Northern Areas Council

Laura Stormwater Management Plan

Draft Report



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Laura Stormwater Management Plan

Draft Report

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Executive Summary

This Stormwater Management Plan for Laura has been prepared for Northern Areas Council. The preparation of the plan has been jointly funded by Northern Areas Council and the Stormwater Management Authority.

This document contains:

- A summary of collated information covering a range of factors relevant to the management of stormwater in the town;
- The identification of flood impacts highlighting performance deficiencies ranging from nuisance ponding to major flooding hotspots;
- A review of the quality of stormwater runoff leaving the town;
- Findings from the community consultation and objectives and targets for managing stormwater within the town;
- Potential management strategies that may be used to meet the objectives and targets;
- Estimated costs and benefits associated with each of the strategies; and
- A clear definition of the priorities, responsibilities and timeframe for implementation of the Stormwater Management Plan.

The study area for this Stormwater Management Plan is approximately 780 hectares in size, and contains both urban land within Laura and the major watercourses of Pine Creek and Rocky River, as well as several smaller watercourses. The study area is not defined by a single contributing catchment, but instead by major watercourses surrounding the town and numerous catchments within the town. The study area is wholly located within the jurisdiction of Northern Areas Council.

The topography of the study area varies, with higher elevations to the west, north and east of the township. Rocky River and Pine Creek come together to the northwest of Laura before running along the western side of the town and flowing to the south out of the study area. The town generally grades from northeast to southwest at a gentle slope, with runoff flowing overland towards the major watercourse channels surrounding the town. Flood protection levees separate the town from Pine Creek along the northern edge of town and Rocky River along the eastern edge of town.

Key issues identified by this Stormwater Management Plan include:

- A range of drainage system performance deficiencies including trapped ponding, insufficient drainage infrastructure and property inundation;
- Limited stormwater quality improvement measures have been implemented across the town to date;
- Future development, largely consisting of greenfield development, will exacerbate flood risk and decrease the quality of water entering the receiving waters; and
- The potential for climate change, in the form of higher intensity rainfall, to increase flood risk within the town.

A set of objectives specific to this Stormwater Management Plan was developed, addressing:

- Providing an acceptable level of flood protection for public and private assets;
- Improving the quality of runoff to the receiving waters;
- Finding opportunities for the beneficial use of stormwater;
- Planning for new developments to provide open space and maximise the onsite retention of stormwater runoff;
- The sustainable asset management of stormwater infrastructure;
- Improving the condition of receiving watercourses; and
- Effective communication and consultation with stakeholders, businesses and the community.

The Stormwater Management Plan recommends a range of structural and non-structural stormwater management responses, which have been summarised in the table below. These measures have been developed with a view to maximising the level of flood protection that can be achieved within practical constraints. In accordance with the objectives and targets, an absolute target of achieving no above floor inundation of properties in the 5% AEP storm was adopted, with an aspirational target to provide a 1% AEP standard.

The proposed flood mitigation strategies include new and upgraded underground drainage systems and various earthworks, all aimed at reducing surface ponding and property inundation in major storm events. Detention basins have also been proposed, which will mitigate runoff from the upstream catchments and improve the performance of downstream drainage systems. Flood damage estimates and structural cost estimates have been developed to evaluate the economic feasibility of the proposed flood mitigation measures. The total cost of implementing the various flood mitigation measures is estimated to be $6.7m.

The existing water quality improvement assets are sparse, and were found to be insufficient to meet the target pollutant reductions. Water quality improvement measures that are recommended in this Stormwater Management Plan include bioretention basins, streetscape raingardens and gross pollutant traps. The total cost of implementing the proposed Water Sensitive Urban Design (WSUD) strategy is estimated to be $1.6m, with an annual maintenance cost of $46,000.

Water quality modelling has shown that the proposed WSUD strategy outlined in this plan would achieve the adopted water quality improvement targets. The opportunity for further measures also exists at the street level, such as raingardens being incorporated into road reconstructions, and on private property.

A Multi-Criteria Analysis (MCA) was developed to enable relative priorities to be assigned to all proposed stormwater management responses, taking into account financial, environmental and social factors. A consolidated list of the prioritised measures is presented in the table below, which also provides capital cost estimates and highlights the actions that are potentially eligible for Stormwater Management Authority funding.

Priority	Project Description	Benefits	Capital Cost	Potentially Eligible for SMA Funding
Very High	West Terrace Flow Path Works	Flood mitigation, drainage service	$360,000	
Very High	Levee Tenure and Structural Assessment Program	Flood mitigation, information and knowledge	-	✓
Very High	SES Community FloodSafe Program	Flood mitigation, information and knowledge	-	✓
High	Rocky River Flood Protection	Flood mitigation, drainage service	$1,530,000	✓
High	Hughes Street Drainage	Flood mitigation, drainage service	$660,000	✓
High	Streetscape Raingardens	Water quality improvement	$300,000	
High	Flood Warning Systems	Water quality improvement, amenity improvement	-	✓
High	Council's Emergency Management Plan	Flood mitigation, information and knowledge, administration efficiency	-	
Moderate	Laura Parkland Stormwater Upgrade	Flood mitigation, drainage service	$1,160,000	
Moderate	Laura Parkland Bioretention Basin	Water quality improvement	$210,000	
Moderate	Rezoning Flood-prone Land	Flood mitigation, information and knowledge	-	
Moderate	New Building Floor Levels	Flood mitigation	-	
Low	William Street Open Channel	Flood mitigation, drainage service	$360,000	
Low	Verge Works throughout Laura	Flood mitigation	$350,000	
Low	South Terrace Bioretention Basin	Water quality improvement	$585,000	
Low	Stormwater Harvesting and Reuse Scheme	Stormwater reuse	$220,000	
Low	Gross Pollutant Traps	Water quality improvement	$270,000	
Low	Rainwater Tanks and Allotment Level Reuse	Stormwater reuse, water quality improvement, information and knowledge	-	
Low	Ongoing Maintenance and Monitoring of Council Assets	Flood mitigation, drainage service, information and knowledge, administration efficiency	-	
Low	Education and Promotion of WSUD Measures	Stormwater reuse, water quality improvement, ecological improvement, information and knowledge	-	✓
Low	Development Controls – Beneficial Use of Stormwater	Stormwater reuse, information and knowledge	-	✓
Very Low	Northern Catchment Diversion Works	Flood mitigation, drainage service	$2,280,000	

1 Introduction

This Stormwater Management Plan (SMP) for the township of Laura has been prepared for the Northern Areas Council in accordance with the requirements of the brief. The preparation of the plan has been jointly funded by the Northern Areas Council (Council) and the Stormwater Management Authority (SMA).

The Plan will provide an overview of the existing catchments and issues relating to current stormwater management in the township of Laura. It also provides an overview of the opportunities to improve stormwater management to both address flood protection and the sustainable management of this resource and the environment.

This Plan has been developed primarily in consultation with Council staff, with external stakeholders from relevant State Government Authorities providing technical guidance regarding the objectives, targets and preferred management responses.

This progress report provides background on the township in the form of a baseline assessment, describing the current state and condition of the catchment and establishing a baseline against which the effectiveness of stormwater management options can be assessed. This report also summarises the proposed approach to identifying and managing stormwater risk and issues.

2 Baseline Assessment

2.1 Introduction

A baseline assessment of the township of Laura has been undertaken. This assessment describes the current state of the township and its catchments, establishing a baseline against which the effectiveness of future stormwater management options can be assessed. The following sections describe the elements included in the baseline assessment.

2.2 Administrative Boundaries

A Stormwater Management Plan boundary, forming the Study Area, has been prepared, and can be seen in Figure 2.1 below.

The Study Area is wholly contained within the Northern Areas Council local government area. The relevant Landscape SA board for the Study Area is the Northern and Yorke region, and the Study Area falls under the Southern and South-Western Flatlands (East) national resource management sub cluster.

2.3 Topography, Land Use, Geology and Soils

2.3.1 Major Catchments

The Study Area contains two major channels flowing around the town from the north, being Rocky River and Pine Creek. There is also an unnamed watercourse flowing past the town to the east, crossing under Horrocks Highway to the south of Laura. Major catchment boundaries for these watercourses were delineated using regional topographic data obtained from the ELVIS online spatial data service developed and maintained by Geoscience Australia.

