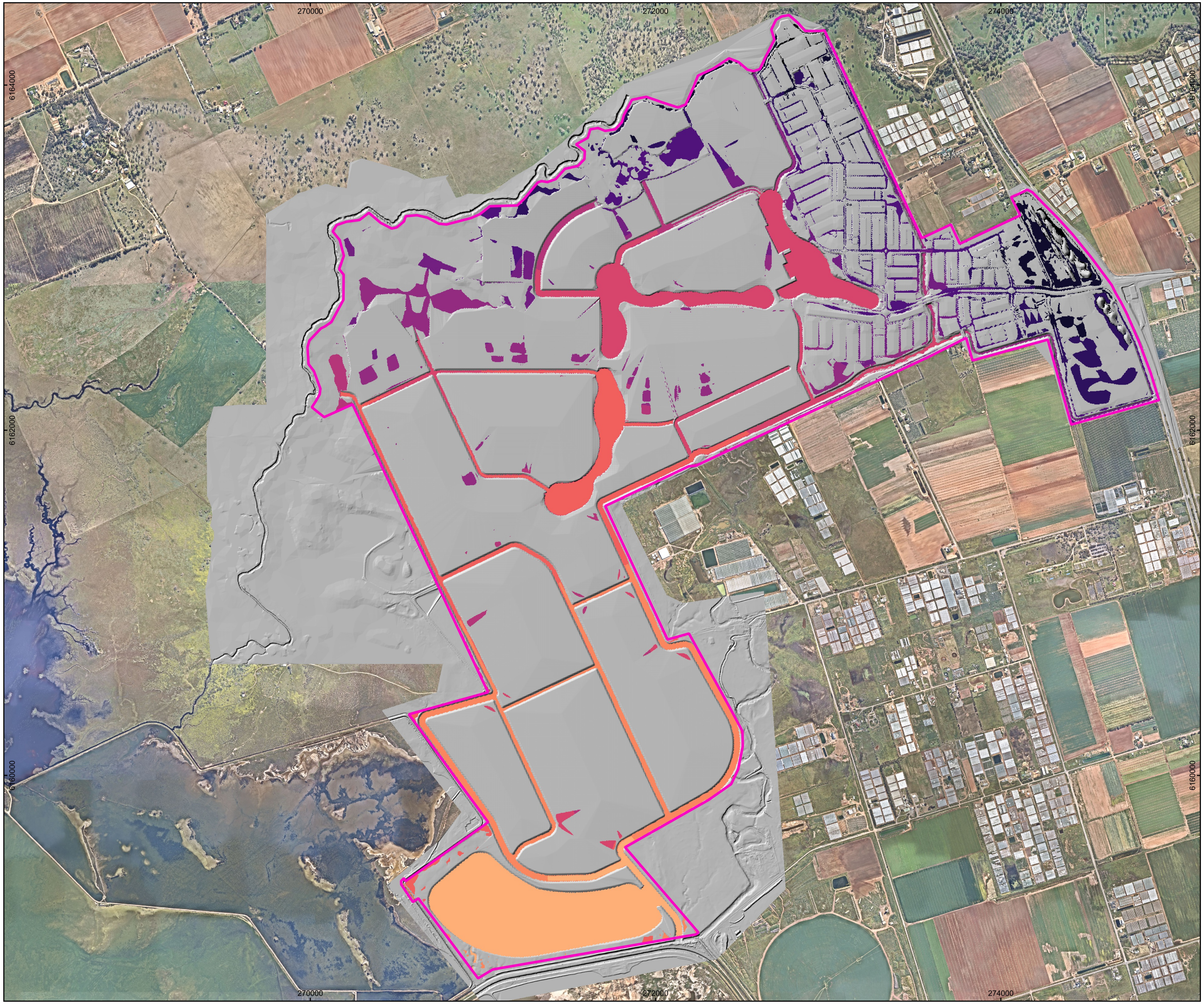
Coordinate System: GDA 1994 MGA Zone 54

WGA

Map 01

Riverlea Development

Peak Flood Depth
1% AEP



LEGEND

Hydraulic Model Boundary

Peak Flood Height (mAHD)

- <= 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 9.0
- 9.0 - 10.0
- 10.0 - 11.0
- > 11.0

200 0 200 400 600 800 m

Scale 1:21,000 on A3

Coordinate System: GDA 1994 MGA Zone 54

WGA

Map 02

Riverlea Development

Peak Flood Height
1% AEP

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

APPENDIX C
GAWLER RIVER FLOODING

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

MEMORANDUM

To	Brent Eddy
From	Alison Miller
Date	31 October 2022
Subject	Modelling of Riverlea development in the broader Gawler River floodplain model

Riverlea is a proposed housing development at Buckland Park, currently under development by Walker Corporation. Water Technology have been engaged at various stages of the project to provide advice on riverine flood impacts at the development site and adjacent properties.

This memo documents the hydraulic modelling undertaken to assess the performance of the proposed division of floodwaters from the Gawler River along the western side of the development. Modelling was undertaken in the broader Gawler River floodplain model, versions of which are currently being used in the development of the Gawler Stormwater Management Plan and for the Enhanced Flood Hazard Mapping project.

MODEL DETAILS

The existing conditions model, currently being developed for the Enhanced Flood Hazard Mapping project, was adopted as the base case for assessment of the Riverlea development. The model is a coupled MikeFlood model, with the river and floodplain represented in 2D (Mike21), linked to 1D representation of culverts (Mike11).

Topography

The model adopts a flexible mesh representation, which allows higher resolution detail to be incorporated in the model where required (e.g. along the river) without dramatically increasing run times. The model adopts elevations from the two recently captured LiDAR datasets:

- Middle Beach 50cm LiDAR, captured 26 November 2021
- Adelaide Metro LiDAR, captured 21-31 January 2022.

The two datasets overlap along the alignment of the Gawler River. Where this has occurred, the 2022 data has been used in preference.

Note that the only difference between the model adopted for this assessment, and that in development for the Gawler SMP, is the underlying topography. The Gawler SMP model adopts the 2021 LiDAR, but the topography on the south-eastern side of the river alignment is based on a series of earlier topographic datasets.

The model incorporates 344 dike structures, which have been used to control the level at which water can move across various areas. Typically, these are representative of levees, however dikes have also been used to incorporate other key features such as road crests, where the element vertex sampling may have missed this detail. Crest elevations for each dike have been sampled from the 2021 or 2022 LiDAR.

Inflow/outflow boundaries

Inflow boundaries to the model were retained, and include:

- A hydrograph input for the South Para River at South East of Gawler
- A hydrograph input for the North Para River downstream of Turretfield.

Note that the hydrology inputs were derived from the XP-RAFTS hydrology model which incorporates the Bruce Eastick Dam and the upgraded South Para Dam. Hydrographs to the model were extracted at the spatial location of the hydraulic model. This is downstream of the South Para Dam (hence the flood mitigation is incorporated in the hydrology) and upstream of the Bruce Eastick Dam (flood mitigation here is incorporated in the hydraulic model).

A sea level of 1.5 mAHD (equivalent to the Highest Astronomical Tide) was applied as a downstream boundary along the western and (partial) southern model edges. This has been retained form the original study in 2008 which assessed tidal data for Port Adelaide and Outer Harbour.

A second 'free outflow' boundary has been incorporated on the southern edge of the model further upstream, on the western side of the Northern Expressway. This was to prevent breakouts from the Gawler River from artificially ponding at the model edge. In reality, this water is anticipated to flow initially south-west and then further west to meet other breakout flows from the Gawler River near Port Wakefield Road.

Infrastructure

All major bridges and culverts, of which there are 89, have been incorporated in the 1D domain. These were adopted from the previous Light River and Smith Creek models. Where these relate to drainage infrastructure for the Northern Expressway, these have been validated against details in the DRAINS model provided by City of Playford.

Where the mesh resolution was coarser than the width of the culvert/bridge outlet, the elevation of the linking cell has generally required altering to represent the invert.

Updates for the current assessment

The underlying mesh was refined across the area of the Riverlea site, to ensure sufficient resolution to capture the proposed development layout of swales. As a result of changes to the mesh, existing conditions have also been updated to ensure the same representation of detail.

The proposed development conditions have been represented by sampling a digital elevation model of the proposed conditions, created from the design drawing provided by Walker Corporation 'Riverlea_Existing+Sitewide EW_05092022.dwg'.

Further details of the model schematisation will be made available through the Enhanced Flood Hazard Mapping project report for the Gawler River.

Note that the model is currently undergoing validation, and further refinements will be made. This will include re-enforcement of the bank levels on the eastern side of the Gawler River near Windermere. The model version adopted here, is appropriate for comparing like-for-like but may not necessarily be representative of actual flood levels, depending on the outcome of the validation process.

SCENARIOS

Scenarios analysed for this assessment include:

- Current conditions (referred to as 'existing').
- Future development conditions.

The digital elevation model for the proposed developed conditions can be seen in Figure 1. The proposed design includes a concept for diverting breakouts from the Gawler River into a zone along the northern edge of the development, conveying floodwaters along the north and western borders to a discharge point at the south-western corner.

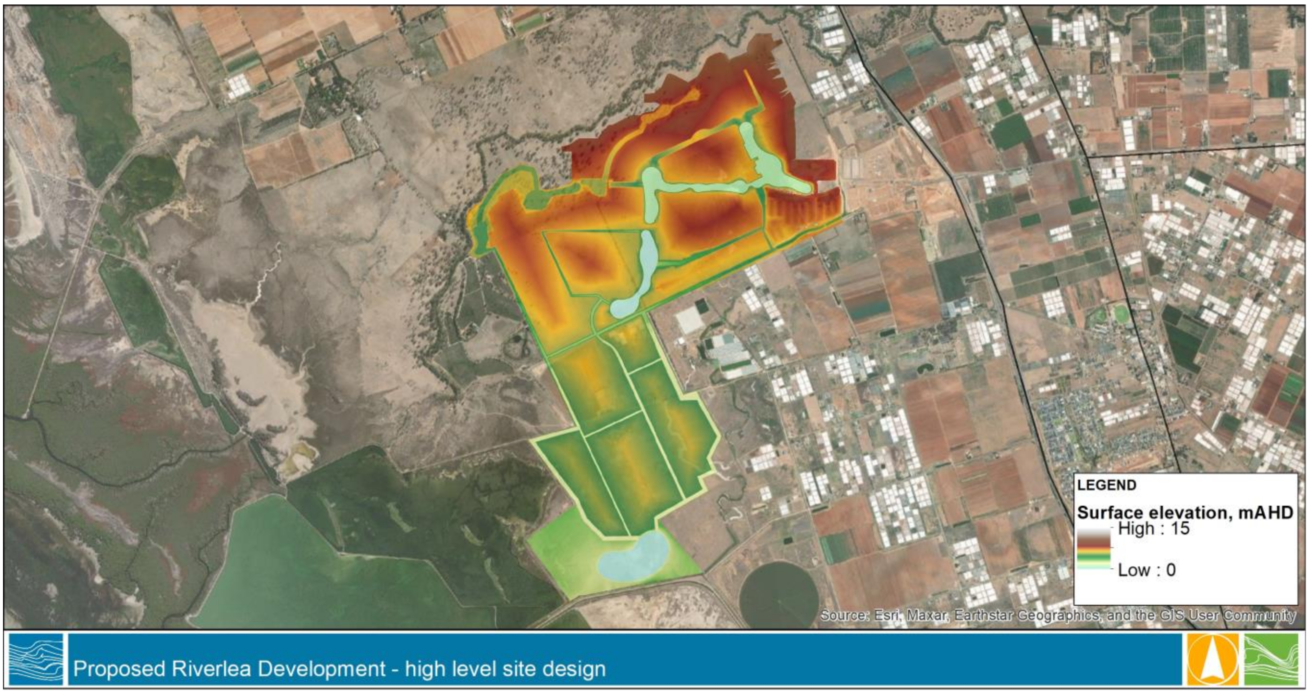


Figure 1 Proposed development surface elevations

RESULTS

The resulting flood depth for the 1% AEP flood event in the Gawler River for the current and future development scenarios is provided in Attachment 1 and 2. The scheme to divert breakouts to the south-western corner works as intended, however it demonstrates that the floodwaters are diverted from the location further west than intended.

The developed conditions (Attachment 2) show an extensive area of flooding surrounding the most southern basin, near the existing salt pans. While the majority of this area is inundated in existing conditions, refinement to the outflow path may need to be considered.

Differences in 1% AEP flood levels between the two scenarios is shown in Figure 2 (and Attachment 3). The results indicate reduced flooding along the western portion of the development (i.e. 'was wet now dry'), and reduced flood levels further west and south of the site.

Note that the existing conditions 1% AEP flood extent differs slightly to that provided previously. Output from the previously adopted TUFLOW site specific model indicated floodwaters breakout out near the intersection with Port Wakefield Road to south of the Gawler River, inundating the existing greenhouses and extending south-west across the Riverlea site. This breakout flow is not observed in the updated modelling adopted here as the bank heights have been more accurately represented through the adoption of recently captured 2022 LiDAR.