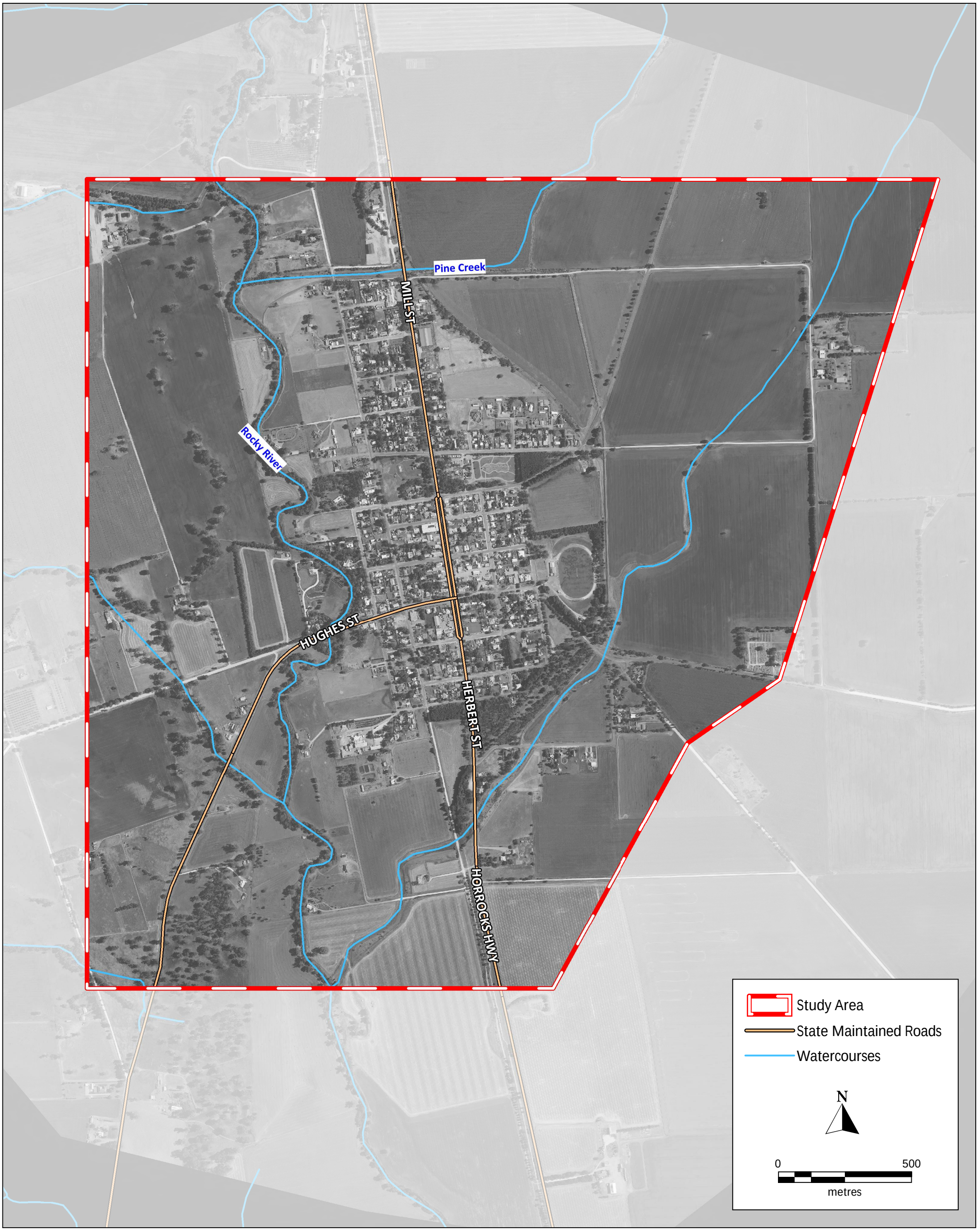
In general, the upstream catchments are rural in nature with minimal development. The Rocky River catchment contains the township of Wirrabara, and the Pine Creek catchment contains the townships of Appila and Tarcowie. The unnamed watercourse catchment is also largely rural in nature, comprised of mainly agricultural land.

The Rocky River catchment is characterised by hilly, steep terrain upstream in the catchment with grades upwards of 3%, and flatter terrain further south towards Laura with a grade of 0.3%. The catchment extends north into the District Council of Mount Remarkable.

The Pine Creek catchment is comprised of two distinct regions, separated by a long ridge between Appila and Tarcowie. West of this ridge, the catchment topography is fairly gentle, with grades of less than 1%, however east of the ridge the elevation increases, with slopes reaching over 3%. Both regions come together as the main channel flows towards Laura, where the grade flattens to under 0.5%. The catchment extends north into the District Council of Mount Remarkable and the District Council of Orroroo Carrieton.

The unnamed watercourse catchment is characterised by a relatively flat channel with a longitudinal grade of under 0.5%, and steeper hilly terrain in the upstream reaches with channel slopes of 1% to 3%.

The catchments for the Rocky River and Pine Creek were found to be very large. A summary of catchment sizes is presented in Table 2.1, and the catchment extents are shown in Figure 2.2.



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Data Sources:
Northern Areas Council (Aerial Photography)
Data SA (State Maintained Roads, Watercourses)

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FIGURE 2.1 - STUDY AREA

Table 2.1 Catchment Size Information

Catchment	Area (km^2)
Rocky River	285
Pine Creek	583
Unnamed Watercourse	11

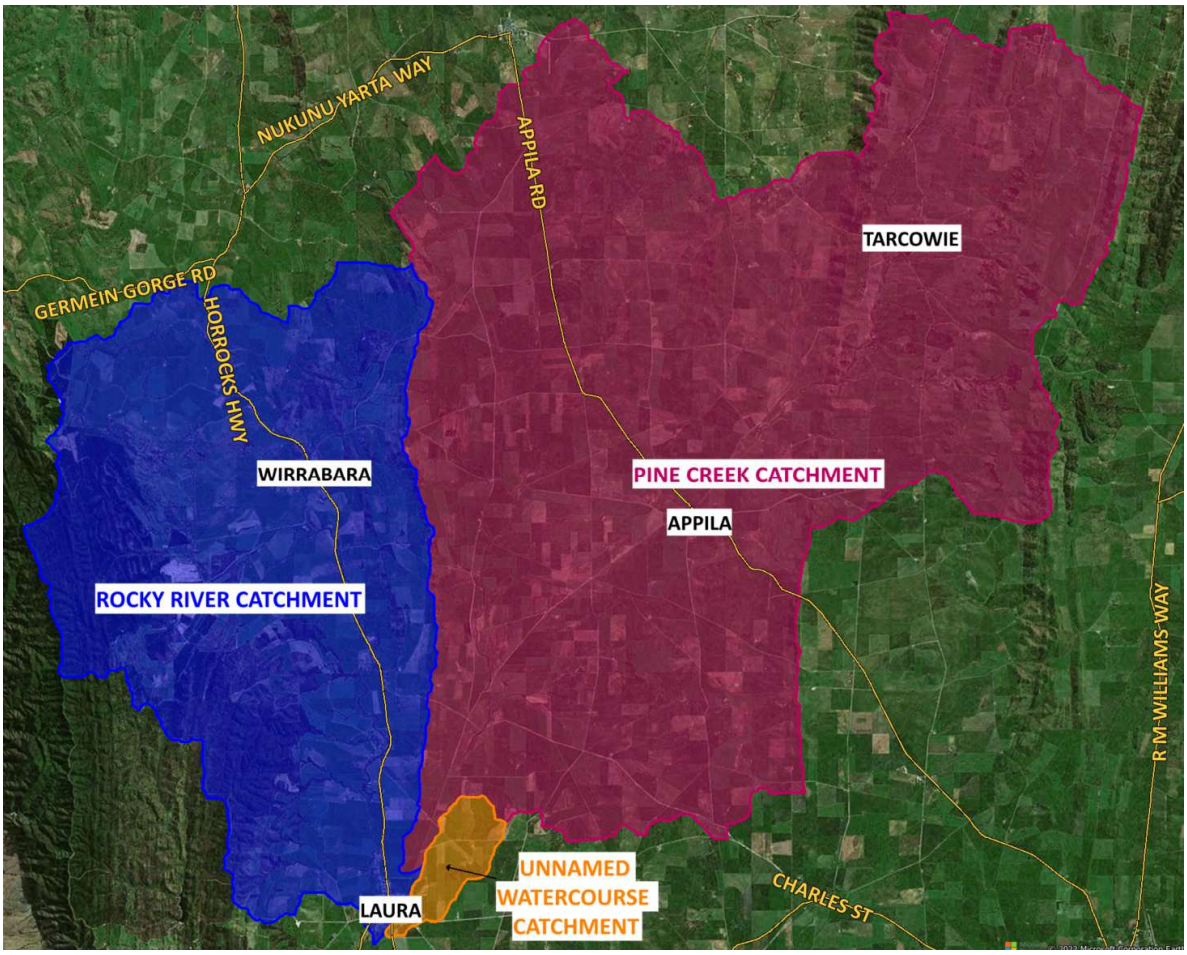
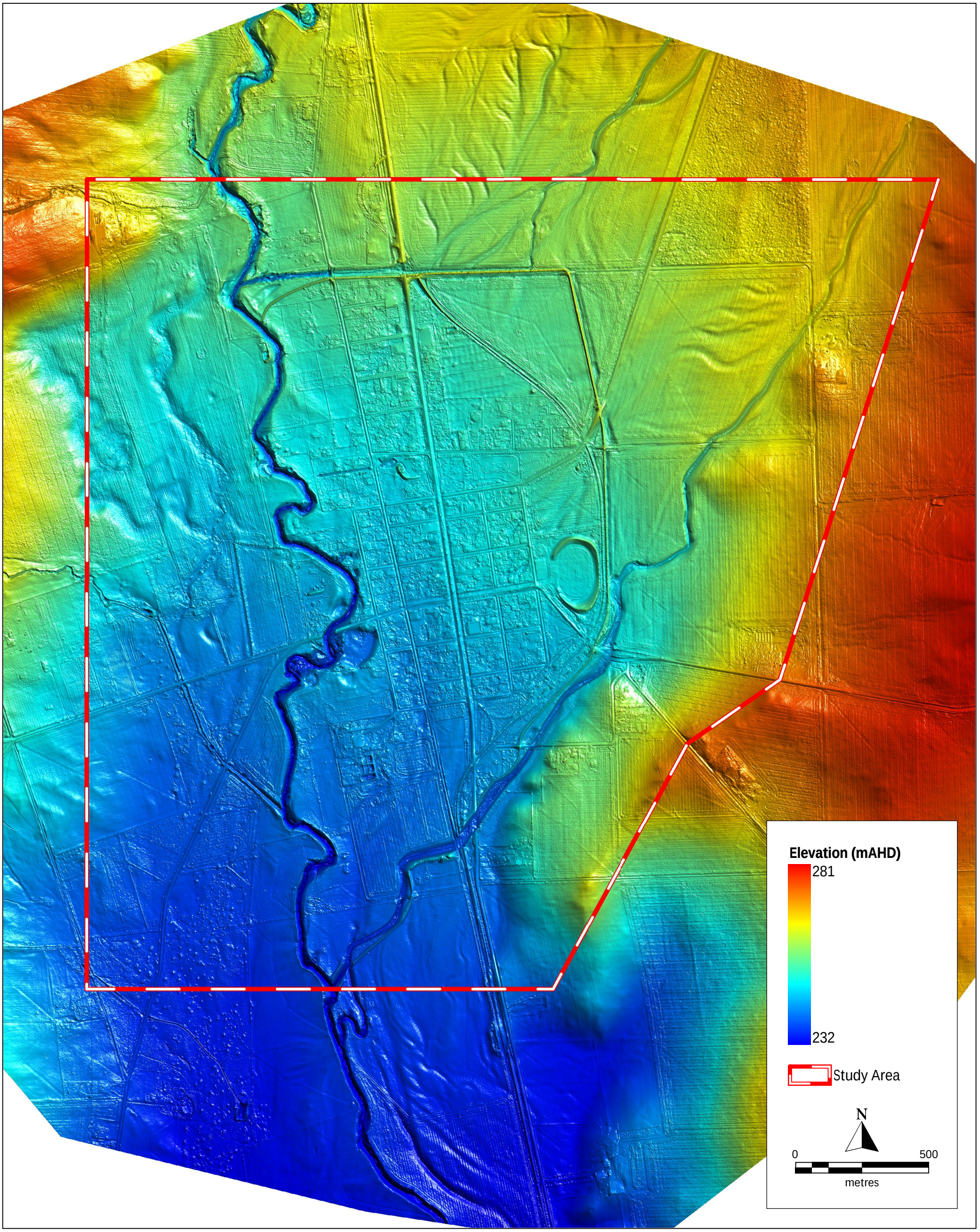


Figure 2.2 Major Catchment Boundaries

2.3.2 Topography

A Digital Terrain Model (DTM) of the Laura township has been provided by Council for this SMP. The DTM was generated from a Light Detection And Ranging (LiDAR) point data capture of nine regional South Australian townships undertaken between October 2021 and November 2021. The LiDAR has a spacing of approximately 14.2 to 15.6 points per square metre, and a reported vertical accuracy of +/- 0.06 m (95% confidence interval). The DTM is shown in Figure 2.3 below.

Regions of higher elevation can be seen to the west, north and east of the township, with Rocky River and Pine Creek coming together before running along the western side of the town and flowing south out of the Study Area. Flood protection levees can be seen separating the town from the watercourses. The township is shown to grade generally from northeast to southwest, with water running overland towards the major channels.



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Data Sources:
Southfront (Study Area)
Northern Areas Council (DTM)

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FIGURE 2.3 - TOPOGRAPHY

2.3.3 Land Use

Land use throughout the study area has been sourced from the Valuer General's Generalized Land Use Dataset (2021). This GIS layer is based on actual land use rather than zoning, and within the Study Area can be broken down as follows:

- 57 ha of Residential, 123 ha of Rural Residential and 13 ha of Vacant Residential;
- 431 ha of Agriculture, 22 ha of Livestock, 8 ha of Horticulture and 4 ha of Food Industry;
- 7 ha of Utility/Industry;
- 4 ha of Retail Commercial and 1 ha of Commercial;
- 3 ha of Public Institution and 2 ha of Education;
- 30 ha of Recreation and 4 ha of Reserve; and
- 42 ha of Vacant.

Land Use within the Study Area can be seen in Figure 2.4.

2.3.4 Geology and Soils

Geological information throughout the study area and upstream catchments has been sourced from the South Australian Resources Information Gateway (SARIG) website developed by the Department for Energy and Mining. This dataset provides stratigraphic information throughout the state and was used to gain an understanding of the geology of the region.

The dataset indicates that the township of Laura is located on holocene alluvial plain sediments. Analysis of the upstream catchments indicates that the Rocky River catchment primarily consists of Saddleworth Formation, Rhynie Sandstone, Quaternary alluvial/fluvial sediments, appila tillite and Skillogalee Dolomite. The Pine Creek catchment was observed to be somewhat similar, comprised of Saddleworth Formation, quaternary alluvial/fluvial sediments, Holocene alluvial/fluvial deposits, Tarcowie Siltstone and Tapley Hill Formation.

As part of the *Laura Stormwater Management Plan* (Wallbridge & Gilbert, 2010), a review of Aquifer Storage and Recharge (ASR) potential was undertaken. This investigation inspected available geology and drillhole data to determine the feasibility of several proposed ASR systems.

The report found that there was some potential for ASR within the region. The report indicates that for larger scale ASR schemes (in the order of 35-45 ML/yr) there is a moderate to high risk that the aquifer systems are not suitable. This is due to the wide range of yields recorded from the shallow sediments in the area and the expected low injection rate achievable, in the order of 2-3 L/s. However, the report suggests ASR may be more suited to smaller bioretention systems with a capacity in the order of 10 ML/yr.

2.4 Climate and Hydrology

2.4.1 Rainfall and Temperature Analysis

Daily rainfall data from the Bureau of Meteorology rainfall gauge in Laura (Station 21031) was obtained from the Bureau of Meteorology weather station directory online service, for the years 1876 – 2022. The mean annual rainfall in Laura was found to be 457 mm.

Land Use

- Agriculture
- Commercial
- Education
- Food Industry
- Horticulture
- Livestock
- Public Institution
- Recreation
- Reserve
- Residential
- Retail Commercial
- Rural Residential
- Utility/Industry
- Vacant
- Vacant Residential
- Study Area

0 500
metres

N

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Data Sources:
Southfront (SMP Study Area)
Data SA (Generalised Land Use)

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FIGURE 2.4 - LAND USE

Statistical analysis of the annual rainfall variation is also provided by the Bureau of Meteorology, which reports variations from the annual mean as summarised in Table 2.2 and Figure 2.5, which show monthly deviations from the annual mean and illustrate monthly trends.

Table 2.2 Rainfall Data for Laura (Station 21031)

Statistic [Year of Occurrence]	Annual Rainfall (mm)	% Difference to Mean
Mean	457.0	-
Lowest [1967]	215.5	-53%
5th percentile	279.6	-39%
10th percentile	324.8	-29%
Median	446.9	-2.2%
90th percentile	609.0	+33%
95th percentile	642.3	+41%
Highest [1992]	861.9	+89%

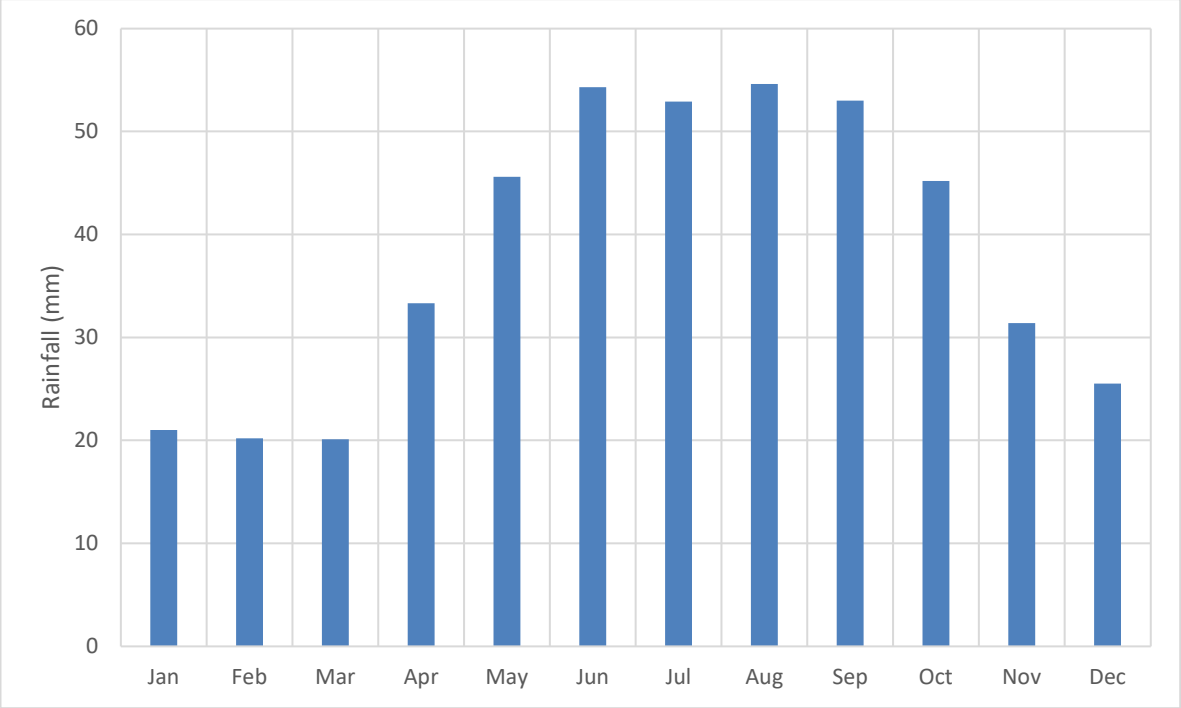


Figure 2.5 Laura Mean Monthly Rainfall

Historical daily maximum temperature information from 1900 to 2022 at Laura was acquired from the SILO website managed by the Queensland Government. This data was analysed and the average maximum temperature for each month was determined. Daily evaporation data for the same time period was also obtained from the SILO website, and analysed to find average monthly evaporation. The two are shown in Figure 2.6 below.