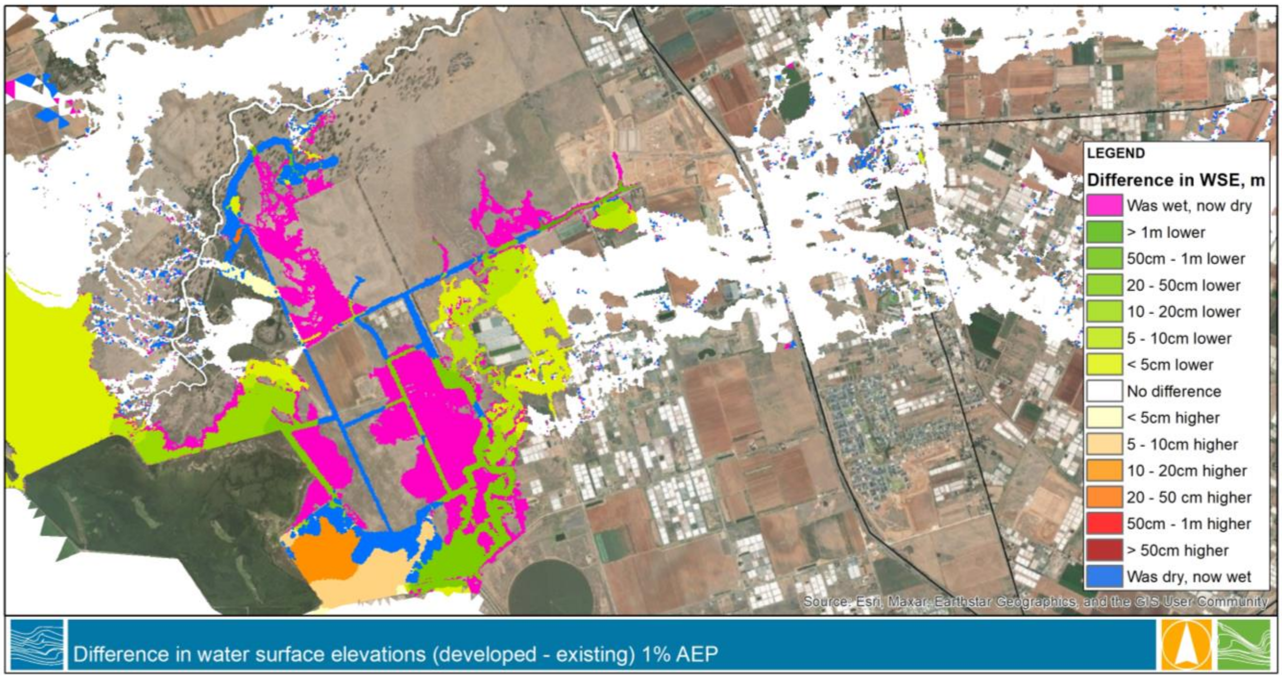


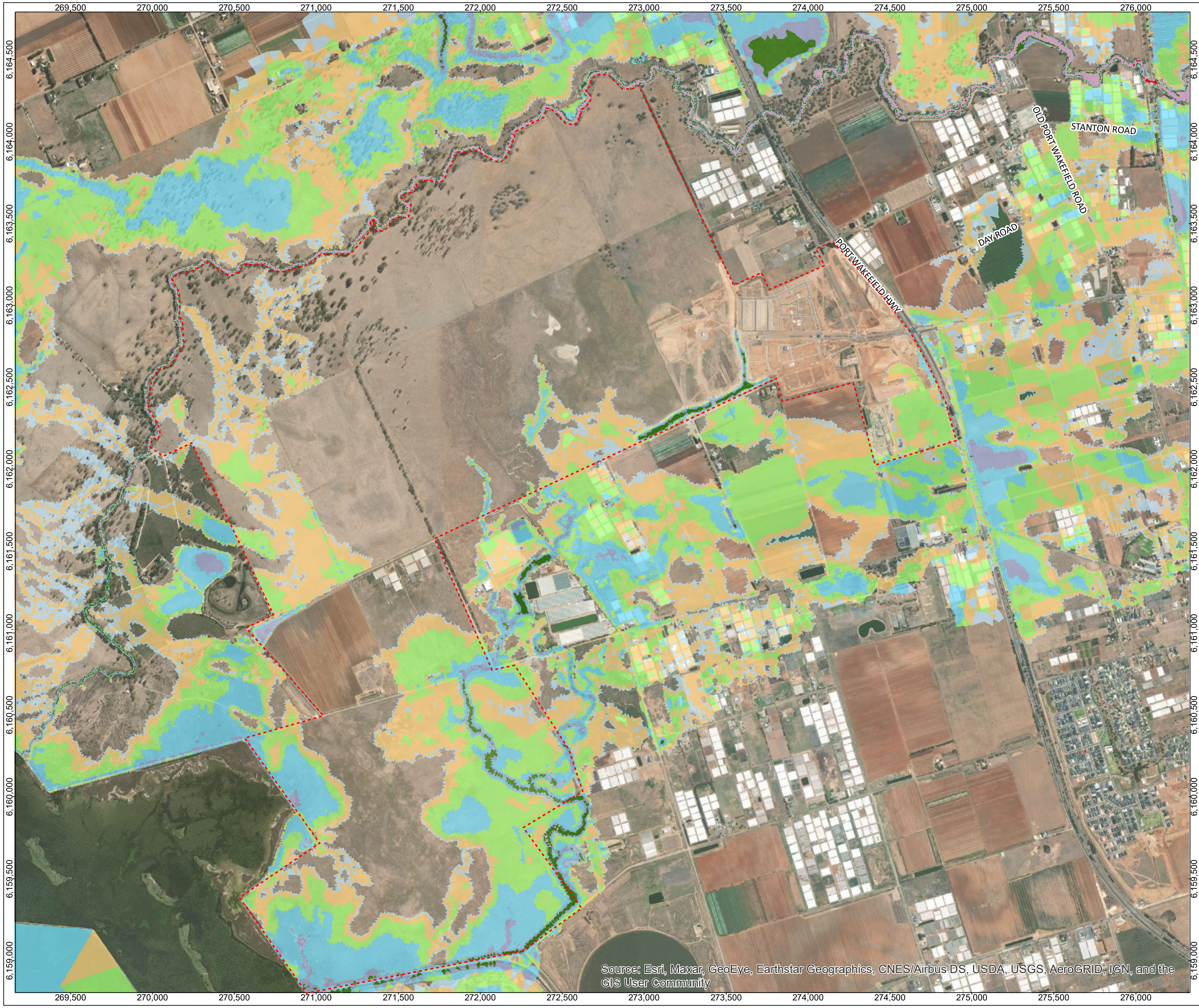
Figure 2 **1% AEP flood depth for current development conditions across site**

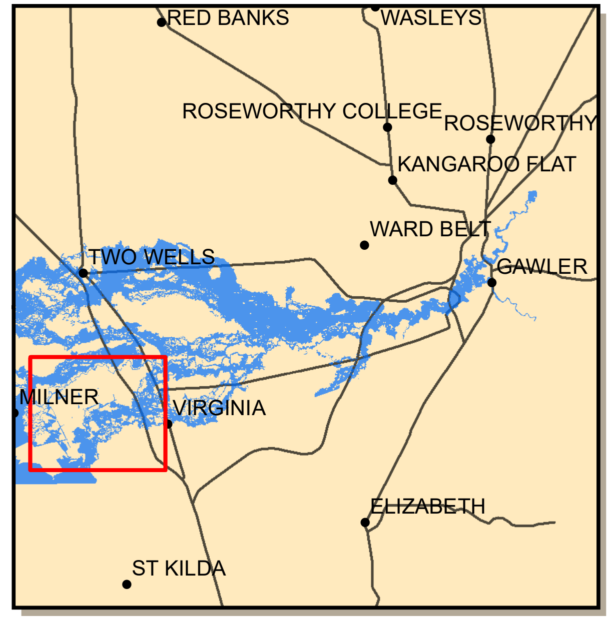
Enclosed:

Attachment 1 – 1% AEP flood depth, existing conditions

Attachment 2 – 1% AEP flood depth, proposed development conditions

Attachment 3 – 1% AEP difference in water surface elevation (developed minus existing)





Legend

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

NOTE
Water Technology Pty. Ltd. has prepared this document in accordance with instruction of Walker Corp for their specific use.

Contains PLB Images, https://maps.sa.gov.au/SAPPA/

N S E W

0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

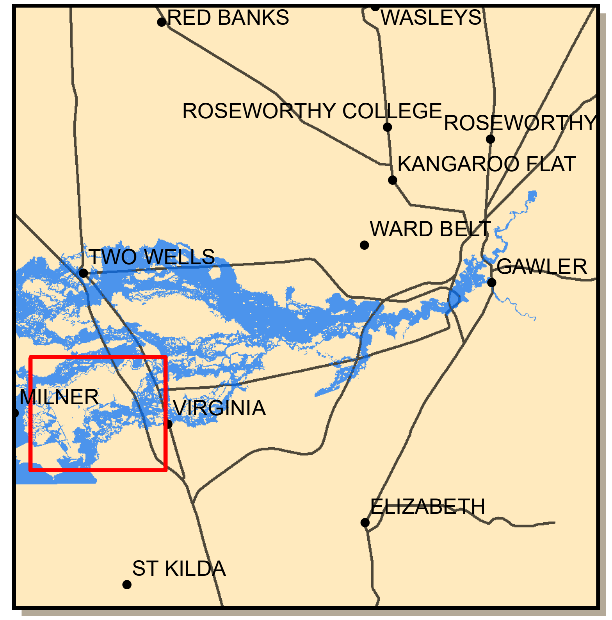
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Existing Conditions 1% AEP Depth

Riverlea Development Site

REFERENCE: A3L_wInset_Riverlea_Ex_1AEP_DEPTH

DATE: 28/10/2022 | SHEET: 1 of 1 | DRAWING NUMBER: 1



Legend

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

N W E S

0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

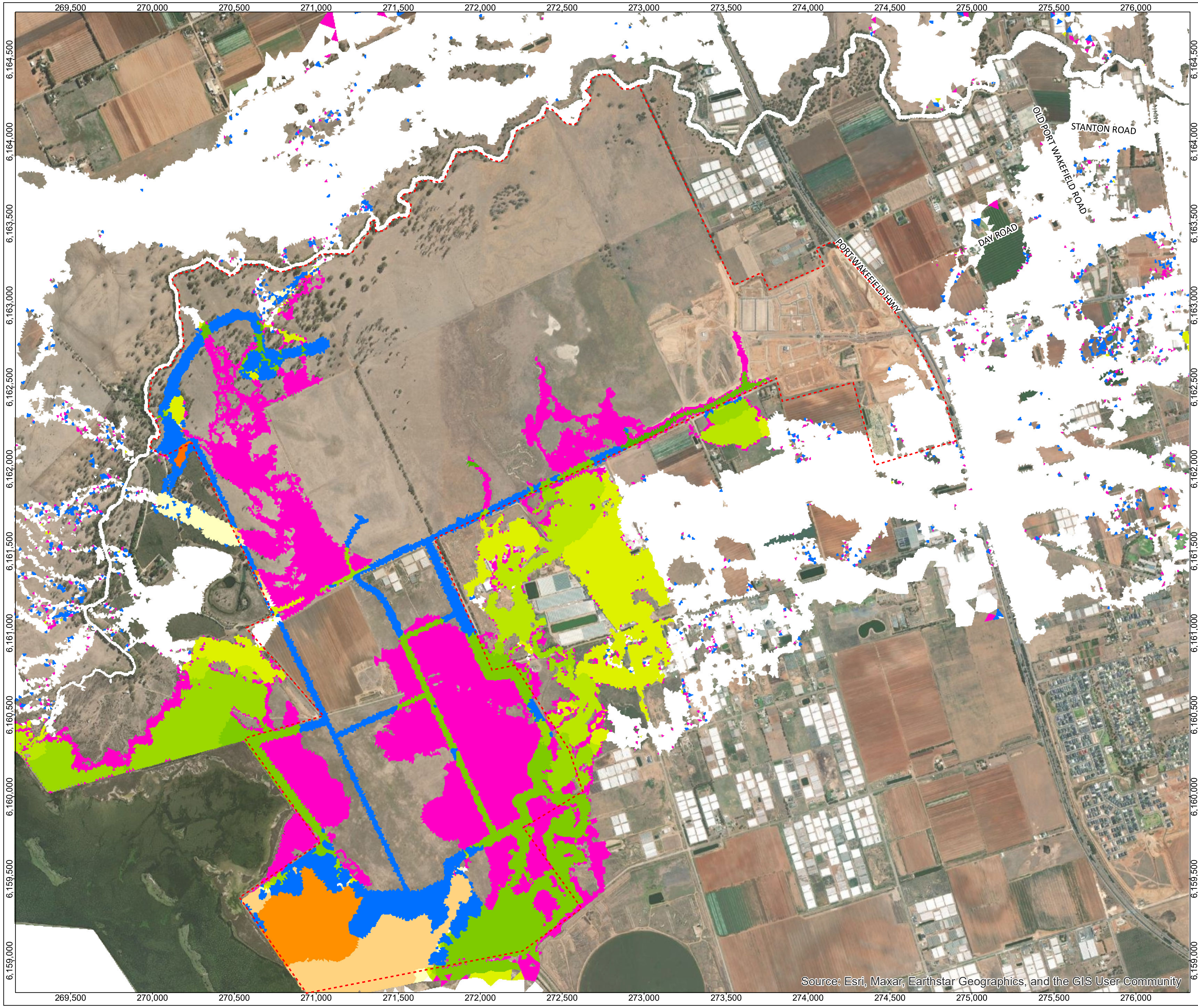
Developed Conditions 1% AEP Depth
Riverlea Development Site

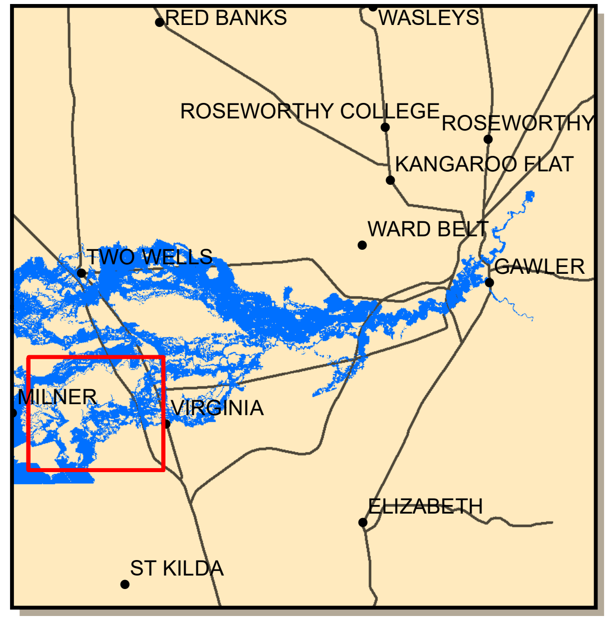
REFERENCE: A3L_wInset_Riverlea_Dev_1AEP_DEPTH_v3

DATE: 28/10/2022 | SHEET: 1 of 1 | DRAWING NUMBER: 1

Difference in flood levels (Dev-Ex) 1% AEP Depth

Riverlea Development Site





LEGEND

Difference in WSE, m

- Was wet, now dry
- > 1m lower
- 50cm - 1m lower
- 20 - 50cm lower
- 10 - 20cm lower
- 5 - 10cm lower
- < 5cm lower
- No difference
- < 5cm higher
- 5 - 10cm higher
- 10 - 20cm higher
- 20 - 50 cm higher
- 50cm - 1m higher
- > 50cm higher
- Was dry, now wet

NOTE
Water Technology Pty. Ltd. has prepared this document in accordance with instruction of Walker Corp for their specific use.

Contains PLB Images, https://maps.sa.gov.au/SAPPA/

0 250 500 1,000 Meters

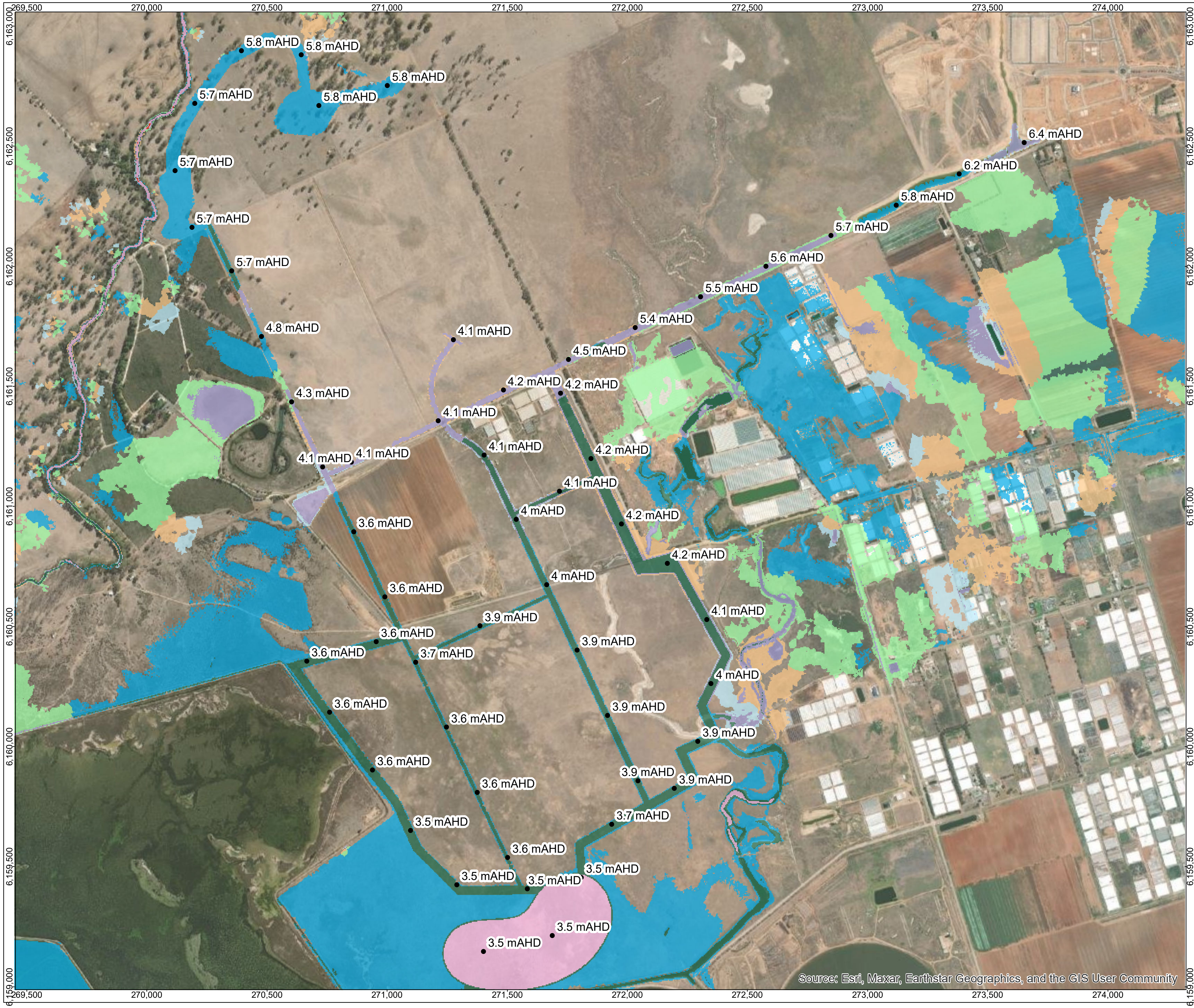
Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

REFERENCE: A3L_wInset_Riverlea_Dev-Ex_1AEP_DIFF_v2

DATE: 31/10/2022 | SHEET: 1 of 1 | DRAWING NUMBER: 1



Legend

- • Water surface elevation at point

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

NOTE
Water Technology Pty. Ltd. has prepared this document in accordance with instruction of Walker Corp for their specific use.

DISCLAIMER
Walker Corp and Water Technology Pty. Ltd. does not warrant that this document is definitive nor free from error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

Contains PLB Images, https://maps.sa.gov.au/SAPPA/

N W E S

0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:17,000at A3

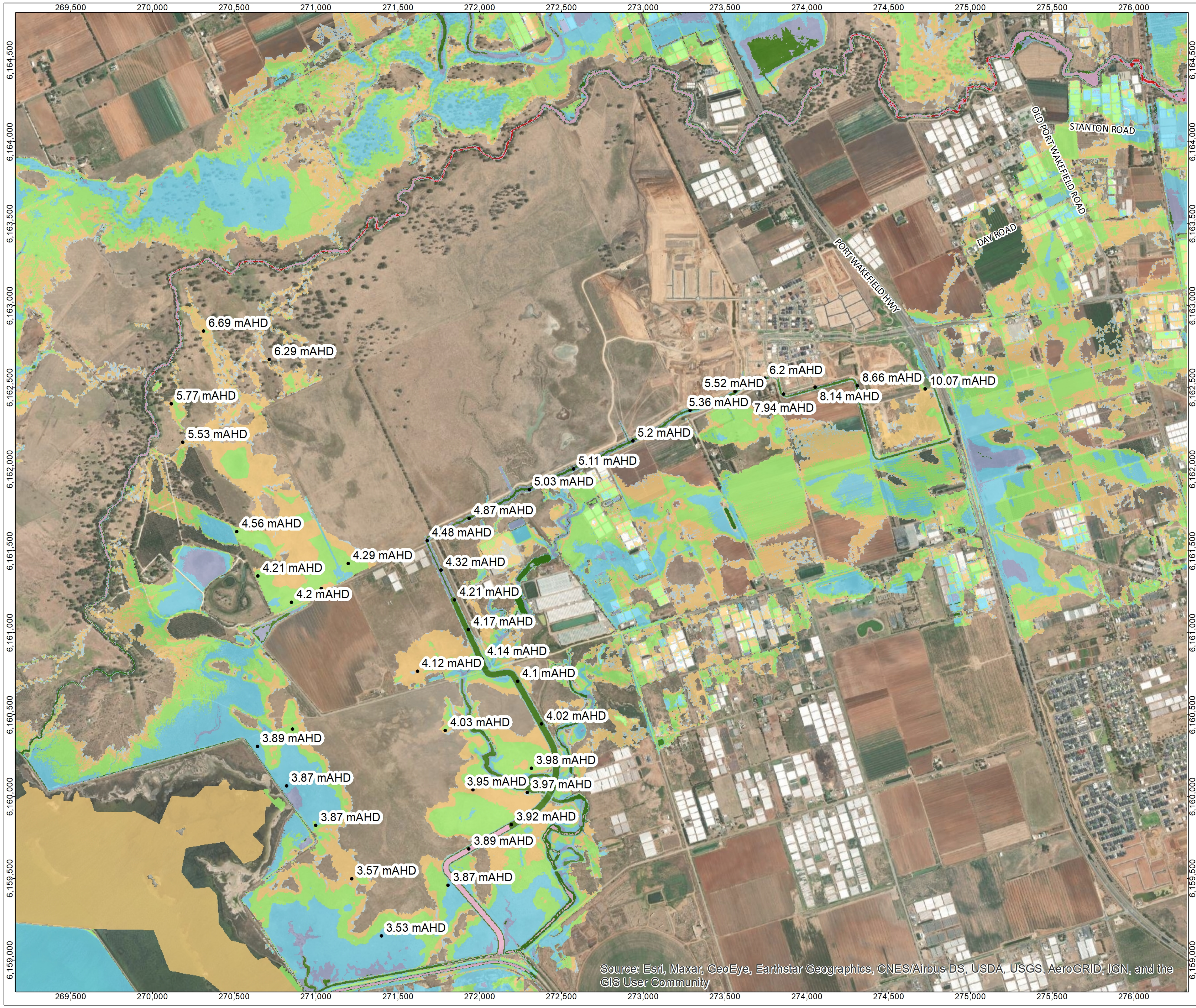
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