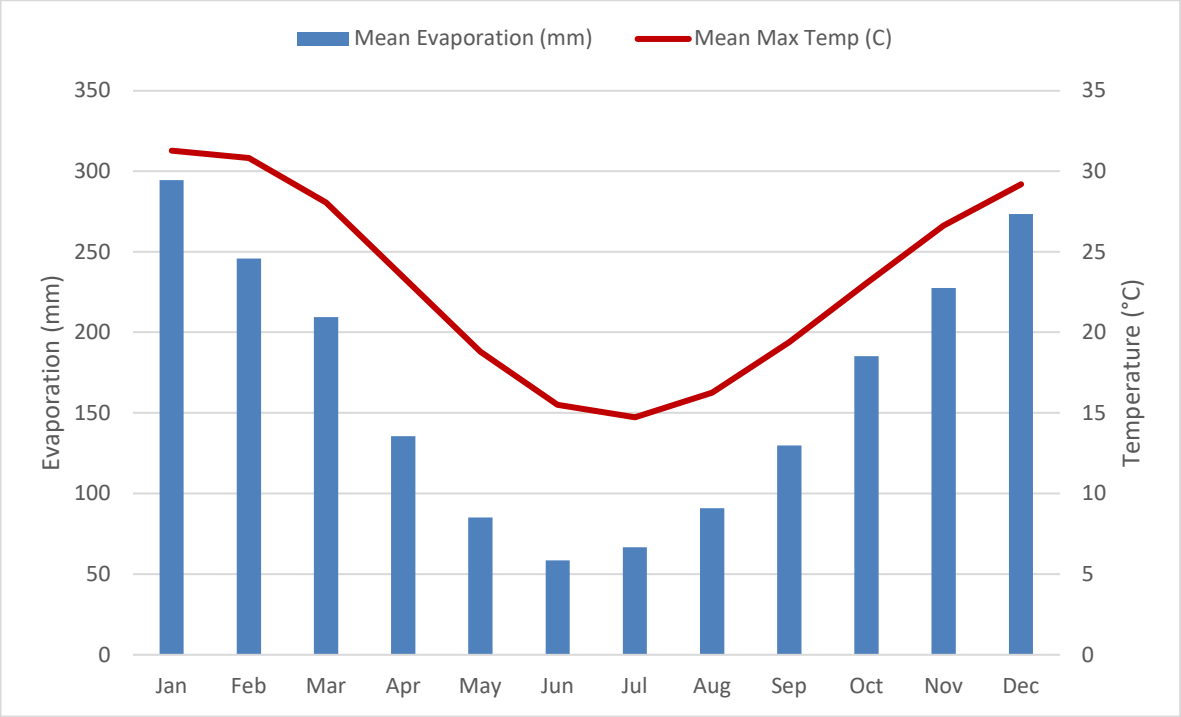


Figure 2.6 Laura Monthly Evaporation and Temperature

Figure 2.6 above shows that evaporation and maximum temperature are strongly correlated as would be expected.

2.4.2 Design Rainfalls

Design rainfall Intensity-Frequency-Duration (IFD) data has been prepared for Laura utilising the Australian Rainfall and Runoff 2019 (ARR 2019) online procedure provided by the Bureau of Meteorology. This data is presented in Table 2.3 for the relevant Annual Exceedance Probabilities.

Table 2.3 IFD Design Rainfall Intensities (mm/hr)

Duration	Annual Exceedance Probability (AEP)					
	18.2%	10%	5%	2%	1%	0.2%
1 min	122	147	177	220	256	331
2 min	106	129	156	196	230	303
3 min	95.2	116	140	175	205	268
4 min	87.0	105	127	158	185	242
5 min	80.3	97.2	117	146	170	221
10 min	59.5	71.9	86.2	107	125	161
15 min	48.3	58.3	70.0	87.0	101	131
30 min	32.3	39.1	47.0	58.5	68.2	88.4
1 hour	20.8	25.1	30.3	37.7	44.0	57.3

Duration	Annual Exceedance Probability (AEP)					
	18.2%	10%	5%	2%	1%	0.2%
2 hour	13.1	15.8	19.0	23.6	27.5	35.8
3 hour	10.0	12.0	14.4	17.8	20.7	26.8
6 hour	6.29	7.49	8.89	10.9	12.6	16.2
12 hour	3.94	4.67	5.51	6.72	7.72	9.90
24 hour	2.44	2.89	3.41	4.15	4.75	6.16
48 hour	1.47	1.75	2.08	2.53	2.91	3.92
72 hour	1.07	1.28	1.52	1.87	2.15	2.93

2.4.3 Impact of Climate Change

Climate change leads to changes in the frequency, intensity, spatial extent, duration and timing of extreme weather and climate events. Within a stormwater management context, potential future changes in rainfall patterns are of particular interest, as these result in changes to levels of flood protection, stormwater drainage performance and the availability of stormwater for harvesting and reuse.

ARR 2019 provides an approach for addressing the risks posed by climate change in projects and decisions that involve estimation of design flood characteristics. It draws on the most recent climate science, particularly the release of the Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report* (IPCC, 2014) as well as *Guide to Climate Projections for Risk Assessment and Planning in South Australia* (Department for Environment and Water, 2022).

The procedure relies on the Climate Futures web tool developed by the CSIRO where projected changes from Global Climate Models (GCMs) can be explored for fourteen 20-year periods based on four Representative Concentration Pathways (RCPs) for greenhouse gas and aerosol concentrations that were used to drive the GCMs. The pathways are provided by regional Natural Resource Management (NRM) clusters (divided into 11 regions nationally), with the Laura Study Area falling within the Southern and South-Western Flatlands (East) region.

ARR 2019 recommends the use of RCPs 4.5 and 8.5 (low and high concentration pathways, respectively) for rainfall intensity impact assessment. Further details can be found at the Australian Climate Futures website (https://www.climatechangeinaustralia.gov.au).

For this study, the designated climate planning horizon was the year 2050. Using the web tool, Table 2.4 indicates the IPCC GCM consensus for rising temperatures as a result of rising greenhouse gas emissions for high and low scenarios for the region.

Table 2.4 GCM Predicted Changes to Annual Mean Surface Temperature (2050)

RCP Scenario	GCM Consensus	Projected Annual Mean Surface Temperature Change (^{o}C)
4.5	Warmer (45 of 46)	+ 0.5 to + 1.5
8.5	Warmer (27 of 48),	+ 0.5 to + 1.5

	Hotter (21 of 48)	+ 1.5 to + 3.0

ARR 2019 recommends using the temperature midpoint of the projected annual mean surface temperature change to calculate adjustments to the projected rainfall intensity using the following equation:

$$I_p = I_{ARR} \times 1.05^{T_m}$$

Where I_p is the projected rainfall intensity, I_{ARR} is the design rainfall intensity for current climate conditions, 1.05 is the assumed temperature scaling based on the approximately exponential relationship between temperature and humidity, and T_m is the temperature at the midpoint of the selected class interval.

As the models could not come to a consensus for both RCP scenarios, the temperature midpoint of the wider interval +0.5 to +3.0 ^{o}C (1.75 ^{o}C) was used. Therefore, $I_p = I_{ARR}$ x 1.09 (i.e. a 9% intensity increase for 2050). The Intensity-Frequency-Duration data for Frequent and Infrequent storms is shown in Table 2.5 with this climate change factor applied. The modelling of proposed drainage infrastructure will utilise these rainfall intensities.

Table 2.5 IFD Design Rainfall Intensities (mm/hr) with Climate Change Factor (2050)

Duration	Annual Exceedance Probability (AEP)					
	18.2%	10%	5%	2%	1%	0.2%
1 min	133	160	193	240	279	361
2 min	116	141	170	214	251	330
3 min	104	126	153	191	223	292
4 min	94.8	114	138	172	202	264
5 min	87.5	106	128	159	185	241
10 min	64.9	78.4	94.0	117	136	175
15 min	52.6	63.5	76.3	94.8	110	143
30 min	35.2	42.6	51.2	63.8	74.3	96.4
1 hour	22.7	27.4	33.0	41.1	48.0	62.5
2 hour	14.3	17.2	20.7	25.7	30.0	39.0
3 hour	10.9	13.1	15.7	19.4	22.6	29.2
6 hour	6.86	8.16	9.69	11.9	13.7	17.7
12 hour	4.29	5.09	6.01	7.32	8.41	10.8
24 hour	2.66	3.15	3.72	4.52	5.18	6.71
48 hour	1.60	1.91	2.27	2.76	3.17	4.27
72 hour	1.17	1.40	1.66	2.04	2.34	3.19

The Climate Futures web tool also showed that annual rainfall is predicted to decrease within the Southern and South Western Flatlands (East) National Resources Management Sub Cluster. GCM consensus results for RCP scenarios 4.5 and 8.5 are shown in Table 2.6.

Table 2.6 GCM Predicted Changes to Annual Rainfall (2050)

RCP Scenario	GCM Consensus Rainfall	Projected Annual Rainfall Change (%)
4.5	Drier (29 of 68) Little Change (28 of 68)	-15 to -5 -5 to +5
8.5	Drier (25 of 70) Little Change (27 of 70)	-15 to -5 -5 to +5

As can be seen, GCM consensus for both RCP scenarios indicates annual rainfall becoming 'drier' or having 'little change' by the year 2050. Taking the midpoint of the wider range (-15% to +5%), an average annual rainfall reduction of 5% by 2050 is predicted.

The impact of climate change on soil moisture, particularly within the study area, is unclear. However, it is expected that soil moisture will decrease as temperature increases, which is forecasted over the planning horizon for this Stormwater Management Plan.

2.4.4 Hydrology of the Study Area

As discussed in Section 2.3.1, the township of Laura is situated near two major watercourses, Rocky River and Pine Creek, with catchments of 283 km^2 and 584 km^2 respectively. Pine Creek flows towards Laura from the northeast, reaching Switch Back Road, and is then diverted west towards Rocky River by levee banks. In doing so, Pine Creek flows under a major bridge at Horrocks Highway and over Stock Route Road before reaching Rocky River. Rocky River then meanders to the west of Laura as it moves south, crossing beneath Hughes Street before leaving the Study Area.

There are also two smaller, unnamed watercourses within the study area. From the west, a watercourse flows across Laura-Beetaloo Road and Possum Park Road and joins Rocky River. From the east, a watercourse flows along the outskirts of town under Laura-Caltowie Road, Tom Catt Hill Road and Horrocks Highway before connecting into Rocky River.

In the development of this Stormwater Management Plan, Council staff have expressed concerns that the levee banks have previously collapsed after flood events, and that the confluence of Pine Creek and Rocky River is overgrown and contains large dead tree trunks which may affect the area of inundation. A photograph of this has been provided by Council and is shown below in Figure 2.7.



Figure 2.7 Vegetation at the Confluence of Rocky River and Pine Creek

It is understood that the levee banks currently surrounding Laura were constructed in the 1960's following multiple failures of the former levee banks, which were originally constructed between 1920 and 1921. Figure 2.8 below is a photograph provided by Council which shows the levee bank collapsing on the leeward side of the Pine Creek following a flow event. The hospital can be seen in the background, demonstrating the importance of the levee system and the risk facing the community should they be breached.



Figure 2.8 Laura Levee Bank

We are not aware of any maintenance or inspection regime for the levees. Upon inspection of the DEM, the first informal overtopping location of the levee appears to be at the intersection of Horrocks Highway and Mill Street. However this assumes that no prior levee breaches will occur due to structural failure of the levee banks.

2.4.5 History of Flooding and Drought in Laura

As summarised in *Laura Township Stormwater Drainage Assessment* (GHD, 2007), Laura has experienced major flood events in 1921, 1933, 1938, 1940-41, 1973 and 1975. In addition, *Floods in South Australia: 1836-2005* (Bureau of Meteorology, 2006) documents flooding of varying severity in Laura in 1884, 1886, 1887, 1888, 1894, 1895, 1914, 1939 and 1976. The frequency with which flooding has historically occurred within Laura speaks to the stormwater management challenges facing the town, being located between two major watercourses and having relatively low gradients through the township. Figure 2.9, Figure 2.10 and Figure 2.11 below show historic photographs of the 1941 flood, during which Pine Creek broke its banks at Laura, leading to flooding throughout the town.



Figure 2.9 Properties Inundated in Laura (Source: State Library of South Australia)



Figure 2.10 Wide Floodplain near Laura (Source: State Library of South Australia)



Figure 2.11 Flooding in Laura (Source: The Laura Standard)

While Laura has experienced many periods of intense rainfall, it has also experienced a number of droughts, including the following:

- The Federation drought (1895 to 1902);
- The 1914 to 1915 drought;
- The World War II drought (1937 to 1945);
- The 1965 to 1968 drought;
- The 1982 to 1983 drought;
- The Millenium drought (1997 to 2009); and
- The 2017 to 2019 drought.

2.4.6 Available Hydrometric Data

The Water Data SA website, operated by the Department for Environment and Water, was accessed to determine the availability of hydrometric data within the Study Area. No flow gauges were found within either the Rocky River catchment or the Pine Creek catchment, with the nearest gauge being on the Rocky River downstream of Laura, southeast of Crystal Brook. Similarly, there was no data available for the drainage networks within the Study Area.

2.4.7 Surface Water and Groundwater Interaction

We are not aware of any studies or information investigating the interaction between surface water and groundwater in Laura. However publicly available drillhole log information from the WaterConnect website suggests that the groundwater table is in excess of 6 m deep, and is therefore considered unlikely to meaningfully impact surface water from a stormwater management perspective. More broadly, the *Rocky River Catchment Water Resources Assessment* (Department of Water, Land and Biodiversity Conservation, 2005) estimated for the entire catchment an annual groundwater recharge of 2,500-24,000 ML.

2.5 Stormwater and Flood Infrastructure

2.5.1 Existing Infrastructure

Northern Areas Council maintains records of existing stormwater infrastructure, which have been provided for this Stormwater Management Plan. This information is in the form of a GIS point layer containing asset data, and a separate excel spreadsheet of stormwater asset data.

Using the supplied GIS data, together with aerial photography, the DTM and information gained on a site visit, stormwater pit and stormwater pipe layers were created. Engineering design drawings were sourced from Council to determine the alignment and details of a newly constructed stormwater network, detention basin and GPT. Figure 2.12 below provides an overview of the location and extent of existing stormwater infrastructure within the study area. A summary profile of existing infrastructure is provided in Table 2.7.

Table 2.7 Existing Stormwater Infrastructure

Asset Class	Description	Quantity
Pipe	150mm dia 225mm dia 375mm dia 450mm dia 600mm dia 750mm dia 900mm dia Unknown dia	32 m 57 m 221 m 133 m 190 m 106 m 59 m 30 m
Box Culvert	Size varying	297 m
Node	Side Entry Pit Headwall Grated Inlet Pit Junction Box	16 36 1 2
Gross Pollutant Trap	N/A	1
Detention Basin	N/A	1
Levee	N/A	3,249 m

2.5.2 Stormwater Asset Age and Condition

Council's GIS and spreadsheet stormwater asset databases contain condition information, however as discussed these are not linked to spatially accurate pit and pipe objects, and therefore it is difficult to map asset condition. The two databases do not list asset age, however the spreadsheet lists a date of expiry.

2.5.3 Stormwater Asset Management Planning

Council are in the process of developing a Stormwater Asset Management Plan (personal communication David McKinley, October 2022), which will be used to guide the planning and maintenance of Council's stormwater assets. Other relevant processes and plans include:

- *Stormwater Management Planning Guidelines* (Stormwater Management Authority, 2007);
- *Asset Management Policy* (Northern Areas Council, 2022); and
- *Long Term Financial Plan 2021-22 to 2030-31* (Northern Areas Council, 2021).

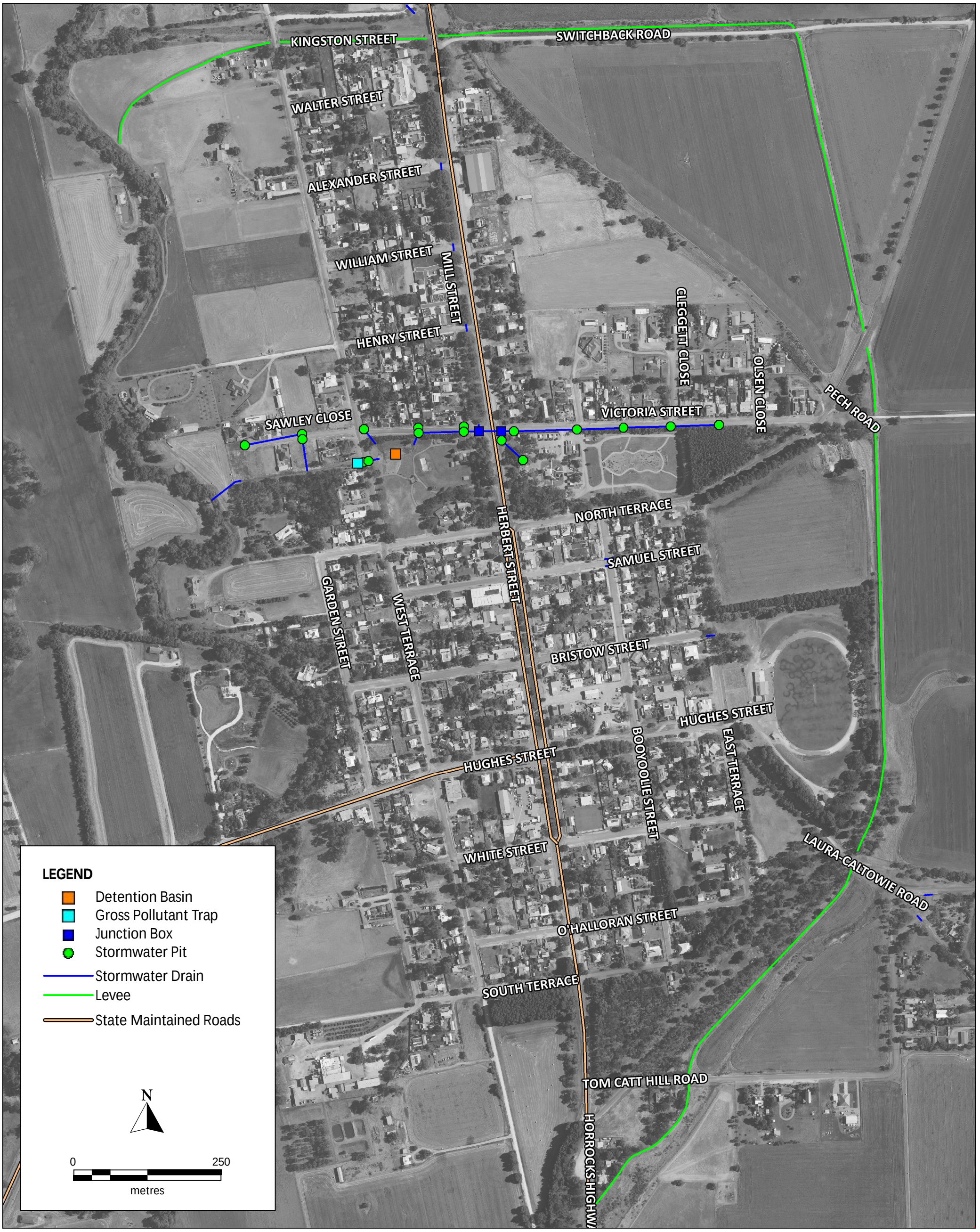
2.5.4 Actual and Desired Level of Service

The existing level of service provided by stormwater infrastructure has previously been investigated in 2007 and 2010. These studies identified a number of problem areas, namely along Herbert Street and West Terrace. The main issues included ponding at intersections, property flooding, standing water after minor storms and wide flow widths in the swales.

The study also raised concerns about future flows from north of Victoria Street, associated with future development, which would exacerbate current conditions. However, it is understood that a stormwater drainage network has been recently constructed within Victoria Street, intercepting the catchment north of Victoria Street and sending it west towards Rocky River and away from the town centre.

From discussions with Council staff, it is assumed that there are no formalised level of service requirements for stormwater management within the Study Area. Rather, priorities involve protecting the town from major flooding and managing more frequent nuisance ponding. Key level of service targets for this study will be selected through discussions with Council staff.

The drainage network within Victoria Street drains through a gross pollutant trap, however the rest of the Study Area flows untreated towards Rocky River. As with flood protection, we are unaware of defined water quality targets set by Council.