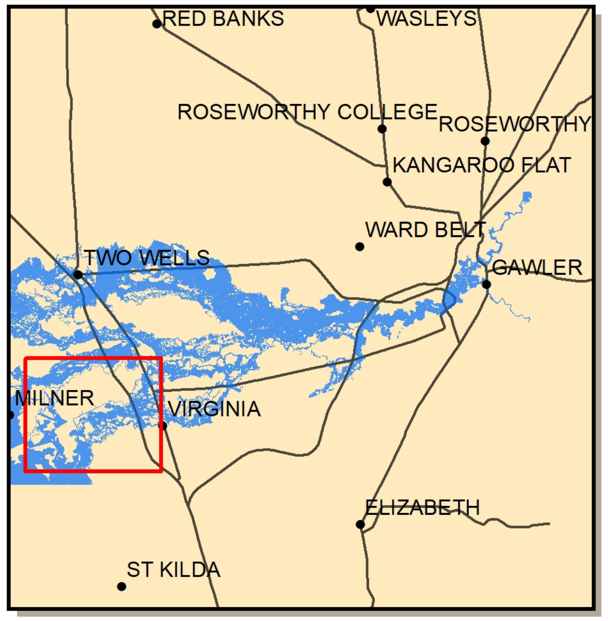
Developed Conditions 1% AEP Depth

Riverlea Development Site

REFERENCE: A3L_wInset_Riverlea_Dev_1AEP_DEPTH_v3_w_WSEpts

DATE: 2/11/2022 | SHEET: 1 of 1 | DRAWING NUMBER: 1





Legend

• Water surface elevation at point

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

N W E S

0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

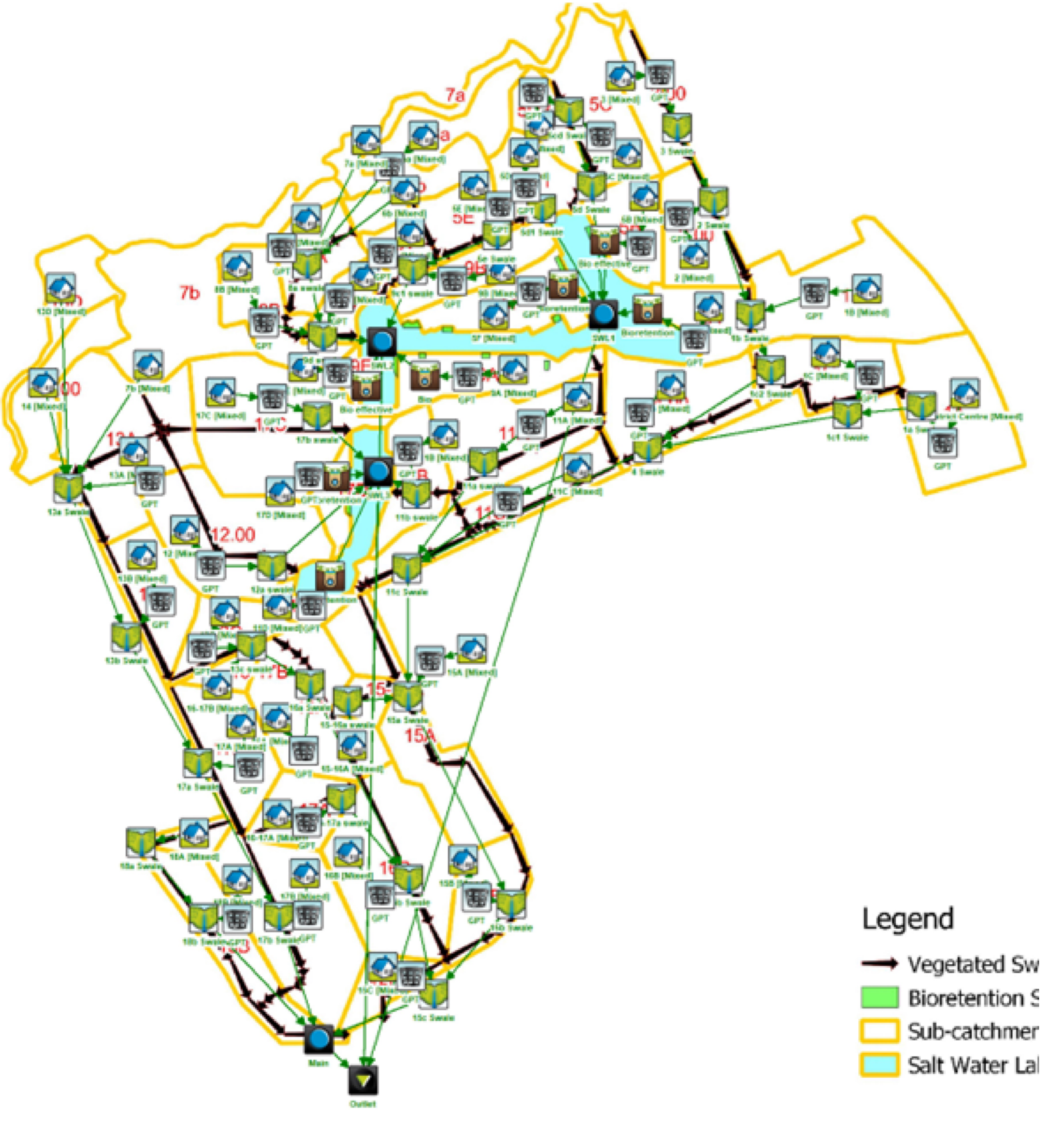
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

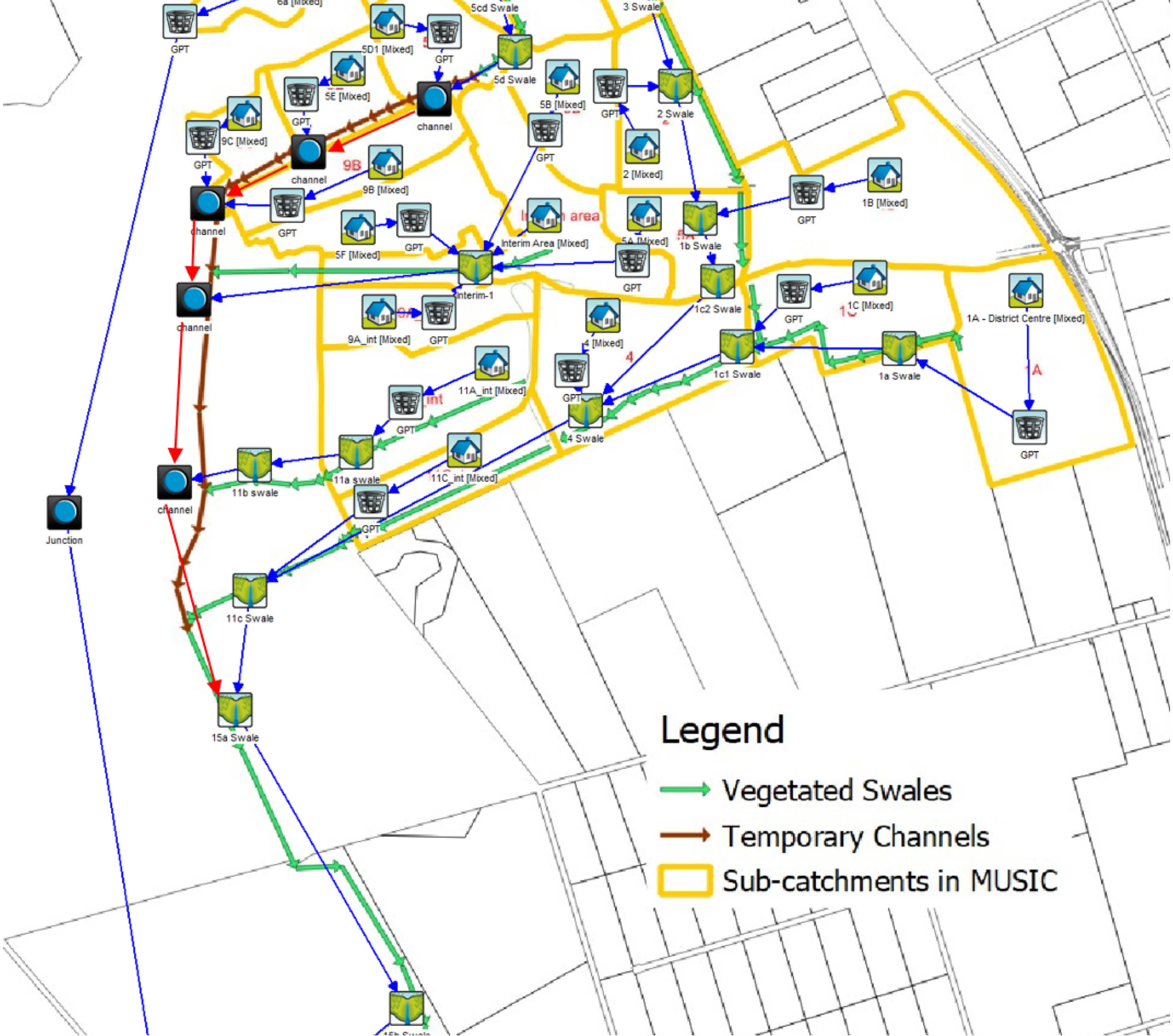
Developed Conditions 1% AEP Depth
Riverlea Development Site

REFERENCE: A3L_wInset_Riverlea_Ex_1AEP_DEPTH-2

DATE: 18/07/2023 | SHEET: 1 of 1 | DRAWING NUMBER: 1

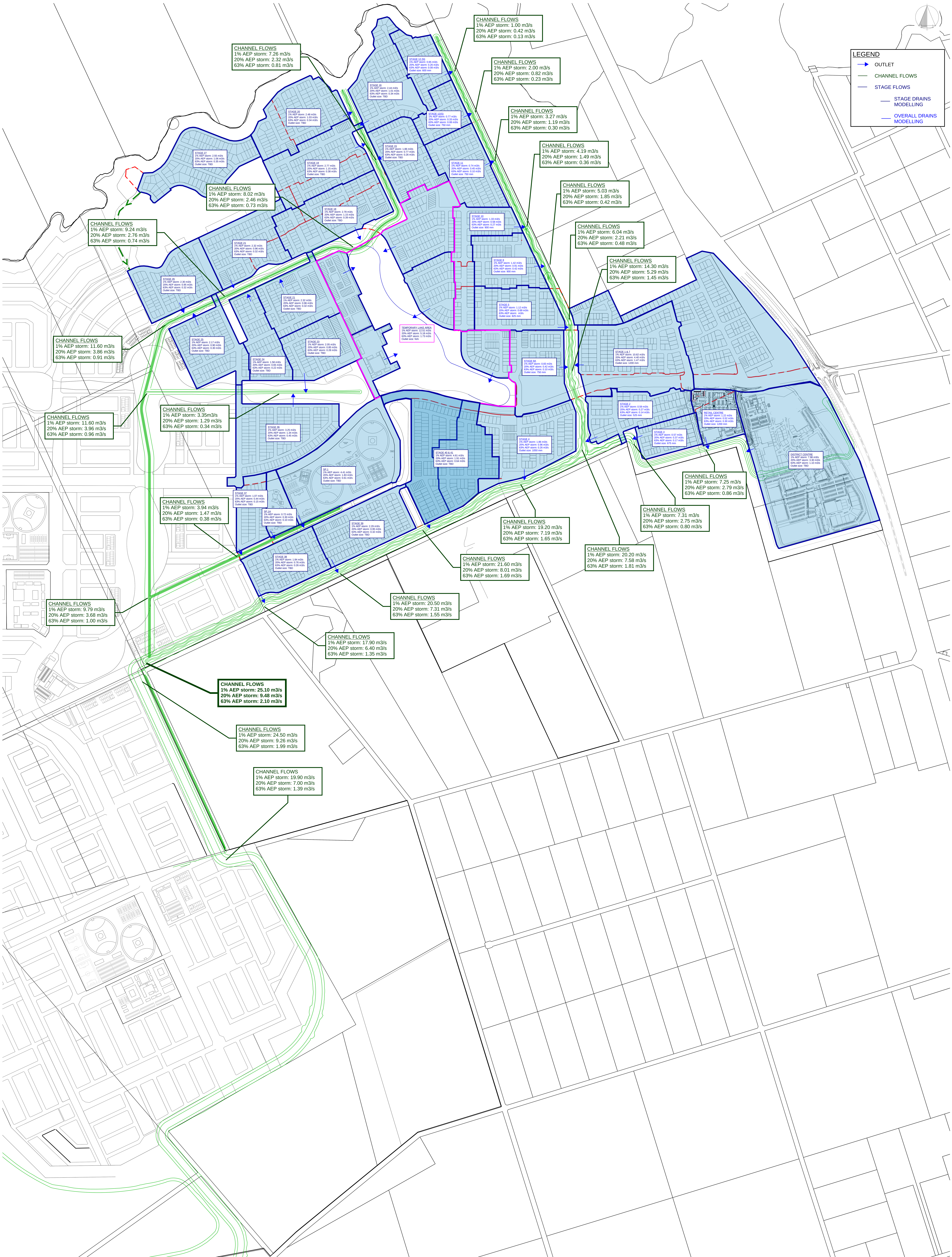
APPENDIX D
MUSIC MODEL SCHEMATICS


7a
7b
12.00
15A
Main
Outlet
Legend
Vegetated Sw
Bioretention S
Sub-catchmer
Salt Water Lal



Legend
Vegetated Swales
Temporary Channels
Sub-catchments in MUSIC
GPT
5D1 [Mixed]
5cd Swale
3 Swale
5d Swale
5E [Mixed]
5B [Mixed]
2 Swale
channel
9C [Mixed]
9B
9B [Mixed]
2 [Mixed]
1B [Mixed]
Interim Area [Mixed]
5A [Mixed]
1b Swale
5F [Mixed]
interim-1
1c2 Swale
1C [Mixed]
1A - District Centre [Mixed]
9A_int [Mixed]
4 [Mixed]
4
1c1 Swale
1a Swale
1A
11A_int [Mixed]
4 Swale
11a swale
11b swale
11C_int [Mixed]
Junction
11c Swale
15a Swale