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Data Sources:
Northern Areas Council (Aerial Photography, Stormwater Assets)
Southfront (Levees)
Data SA (State Maintained Roads)

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LAURA STORMWATER MANAGEMENT PLAN

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FIGURE 2.12 - STORMWATER INFRASTRUCTURE

2.6 Environmental Values

2.6.1 Water Quality

The quality of water within the Study Area is of great importance. The primary downstream receiving waters is Rocky River, and therefore it is important that appropriate consideration is given to pollutants in runoff leaving the Study Area. Additionally, the quality of stormwater will impact the feasibility of potential stormwater harvesting and reuse schemes. *Water sensitive urban design – Creating more liveable and water sensitive cities in South Australia* (Department of Environment, Water and Natural Resources, 2013) provides WSUD performance targets for South Australia, which will be benchmarked against in this report.

As shown in Section 2.5, the underground stormwater network within Victoria Street drains into a large detention basin, before crossing West Terrace where runoff is treated by a GPT prior to discharge towards Rocky River. The remainder of the study area which does not drain to this detention basin makes its way towards Rocky River untreated.

Typical stormwater pollutants include:

- Total suspended solids (TSS), commonly clay, gravel, sand and silt, but also including algae and decomposing organic material;
- Total phosphorus (TP), with common sources including sewage, intensive livestock industries, soil, fertilisers and detergents;
- Total nitrogen (TN), with common sources including food processing industries, sewage, intensive livestock industries, soil and fertilisers; and
- Gross pollutants, typically including rubbish, plant debris and coarse sediment.

We are not aware of any pollutant base load or concentration information specific to the Study Area, however it is expected these would be comparable to those for catchments primarily comprised of agricultural and grazing land use.

The presence of total suspended solids in watercourses can result in cloudier water, affecting the oxygen levels within the water and potentially harming animals and plants living within it, as well as humans if the water is consumed. High levels of total phosphorus and total nitrogen often cause blue-green algal blooms, which can produce harmful toxins to humans through contact or consumption. Gross pollutants such as litter can be harmful to receiving waters if not screened, with animals potentially consuming plastics or other rubbish.

Australian Guidelines for Water Recycling: Stormwater Harvesting and Reuse (Natural Resource Management Ministerial Council, 2009) recommends including stormwater treatment to minimise operational risks. Operational risks include gross pollutants blocking pipes or damaging pumps and organic matter resulting in reduced oxygen levels, potentially creating odours and releasing pollutants from sediments.

2.6.2 Threatened/Sensitive Ecological Communities

It is important to consider the impact of stormwater runoff on the downstream environment. *A River Management Plan for the Broughton Catchment* (Department of Water, Land and Biodiversity Conservation, 2004) describes the water dependent ecosystems and processes throughout the Broughton River Catchment, of which the Rocky River is a major tributary.

Within the bed of the Rocky River downstream of Laura, there are extensive reedbeds containing common reed and bulrush. In the surrounding floodplain, river red gums are present with the vegetation reflecting that of an open forest. Submerged aquatic vegetation is present in permanent pools. A wide range of macro-invertebrates were found within the downstream receiving waters, including worms, amphipods, midge larva and springtails. Fish species identified in Rocky River include blue spot goby, eastern gambusia and goldfish.

2.6.3 Watercourse Assessment

As discussed, the major watercourses within the Study Area are the Rocky River and Pine Creek. *A River Management Plan for the Broughton Catchment* (Department of Water, Land and Biodiversity Conservation, 2004) undertook a condition assessment of all fourth order and larger watercourses, considering watercourse vegetation, channel condition, any structures and surrounding land use.

The Rocky River vegetation within the Study Area was found to consist of exotic trees, transitioning to native watercourse vegetation just downstream of Laura. The understorey vegetation has been modified due to the impact of grazing and clearance, with most areas lacking shrub species. Exotic trees are a significant and widespread problem along the river. The channel condition was found to be healthy, with good bank stability within and immediately surrounding the study area. A number of structures were identified within the watercourse, including fords/culverts and a bridge, which were all reported to have high stability.

Pine Creek was identified having poor native watercourse vegetation, with a region of erosion heads further upstream. Agricultural development has significantly modified most of the native watercourse vegetation along the channel. The condition of the vegetation is generally poor. The bank stability was found to be good within and immediately upstream of the study area. Several fords/culverts were identified in Pine Creek, with one reportedly having medium stability while the others all had high stability. A high stability weir was also identified just upstream of the confluence with Rocky River.

In a site visit undertaken on 12 October 2022, Pine Creek was inspected at the Horrocks Highway crossing, and found to be a wide channel with short grassy vegetation. Thick, reedy vegetation was observed beneath the bridge deck and along the levee bank to the south. Several newly planted trees were also identified along the top of the levee, as shown in Figure 2.13 below. Tree roots can reduce the stability of a levee, and therefore it is recommended that these are removed.



Figure 2.13 Levee Bank with Newly Planted Trees

2.6.4 Areas of Environmental Importance

The Rocky River channel and surrounding floodplain downstream of Laura was identified in *A River Management Plan for the Broughton Catchment* (Department of Water, Land and Biodiversity Conservation, 2004) as an important riverine ecosystem. The lower reaches of the Rocky River comprise extensive reedbeds and sedgelands, sparse trees and shrubs and permanent pool environments. Further downstream the surrounding habitat consists of river red gum open forest and permanent pool environments. In-stream habitats and aquatic habitats, as well as a range of native vegetation were identified. These elements result in increased amenity, higher recreational value and improved environmental health.

2.6.5 Environmental Flows

A River Management Plan for the Broughton Catchment (Department of Water, Land and Biodiversity Conservation, 2004) also assessed the environmental flow regimes and requirements for the different watercourses within the greater Broughton River catchment, including Rocky River and Pine Creek. The ecological communities outlined previously all have varying environmental flow requirements, for example river red gums in the floodplain are dependent on infrequent overbank flows, while macro-invertebrates require various flow regimes ranging from no flow to mid-bank flows. Table 2.8 below describes the environmental flow requirements for Rocky River and Pine Creek in the vicinity of the Study Area.

Table 2.8 Watercourse Environmental Flow Requirements (Department of Water, Land and Biodiversity Conservation, 2004)

Flow Band	Key Functions	Frequency (every X years)	
		Rocky River	Pine Creek
Groundwater table – Riverbed wetted, pools filled	Maintain aquatic habitat Maintain macrophytes	1	1
Mid flow – Low flow channel filled	Increase aquatic habitat Connectivity between pools Migration of macro-invertebrates Migration of fish	1 to 3	0.5 to 2
High-bankfull flow – Three-quarter bankfull to bankfull flows	Maintain water quality Maintain riparian vegetation Trigger for fish breeding Channel maintenance Transport sediment/organic matter Removal of fines (riffles)	1 to 5	2 to 5
Overbank flow – Overbank flows into floodplain	Floodplain inundation River red gum establishment Nutrient and organic matter transport Scouring of pools	5 to 20	N/A

Any activity which will modify the frequency, timing, seasonality or water quality of the natural flow regime can have a large impact on the downstream, often sensitive ecological communities. Additionally, on-line farm dams, which were found to be very common upstream in the Rocky River and Pine Creek catchments, can significantly affect the natural flow regime, detaining low flows and restricting the volume of water entering the downstream channel.

The existing stormwater network in Laura, which includes a detention basin servicing a large portion of the urban catchment, has a modest impact on environmental flows. Regions of storage or detention within an upstream catchment will affect the frequency, magnitude and timing of flows entering the receiving waters. However the water treatment properties of the basin, along with the GPT, will improve the quality of the water being discharged and not materially change the frequency of flows experienced downstream.

The increased level of imperviousness associated with development has had a significant impact on the natural flow regime. Hard surfaces result in larger, more frequent runoff compared to pervious surfaces such as that of the natural catchment, and also reduce the response time for a catchment.

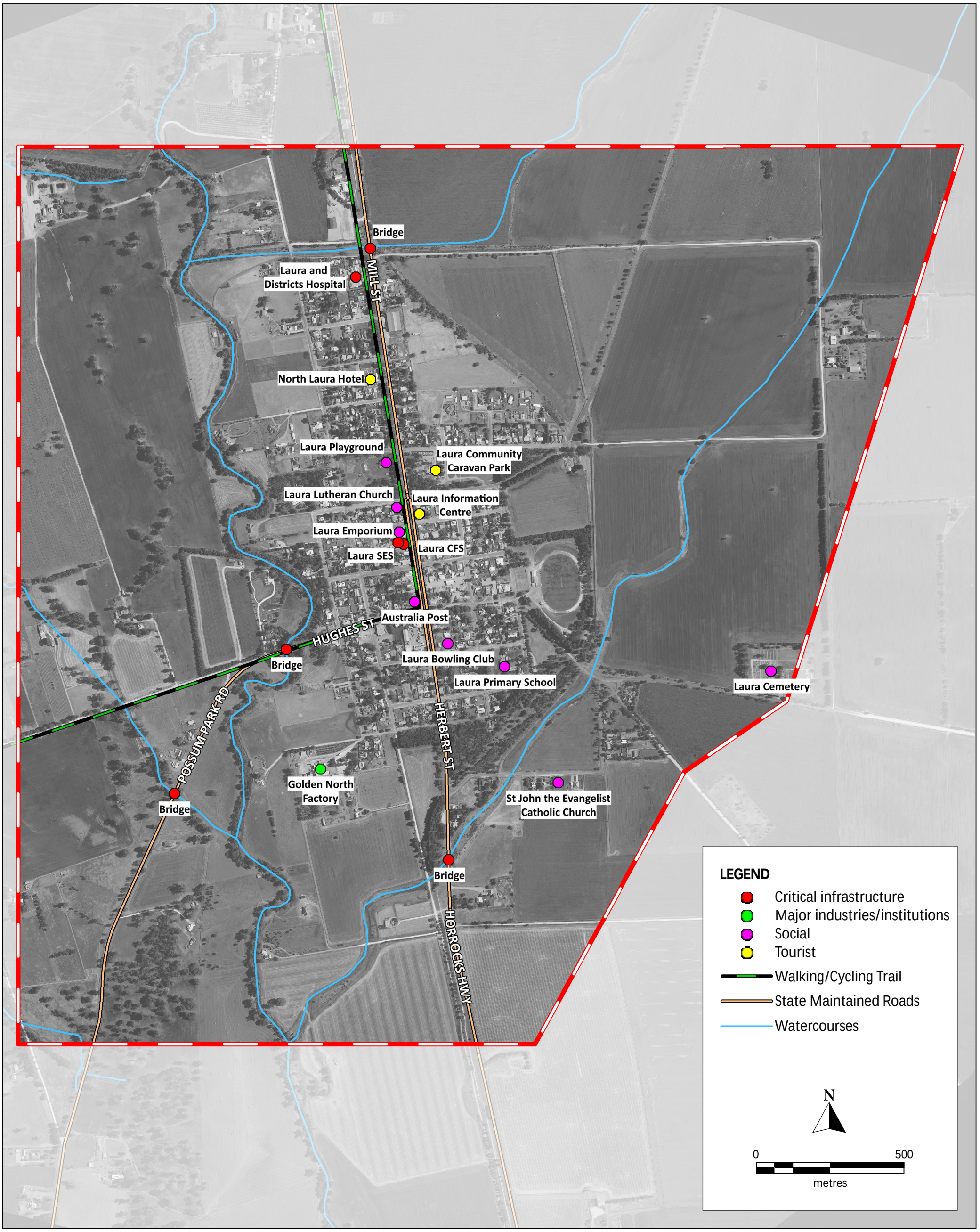
2.7 Social, Socio-Economic and Cultural Values