APPENDIX E
OUTLET FLOWS



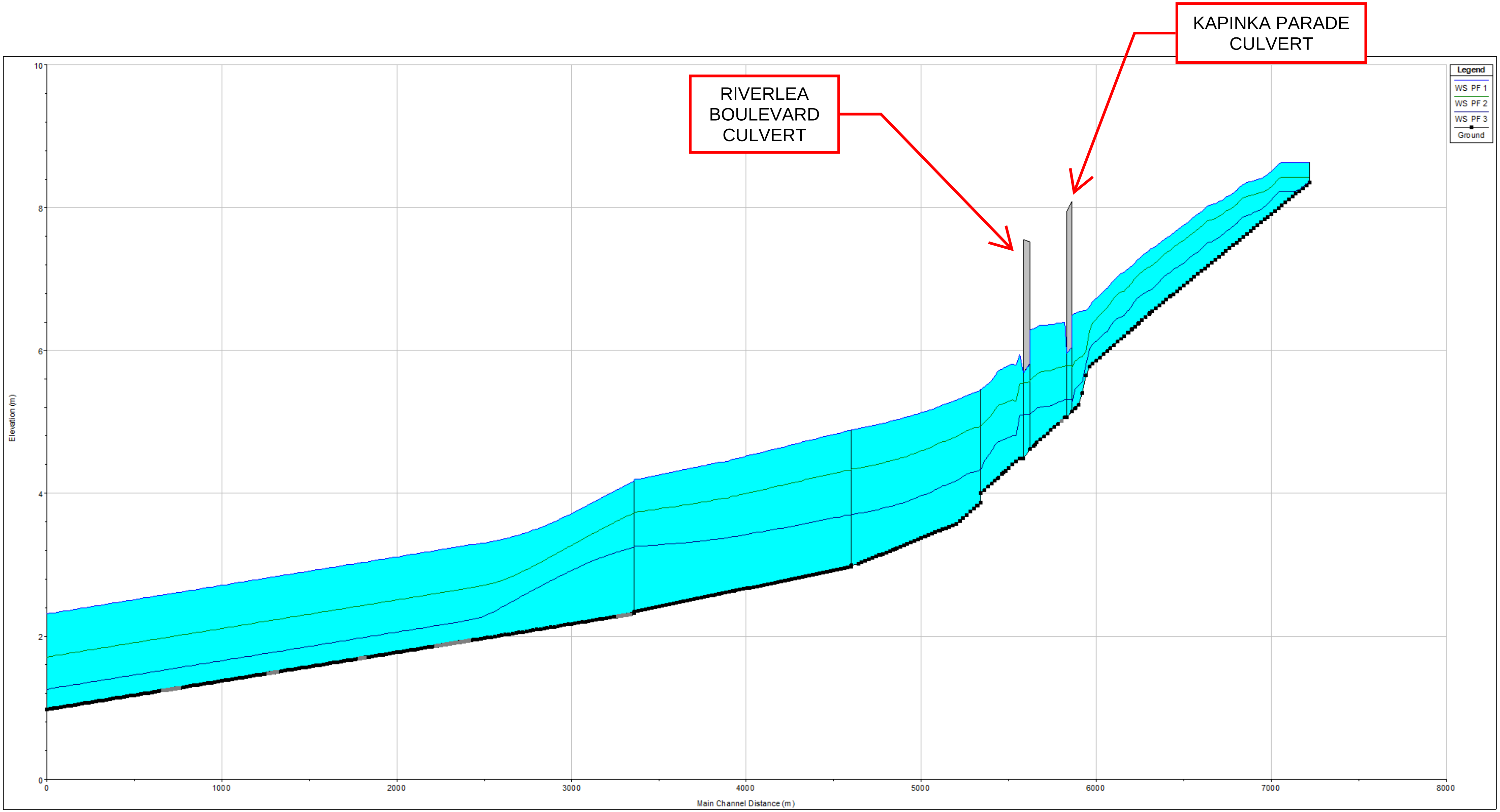
INTERIM CHANNEL DESIGN - OUTLET FLOWS

INTERIM CHANNEL DESIGN LAKE DISCHARGE OPTION - OUTLET FLOWS

APPENDIX F
HEC-RAS

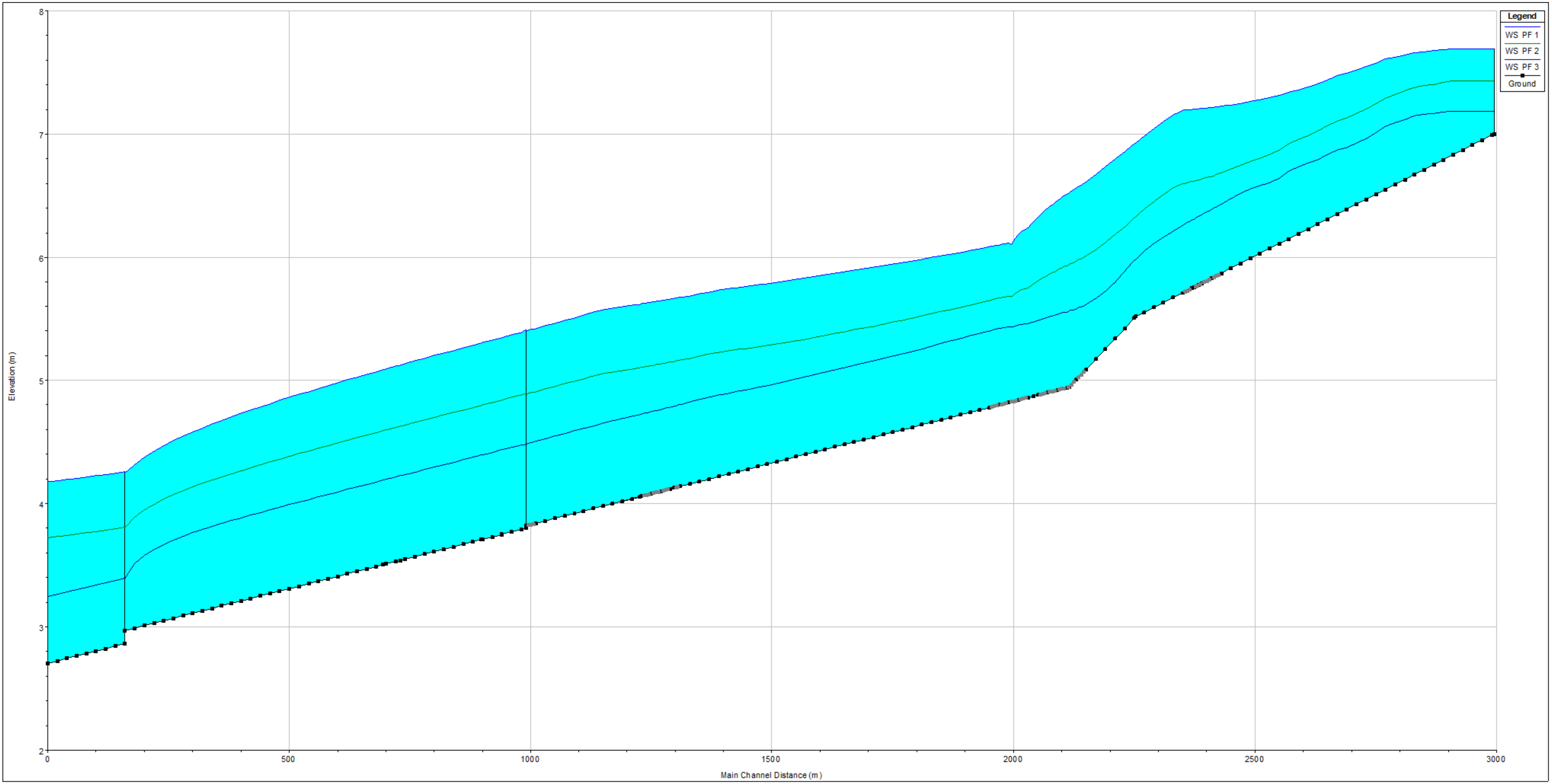
INTERIM CHANNEL DESIGN - PROFILE AND XYZ PERSPECTIVE PLOTS

MAIN CHANNEL (CHANNEL 1) - PROFILE PLOTS



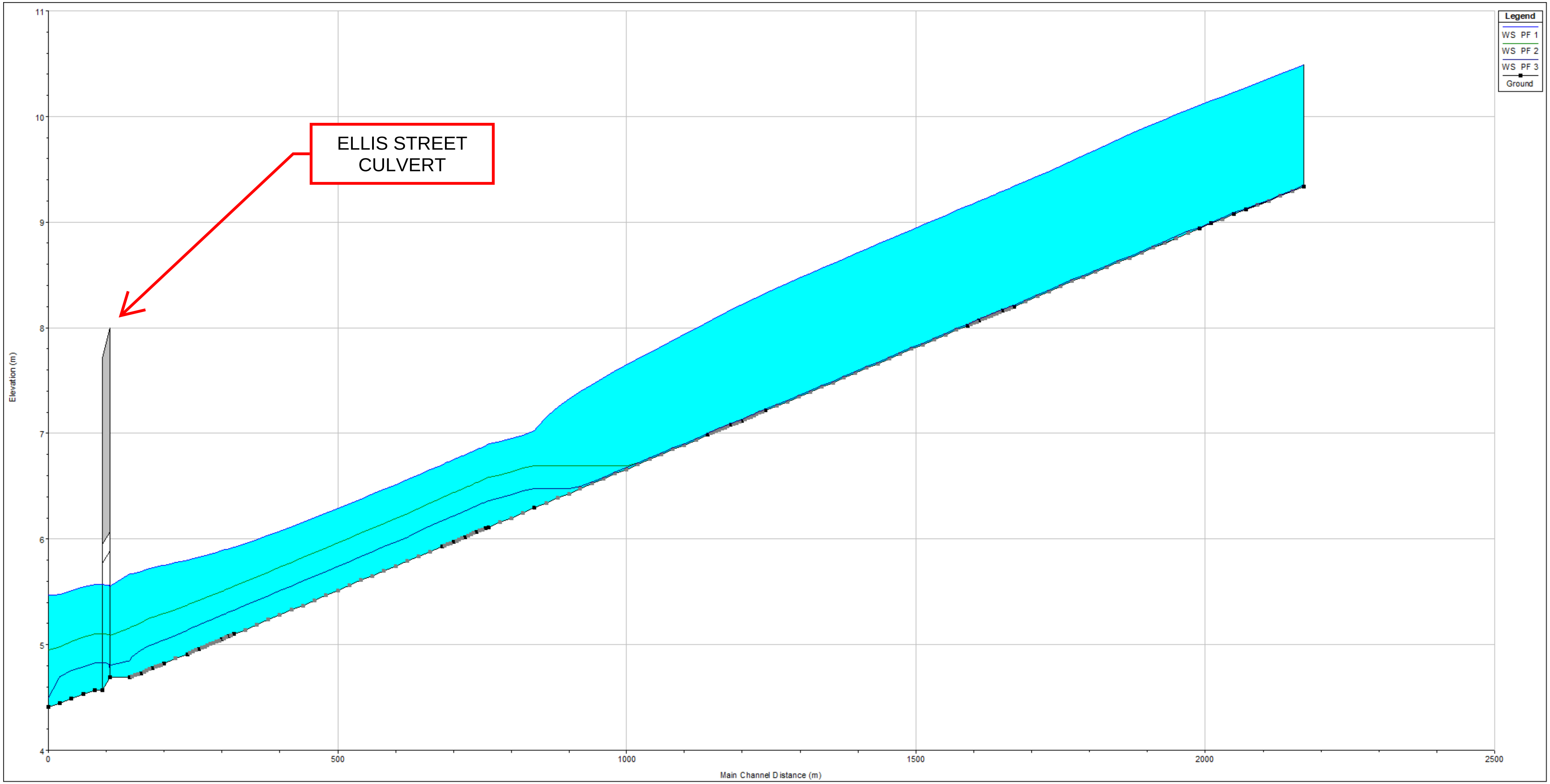
*PF 1 - Major Event; PF 2 - Minor Event; PF 3 - 4 EY