A map has been prepared summarising locations within the study area of social, socio-economic and cultural importance, and is shown in Figure 2.14. This includes major industries and institutions, critical infrastructure, tourist, trade and social facilities and routes. Of note, the Art Gallery (formerly Laura Courthouse) in town is a State Heritage Place, having been given status in 1983.

The Northern Areas Council is located within Ngadjuri and Nukunu land.

2.8 Development Policy

A map showing the planning and design code zones within the Study Area has been prepared, and is shown in Figure 2.15. As can be seen, within the 'Neighbourhood' zone there remains a reasonable amount of vacant land. Vacant lots within this region can be considered potential sites of future development, and are mainly located west of West Terrace, north of Sawley Close, and along Campbell Street, Cleggett Close and Olsen Close. This confirms information provided by Cr Sue Scarman during a site visit on 12 October 2022, who flagged Olsen Close and the area north of Sawley Close as key areas of development potential in Laura.



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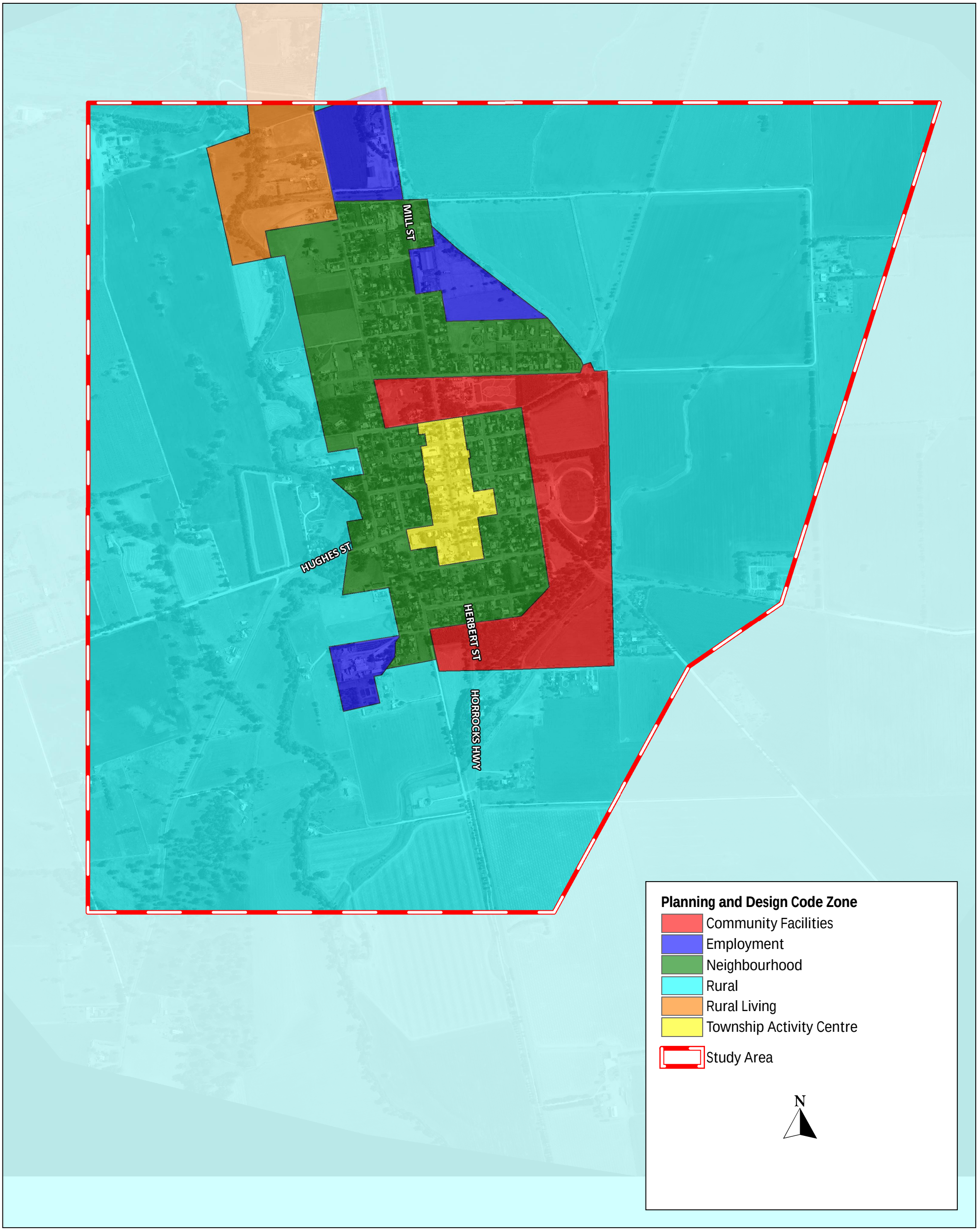
Data Sources:
Northern Areas Council (Aerial Photography)
Southfront (Locations of Interest)
Data SA (State Maintained Roads, Watercourses)

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LAURA STORMWATER MANAGEMENT PLAN

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FIGURE 2.14 - SOCIAL, SOCIO-ECONOMIC AND CULTURAL VALUES



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Data Sources:
Northern Areas Council (Aerial Photography)
Southfront (SMP Study Area)
Data SA (Roads, Planning and Design Code Zones)

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LAURA STORMWATER MANAGEMENT PLAN

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FIGURE 2.15 - PLANNING AND DESIGN CODE ZONES

3 Identification of Stormwater Risks and Issues

3.1 General

Stormwater modelling of the study area has been undertaken, including hydrologic, hydraulic and water quality modelling. Details regarding the development of these models and their key results are provided in *Laura Stormwater Management Plan Modelling Report* (Southfront, 2025). The results from these models have been used to identify risks and issues relating to stormwater within the township.

3.2 Model Scenarios

The hydrological and hydraulic modelling undertaken consider three scenarios, which are described below:

- Scenario A: Current stormwater infrastructure, current development and current climate;
- Scenario B: Current stormwater infrastructure, future development and future climate to the year 2050; and
- Scenario C: Proposed stormwater infrastructure, future development and future climate to the year 2050.

The range of storm frequencies modelled includes the 18% Annual Exceedance Probability (AEP), 10% AEP, 5% AEP, 2% AEP, 1% AEP and 0.2% AEP events.

The water quality modelling considered four scenarios as follows:

- Scenario 1: Existing development with no WSUD infrastructure;
- Scenario 2: Future development with no WSUD infrastructure;
- Scenario 3: Future development with existing WSUD infrastructure; and
- Scenario 4: Future development with existing and proposed WSUD infrastructure.

The climate data used was the Northern and Yorke climate template, as recommended in *South Australian MUSIC Guidelines* (Water Sensitive South Australia, 2021). This data was captured in Roseworthy between 2001 and 2010, during which time the mean annual rainfall was 404 mm. No climate change assumption has been applied in any scenario in line with the specifications of the brief.

3.3 Stormwater Infrastructure Hydraulic Performance

3.3.1 Background

The hydraulic performance of the stormwater network has been modelled across the required range of events and scenarios listed above. The development of the hydrological and hydraulic models has been documented in *Laura Stormwater Management Plan Modelling Report* (Southfront, 2025). The list of deficiencies considered includes over floor flooding (discussed in Section 3.5), high or extreme flood hazard, low freeboard or upwelling in the minor network, stormwater inlet capacity and excessive gutter flow depths or flow widths.

3.3.2 High/Extreme Flood Hazard

Flood hazard is defined by the Australian Institute for Disaster Resilience's Flood Hazard Guideline 7-3 (AIDR, 2017) as a relationship between water depth and velocity. This definition breaks hazard into 6 categories, ranging from lower hazard at H1 through to maximum hazard at H6, as shown in Figure 3.1 below.