CHANNEL 5 - PROFILE PLOT



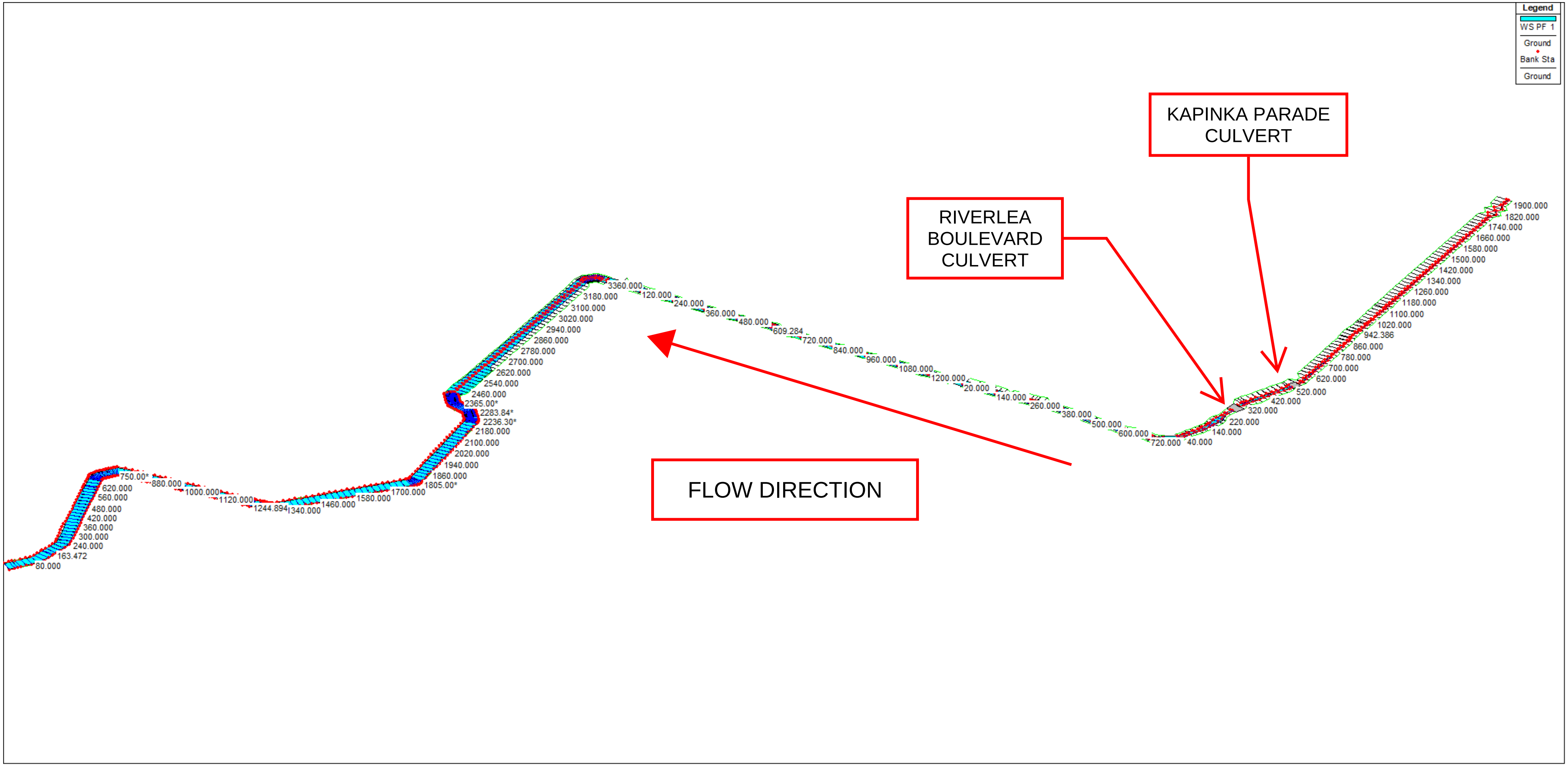
*PF 1 - Major Event; PF 2 - Minor Event; PF 3 - 4 EY

DISTRICT CENTRE CHANNEL (ULTIMATE) - PROFILE PLOT

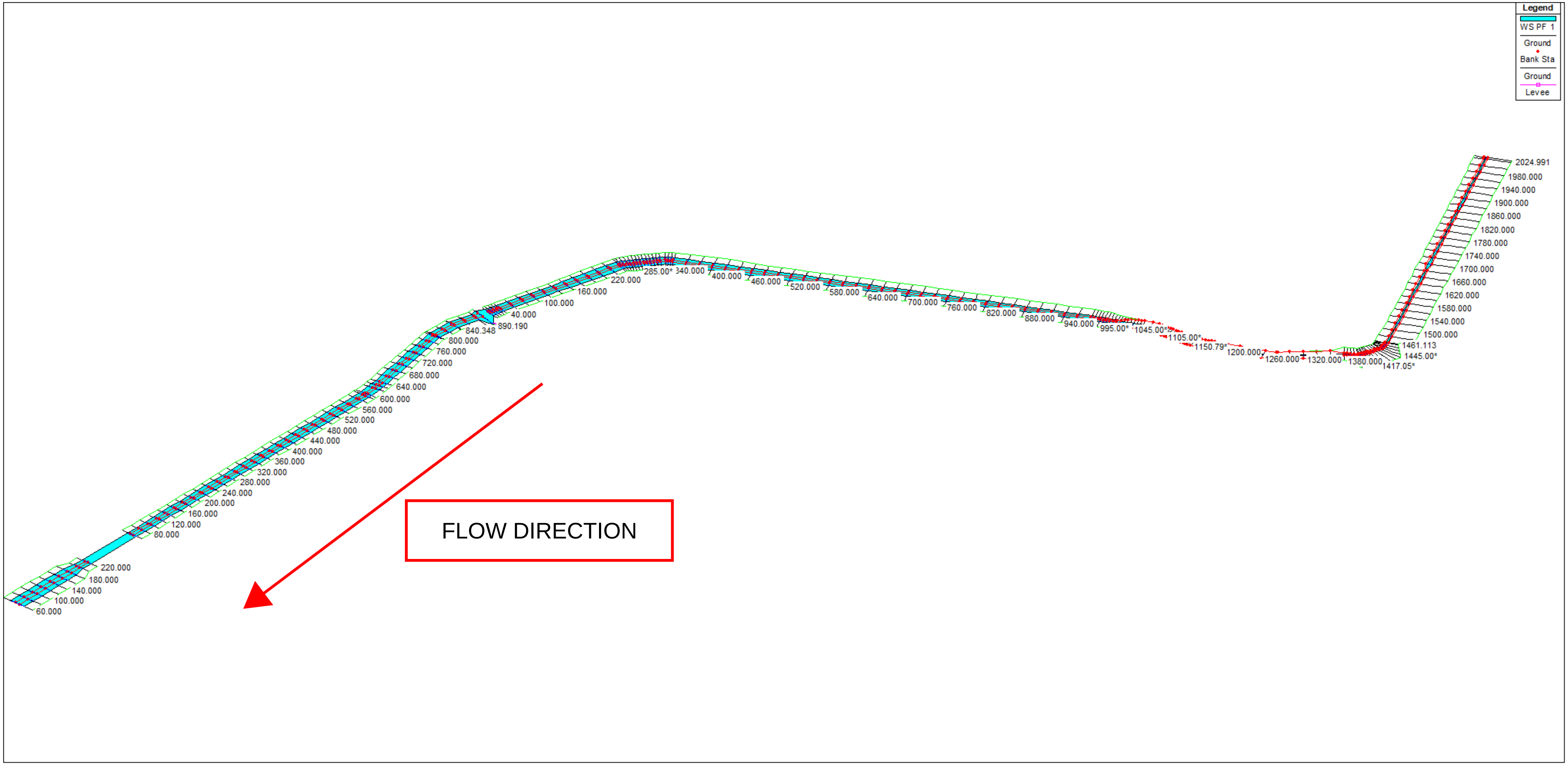


*PF 1 - Major Event; PF 2 - Minor Event; PF 3 - 4 EY

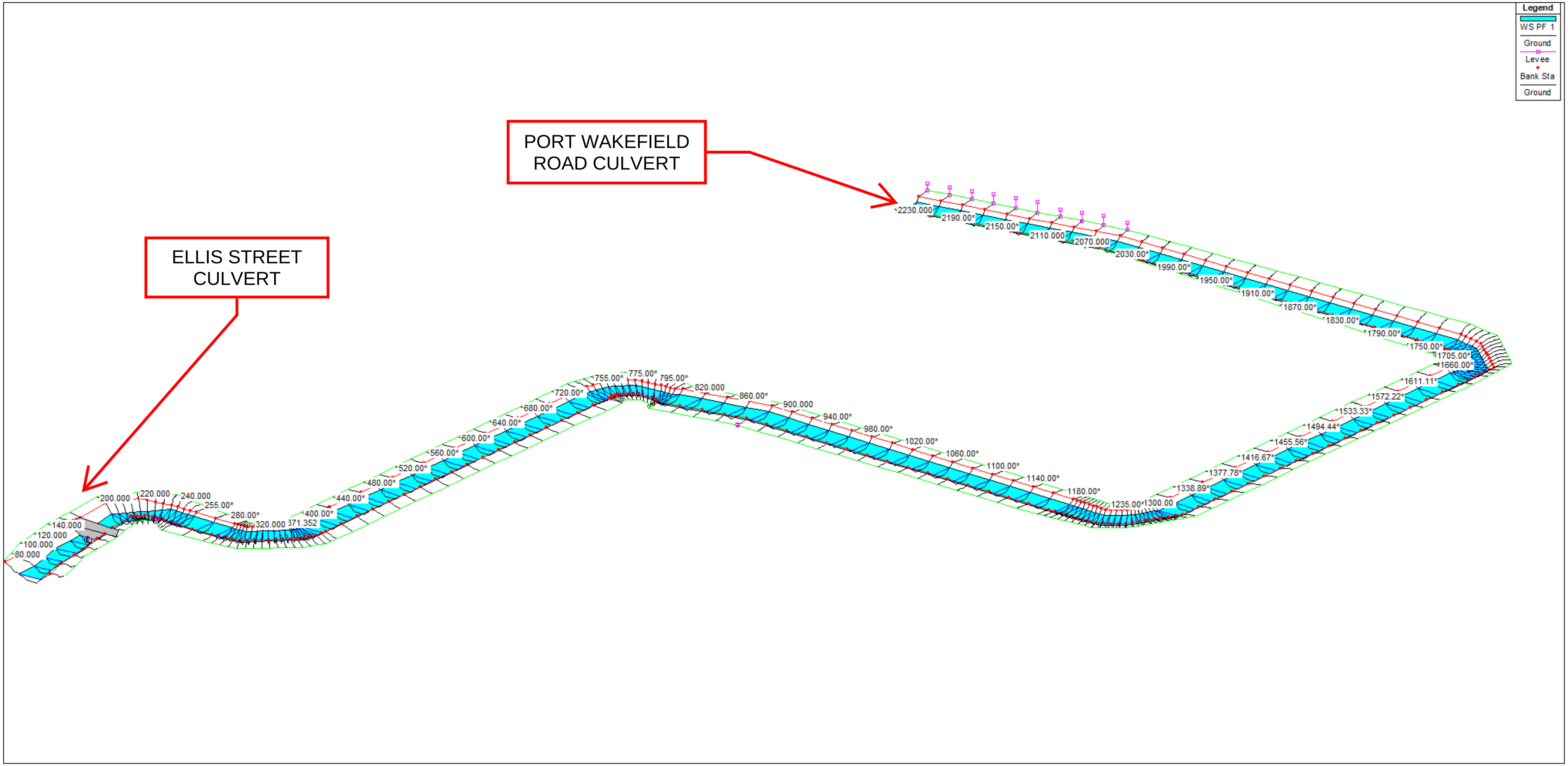
MAIN CHANNEL (CHANNEL 1) - 1% AEP MAJOR EVENT XYZ PERSPECTIVE PLOT



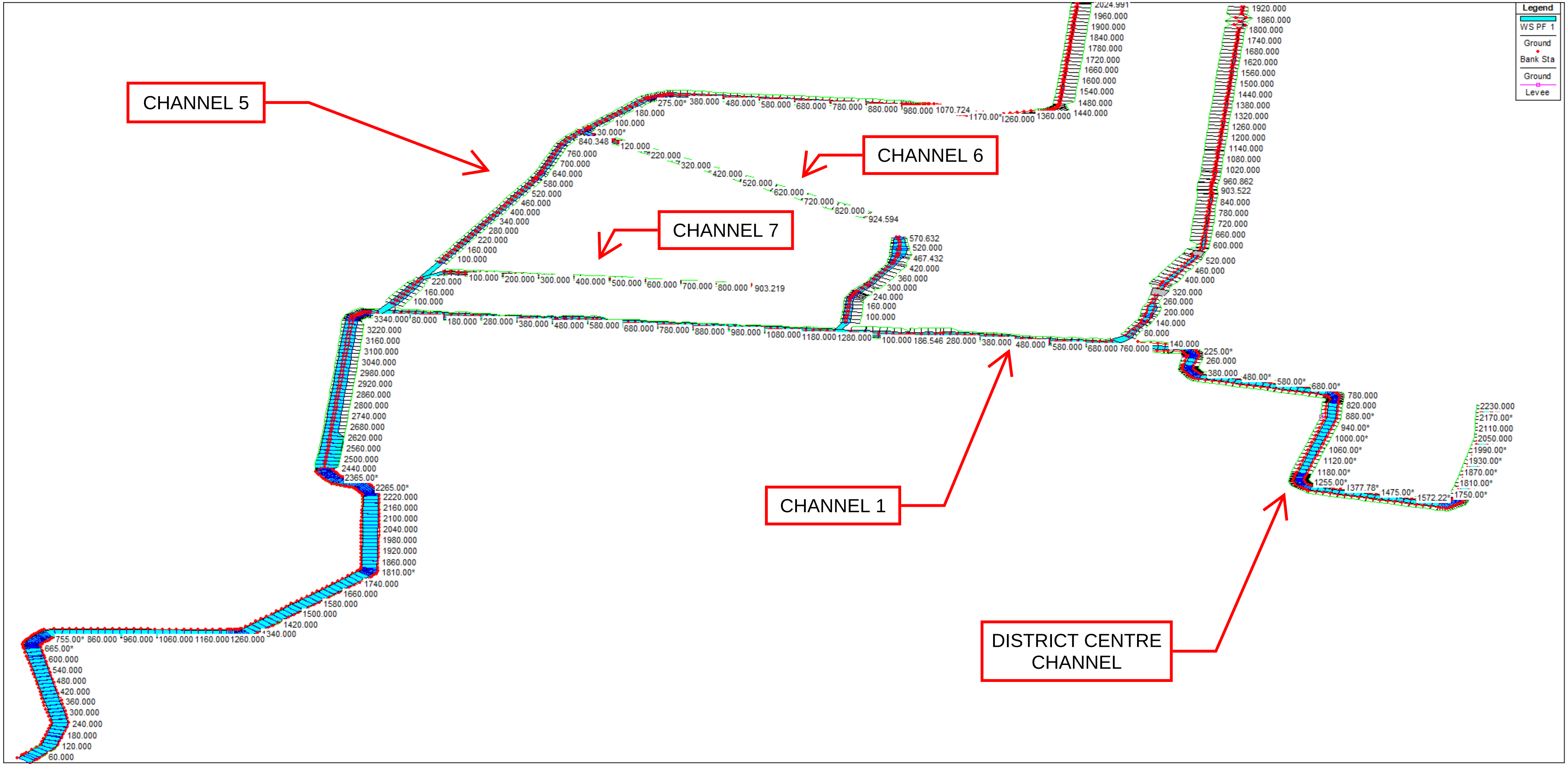
CHANNEL 5 - 1% AEP MAJOR EVENT XYZ PERSPECTIVE PLOT



DISTRICT CENTRE CHANNEL (ULTIMATE) - 1% AEP MAJOR EVENT XYZ PERSPECTIVE PLOT

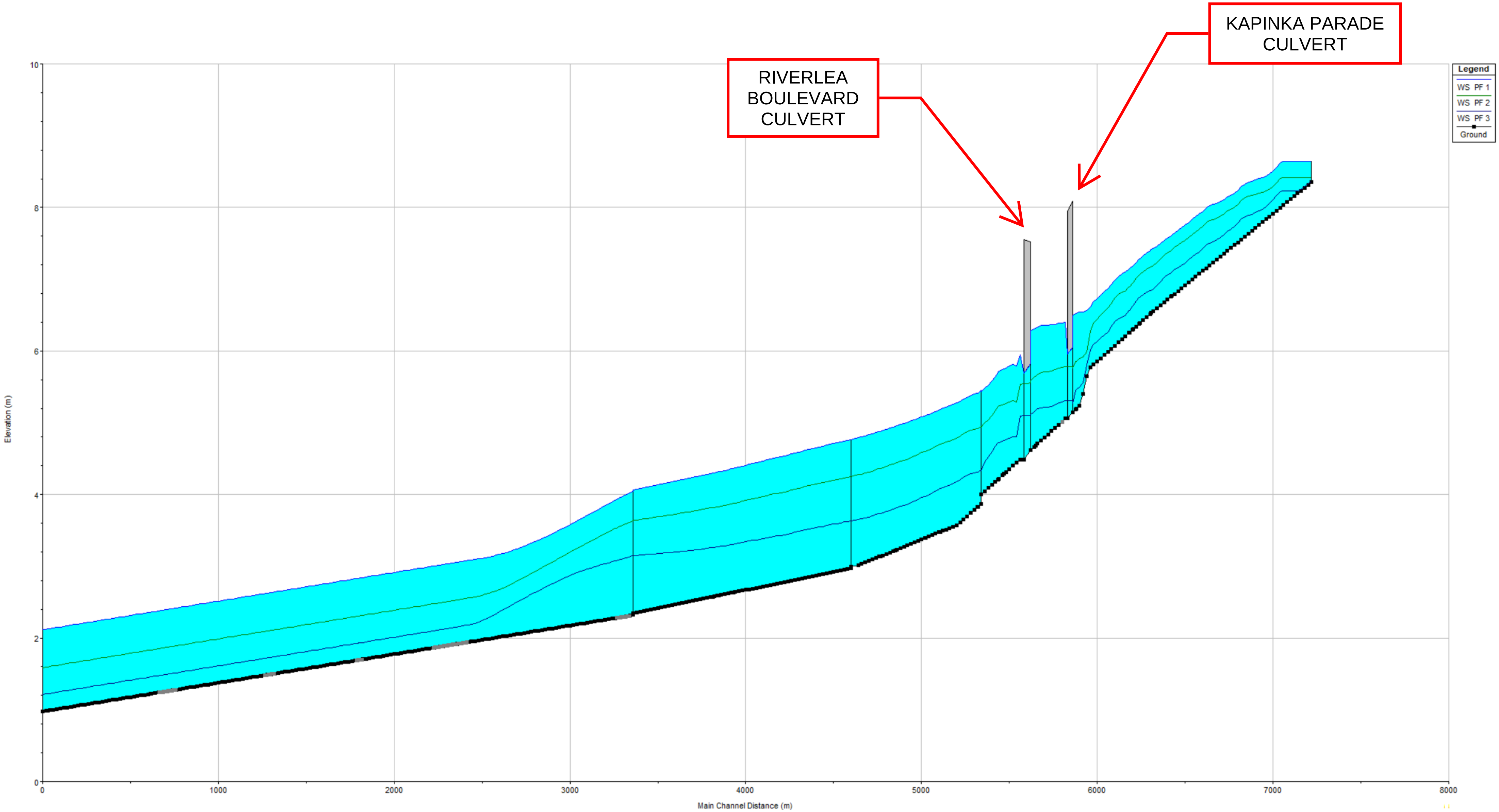


RIVERLEA STORMWATER CHANNEL INTERIM DEISGN - 1% AEP MAJOR EVENT XYZ PERSPECTIVE PLOT



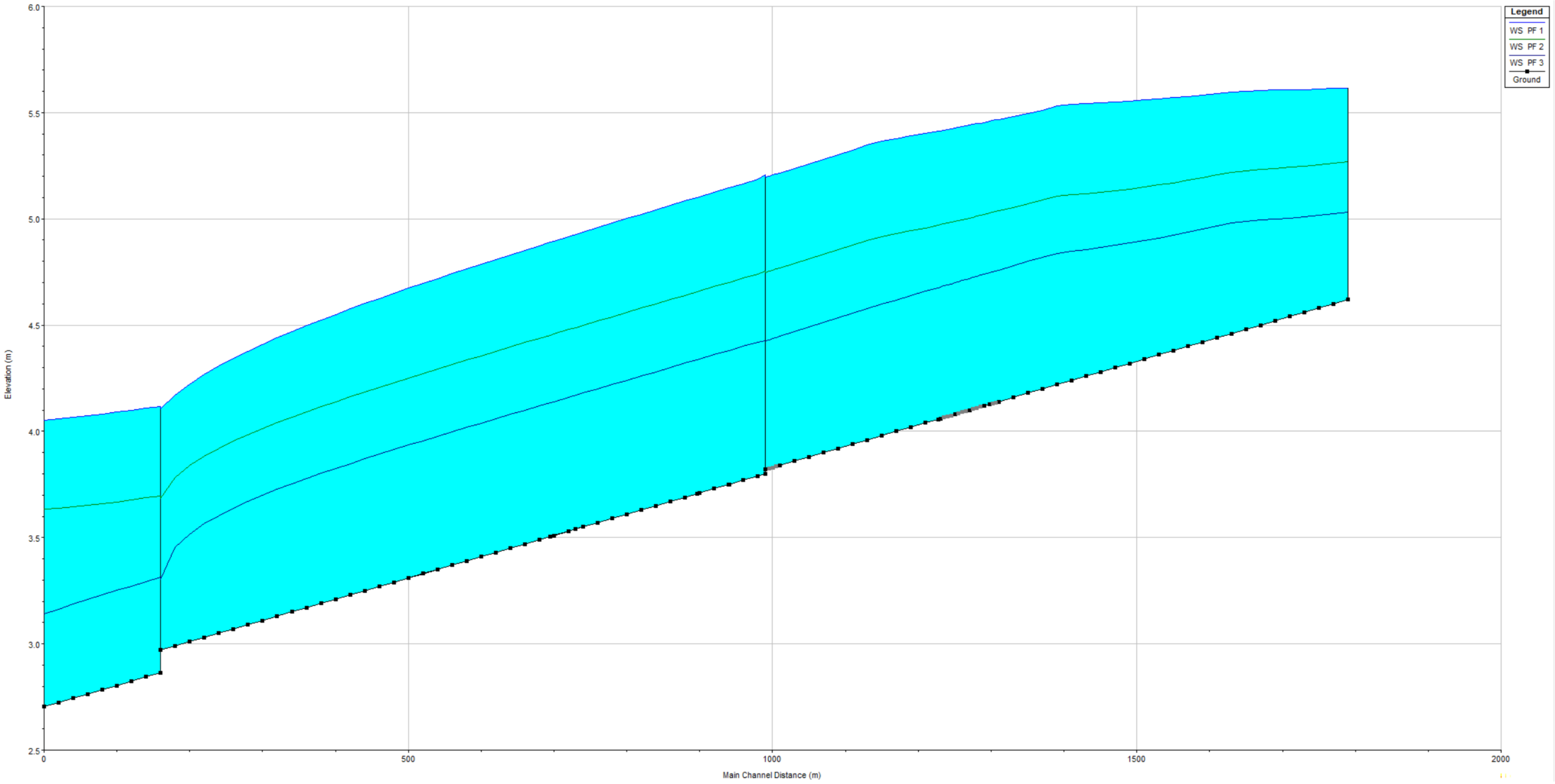
INTERIM CHANNEL DESIGN LAKE DISCHARGE OPTION - PROFILE AND XYZ PERSPECTIVE PLOTS

MAIN CHANNEL (CHANNEL 1) - PROFILE PLOTS



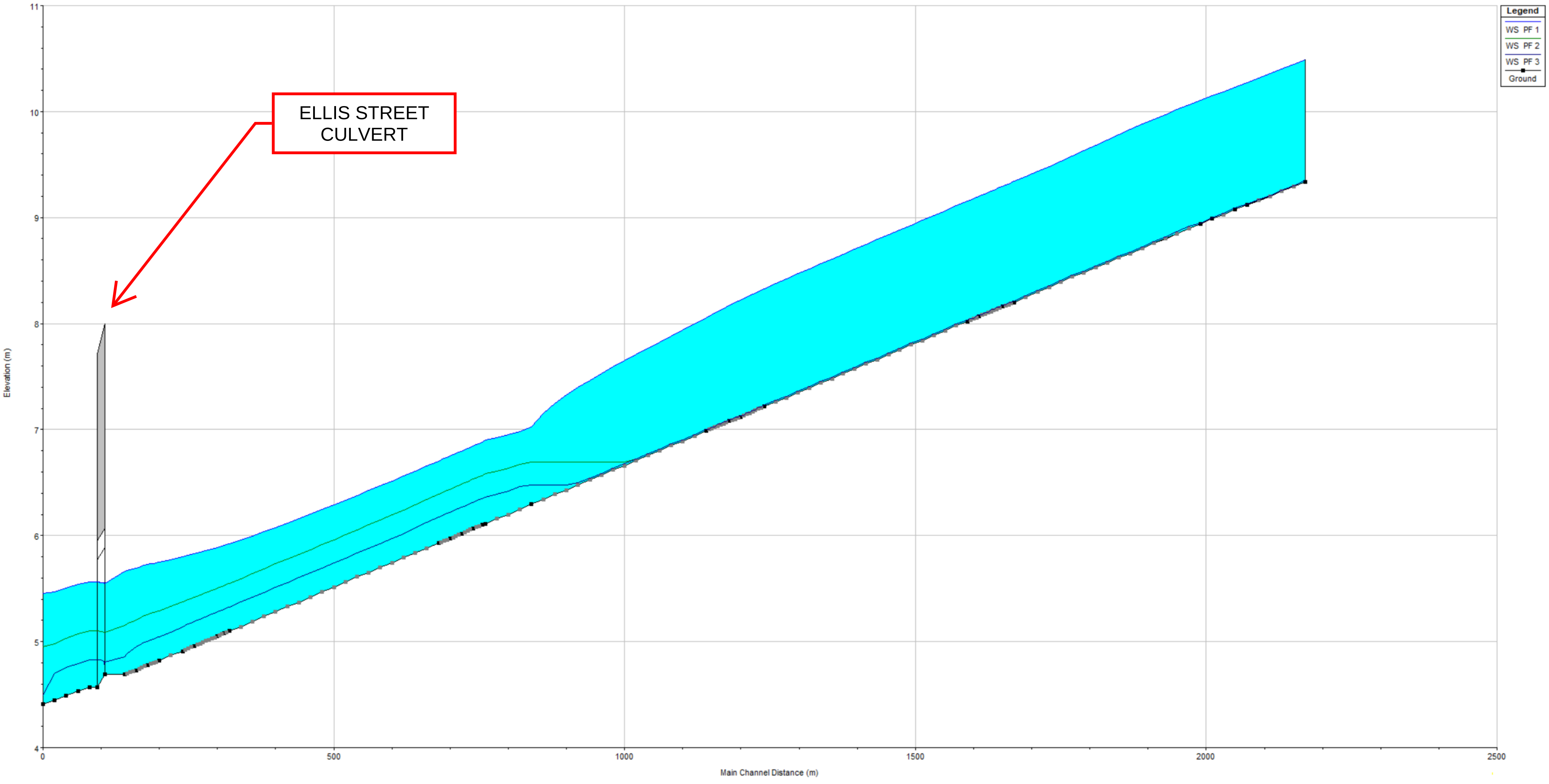
*PF 1 - Major Event; PF 2 - Minor Event; PF 3 - 4 EY

CHANNEL 5 - PROFILE PLOT



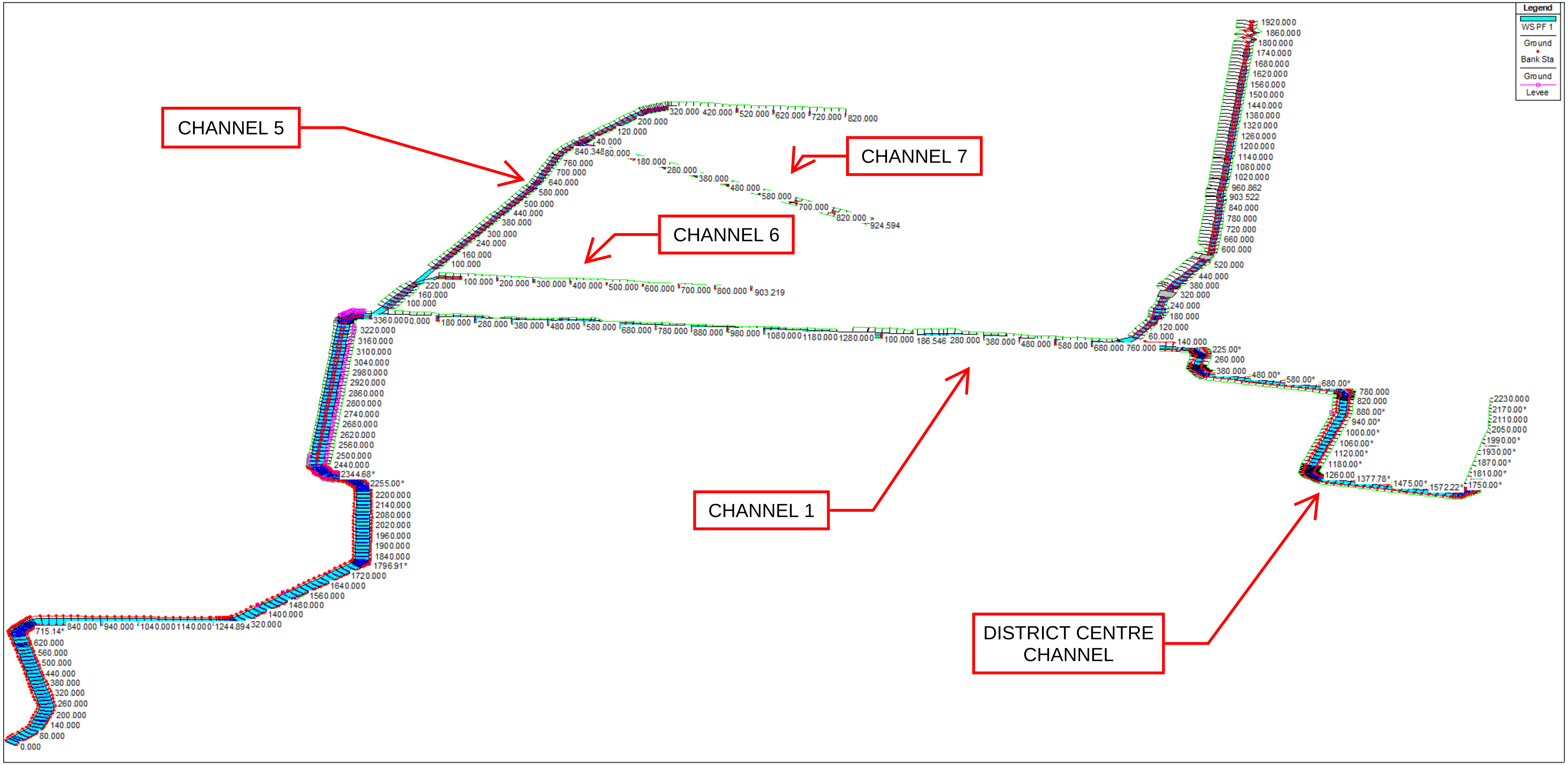
*PF 1 - Major Event; PF 2 - Minor Event; PF 3 - 4 EY

DISTRICT CENTRE CHANNEL (ULTIMATE) - PROFILE PLOT



*PF 1 - Major Event; PF 2 - Minor Event; PF 3 - 4 EY

RIVERLEA STORMWATER CHANNEL INTERIM DEISGN (LAKE DISCHARGE OPTION) - 1% AEP MAJOR EVENT XYZ PERSPECTIVE PLOT



FOR FURTHER INFORMATION CONTACT:

Damien Byrne
Director

T 08 8223 7433
M 0417 841 948
E dbyrne@wga.com.au

WGA.COM.AU
WGANZ.CO.NZ

Appendix B

Atlan Concept Pricing for Stage 14

	Date:	29/08/2024
	Start Year:	
	Client:	Walker Corp
	Project Name:	Riverlea Stage 14
	Project Address:	Buckland Park

Version 15/09/2021

			Stages 14 A&B	Stage 14A		Stage 14B	
ASSET			**Constructed Wetlands**	**Atlan Vortceptor OVOR.360**	**Atlan Flow Filter 4000.39**	**Atlan Vortceptor OVOR.22(**	**Atlan Flow Filter 3500.31**
Inspections (Per Year)			$ -	$ 500	$ 800	$ 500	$ 800
Minor Reset ($/m2) or (Per year)			$ 2	$ 2,000	$ 1,300	$ 2,000	$ 1,100
Full Reset ($/m2)			$ 75	$ 40,000	$ 105,000	$ 38,000	$ 85,000
Construction ($/m2)			$ 100				
				CAPEX			
Size (M2)			8500				
Asset Construction / Purchase Price			$ 850,000	$ 80,000	$ 220,000	$ 75,000	$ 175,000
Asset Installation Price Estimate				$ 40,000	$ 110,000	$ 37,500	$ 87,500
Total CAPEX			$ 850,000	$ 120,000	$ 330,000	$ 112,500	$ 262,500
				OPEX			
0	Year 1 - Establishment Period	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 85,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
1	Year 2 - Establishment Period	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 85,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
2	Year 3	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
3	Year 4	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
4	Year 5	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000				
5	Year 6	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
6	Year 7	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		SPEL Major Maintenance	$ -		$ 105,000		$ 85,000
7	Year 8	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
8	Year 9	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
9	Year 10	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000	$ -	$ -	$ -	$ -
10	Year 11	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
11	Year 12	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
12	Year 13	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
13	Year 14	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		SPEL Major Maintenance	$ -		$ 105,000		$ 85,000
14	Year 15	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000				
15	Year 16	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
16	Year 17	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
17	Year 18	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
18	Year 19	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
19	Year 20	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000	$ -	$ -	$ -	$ -
20	Year 21	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		SPEL Major Maintenance	$ -		$ 105,000		$ 85,000
21	Year 22	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
22	Year 23	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
23	Year 24	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
24	Year 25	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000	$ 40,000	$ -	$ 38,000	$ -
25	Year 26	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
26	Year 27	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
27	Year 28	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		SPEL Major Maintenance	$ -		$ 105,000		$ 85,000
28	Year 29	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
29	Year 30	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Full Reset	$ 637,500	$ -	$ -	$ -	$ -
30	Year 31	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
31	Year 32	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
32	Year 33	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
33	Year 34	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
34	Year 35	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000	$ -	$ -	$ -	$ -
		SPEL Major Maintenance	$ -		$ 105,000		$ 85,000
35	Year 36	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
36	Year 37	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
37	Year 38	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
38	Year 39	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
39	Year 40	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000	$ -	$ -	$ -	$ -
40	Year 41	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
41	Year 42	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		SPEL Major Maintenance	$ -		$ 105,000		$ 85,000
42	Year 43	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
43	Year 44	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
44	Year 45	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000	$ -	$ -	$ -	$ -
45	Year 46	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
46	Year 47	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
47	Year 48	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
48	Year 49	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		SPEL Major Maintenance	$ -	$ 40,000	$ 105,000	$ 38,000	$ 85,000
49	Year 50	Inspections		$ 500	$ 800	$ 500	$ 800
		Maintenance	$ 17,000	$ 2,000	$ 1,300	$ 2,000	$ 1,100
		Wetland Minor Reset Sedime	$ 51,000	$ -	$ -	$ -	$ -
30 Year - Overall Investment			**Constructed Wetlands**	**Vortceptor 14A**	**Atlan Flow Filter 14A**	**Vortceptor 14B**	**Atlan Flow Filter 14B**
Total OPEX - 30yrs			**$ 1,538,500**	**$ 115,000**	**$ 483,000**	**$ 113,000**	**$ 397,000**
Total Cost of Ownership (TCO)			**$ 2,388,500**	**$ 235,000**	**$ 813,000**	**$ 225,500**	**$ 659,500**

NOTE: This is a guide, not to be used to make economic decisions around purchasing land. SPEL is not liable for any loss incured as a result

ASSET	ASSET PARAMETERS	CONSTRUCTION[1]	MAINTENANCE		RENEWAL
			ESTABLISHMENT (FIRST TWO YEARS)	ONGOING	
WETLANDS[2]	< 500 m² 500 to 10,000 m² > 10,000 m²	$150/m² $100/m² $75/m²	Two to five times ongoing maintenance cost	$10/m²/yr $2/m²/yr $0.5/m²/yr	No data
SEDIMENT BASINS[2]	< 250 m² 250 to 1000 m² > 1000 m²	$250/m² $200/m² $150/m²		$20/m²/yr $10/m²/yr $5/m²/yr	Remove and dispose of: Dry waste = $250/m³ Liquid waste = $1,300/m³
ON-STREET RAINGARDENS[3]	< 50 m² 50 to 250 m² > 250 m²	$2000/m² $1000/m² $500/m²		$30/m²/yr $15/m²/yr $10/m²/yr	Minor reset = $50 to $100/m²
BIORETENTION BASINS[3]	< 100 m² 100 to 500 m² > 500 m²	$1000/m² $350/m² $250/m²		$5/m²/yr	No data
TREE PITS[3]	< 10 m² total 10 to 50 m² total > 50 m² total	$8000/m² $5000/m² $1000/m²		No access issues = $150/asset/yr Traffic issues or specialist equipment required = $500/asset/yr	No data
GRASS SWALES AND BUFFER STRIPS[4]	Seeded – no subsoil drain Seeded – subsoil drain Turfed – no subsoil drain Turfed – subsoil drain Native grasses established	$15/m² $25/m² $20/m² $35/m² $60/m²		$3/m²/yr	No data
VEGETATED SWALES AND BIORETENTION SWALES[3]		150/m²		$5/m²/yr	No data
IN-GROUND GPTS	< 300 L/s 300 to 2000 L/s > 2000 L/s	$50,000/asset $150,000/asset $250,000/asset	N/A	Inspection = $100/visit Cleanout = $1000/visit	No data

1 Includes planning and design
2 Area at normal water level
3 Area of filter media at bottom of extended detention
4 Total vegetated area

Disclaimer: The cost estimates provided should be considered as a starting point only and represent the best cost estimates available based on current information (Oct 2013). The cost estimates will be reviewed and refined over time as better data becomes available. It should be noted that data are generally based on 'standard residential' developments and the cost of equipment hire is not included in the estimates.

Maintenance

A sediment basin needs to be cleaned out when the sediment builds up to 0.5 metres below the water level, which usually takes about two to five years. To clean out a sediment basin:

1. The sediment basin is drained of water to allow access
2. An excavator reaches from the side or a bob-cat enters the basin to clean out the sediment
3. Wet sediment is placed in a nearby de-watering area to dry, reducing the weight and cost of disposal.

For an example of a sediment basin clean out, view our case study.

NOTE: This is a guide, not to be used to make economic decisions around purchasing land. SPEL is not liable for any loss incured as a result

50 Year - Overall Investment	Constructed Wetlands	Vortceptor 14A	Atlan Flow Filter 14A	Vortceptor 14B	Atlan Flow Filter 14B
Total OPEX - 50yrs	**$ 2,082,500**	**$ 204,500**	**$ 839,200**	**$ 200,500**	**$ 689,200**
Total Cost of Ownership (TCO)	**$ 2,932,500**	**$ 324,500**	**$ 1,169,200**	**$ 313,000**	**$ 951,700**

NOTE: This is a guide, not to be used to make economic decisions around purchasing land. SPEL is not liable for any loss incured as a result