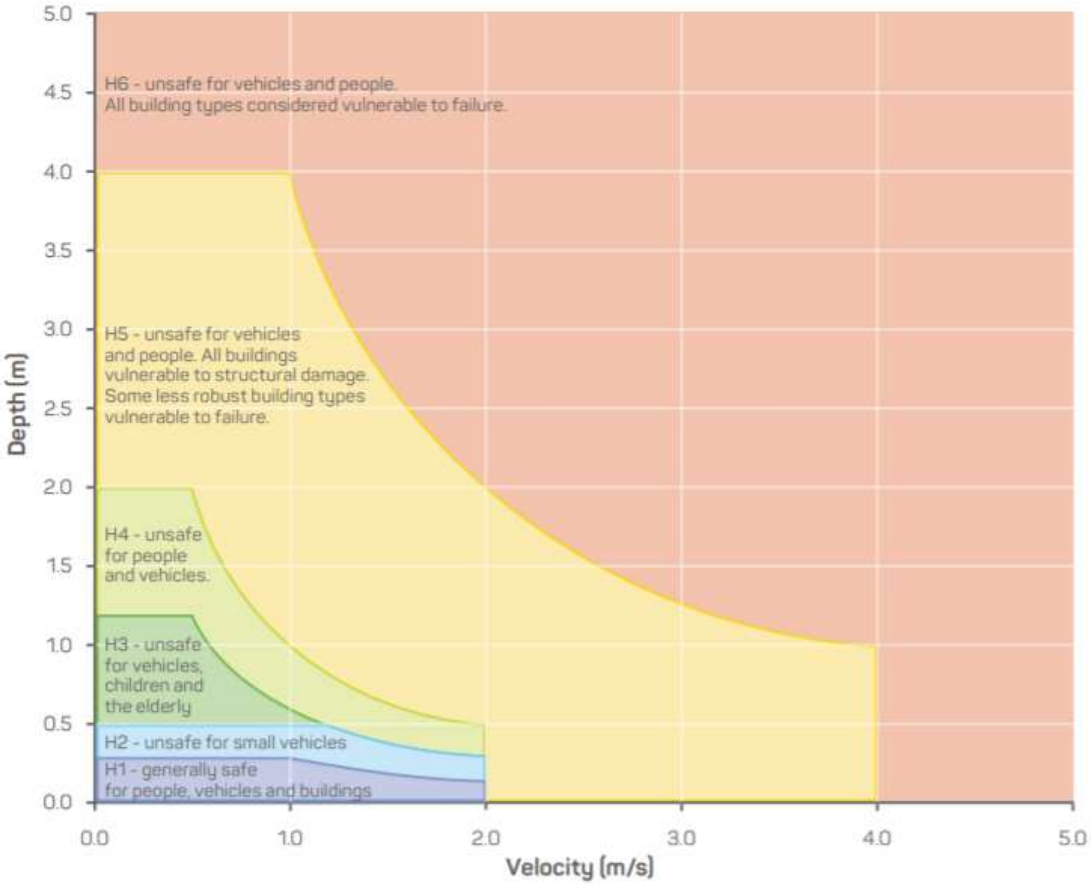


Figure 3.1 Flood Hazard Classification

For this assessment, high flood hazard is defined as category H3 or H4, while extreme flood hazard is defined as category H5 or H6. High and extreme flood hazard within the major watercourses has been ignored for this assessment, and instead flood hazard on roads and through developed land has been considered.

3.3.3 Low Freeboard and Upwelling

The results of the hydraulic modelling have been inspected to determine the maximum HGL level experienced at each stormwater inlet for each AEP. These levels were compared with the node surface level and the level 150 mm below the surface, and when these were exceeded the pit was considered to have upwelled or had insufficient freeboard respectively.

3.3.4 Stormwater Inlet Capacity

An assessment of inlet capacity was undertaken for the stormwater pits in the study area. The capture capacity of each pit was calculated with reference to *SA Road Stormwater Drainage Inlets: Hydraulic Study* (Urban Water Resources Centre). This study examined the performance of the most common stormwater drainage inlets used throughout South Australia, and produced curves relating approach flow with capture flow. Curves for standard side entry pits

have been taken from the City of Charles Sturt pits, while curves for double side entry pits were taken from the City of West Torrens pits.

The peak flow rate approaching each stormwater pit in the 18% AEP storm event was compared with the calculated pit capture capacity, highlighting locations where stormwater pits are undersized relative to their contributing catchment.

3.3.5 Gutter Flow Depth and Flow Width

An assessment was undertaken to determine excessive gutter flow depths and widths in the 18% AEP flood based on flood mapping results. Excessive gutter flow depths have been defined as flooding greater than 100 mm deep in the 18% AEP flood, while excessive gutter flow widths have been defined as flooding greater than 2.5 m wide in the 18% AEP flood.

3.3.6 Hydraulic Performance Assessment

Table 3.1 below presents the various identified stormwater issues for Scenario A in an impact register, providing an ID and a location, describing the type of deficiency, listing the AEP at which the deficiency occurs and providing any additional comments.

Table 3.1 Scenario A Flood Impact Register

ID	Location	Type of Deficiency	AEP Occurring	Comment
1	Rocky River channel west of Walter Street	N/A	2% AEP	Rocky River breaks banks causing widespread road and property inundation throughout Laura
2	Laura-Caltowie Road	High/Extreme Flood Hazard	18% AEP/ 5% AEP	Channel spills across road
3	Pech Road (Central)	Extreme Flood Hazard	18% AEP	Channel spills across road
4	Stock Route Road	Extreme Flood Hazard	18% AEP	Pine Creek channel spills over road
5	Tom Catt Hill Road	High/Extreme Flood Hazard	18% AEP/ 5% AEP	Channel spills across road
6	West Terrace	High/Extreme Flood Hazard	18% AEP/ 5% AEP	Channel spills across road
7	Pech Road (Northeast)	High/Extreme Flood Hazard	18% AEP/ 2% AEP	Channel spills across road
8	Appila-Laura Road	High/Extreme Flood Hazard	5% AEP/ 2% AEP	Flow along levee spills over road
9	Lots on corner of West Terrace/White Street	High Flood Hazard	2% AEP	High flood hazard through residential lots
10	Switchback Road	High/Extreme Flood Hazard	2% AEP/ 1% AEP	Pine Creek overflow spills over road
11	Pech Road (West)	Extreme Flood	2% AEP	Flow along levee spills over

ID	Location	Type of Deficiency	AEP Occurring	Comment
		Hazard		road
12	Possum Park Road	High/Extreme Flood Hazard	2% AEP/ 1% AEP	Channel spills across road
13	West Terrace between Samuel St/White St	High/Extreme Flood Hazard	1% AEP/ 0.2% AEP	Flooding along road
14	Laura-Beetaloo Road west of Hughes Street	Extreme Flood Hazard	1% AEP	Floodplain spills across road
15	West Terrace south of South Terrace	High Flood Hazard	1% AEP	Flooding along road
16	Lots on West Terrace opposite Samuel St	High Flood Hazard	1% AEP	High flood hazard through residential lots
17	Lots on West Terrace between Sawley Close and North Terrace	High Flood Hazard	1% AEP	High flood hazard through residential lots
18	Lots on Stock Route Road north of Pine Creek channel	High Flood Hazard	0.2% AEP	High flood hazard through residential lots
19	Horrocks Highway	Extreme Flood Hazard	0.2% AEP	Floodplain spills across road
20	Victoria Street east of Mill Street	Low Freeboard /Upwelling	10% AEP/ 0.2% AEP	
21	Victoria Street west of Mill Street	Low Freeboard	10% AEP	
		Inlet Capacity	18% AEP	
22	Intersection of Victoria Street and Campbell Street	Low Freeboard	1% AEP	
		Inlet Capacity	18% AEP	
23	Victoria Street between Campbell Street and Cleggett Close	Low Freeboard	2% AEP	
		Inlet Capacity	18% AEP	
		Gutter Flow Depth/Width	18% AEP	
24	Corner of Victoria Street and Cleggett Close	Low Freeboard	5% AEP	
		Inlet Capacity	18% AEP	
		Gutter Flow Depth/Width	18% AEP	
25	Victoria Street between Cleggett Close and Olsen Street	Low Freeboard	1% AEP	
		Inlet Capacity	18% AEP	
26	Victoria Street between Mill Street and West	Low Freeboard	5% AEP	

ID	Location	Type of Deficiency	AEP Occurring	Comment
	Terrace			
27	Corner Victoria Street and West Terrace	Upwelling	18% AEP	Very large contributing subcatchment
		Inlet Capacity	18% AEP	
		Gutter Flow Depth/Width	18% AEP	
28	West Terrace	Low Freeboard	10% AEP	
		Inlet Capacity	18% AEP	
29	Mill Street near Victoria Street	Low Freeboard /Upwelling	18% AEP/ 5% AEP	
		Inlet Capacity	18% AEP	
30	Corner Victoria Street and Mill Street	Low Freeboard	5% AEP	
		Inlet Capacity	18% AEP	
31	Herbert Street between North Terrace and South Terrace	Gutter Flow Depth/Width	18% AEP	
32	West Terrace between Alexander Street and South Terrace	Gutter Flow Depth	18% AEP	
33	Corner Samuel Street and Booyoolie Street	Gutter Flow Depth/Width	18% AEP	
34	Booyoolie Street between O'Halloran Street and South Terrace	Gutter Flow Depth/Width	18% AEP	
35	Corner East Terrace and O'Halloran Street	Gutter Flow Depth/Width	18% AEP	

The various identified stormwater deficiencies are also presented in Figure 3.2. Locations of high or extreme flood hazard were most commonly found where significant channels spilled over roads, with high or extreme flood hazard in even a 18% AEP flood in some locations. Flood hazard for the most part remained low through buildings up until the 1% AEP flood, where substantial spill from the Rocky River channel flows through the town inundating private property. Low freeboard or upwelling were identified at 12 stormwater pits, ranging from a 18% AEP flood standard to a 1% AEP flood standard. Inlet capacity was an issue at several stormwater pits, and gutter flows were excessive along a number of roads.

The Scenario A flood impact register was then updated to reflect the flooding observed in Scenario B, and is presented in Table 3.2 below and shown in Figure 3.3.

Table 3.2 Scenario B Flood Impact Register

ID	Location	Type of Deficiency	AEP Occurring	Comment
1	Rocky River channel west of Walter Street	N/A	2% AEP	Rocky River breaks banks causing widespread road and property inundation throughout Laura
2	Laura-Caltowie Road	High/Extreme Flood Hazard	18% AEP/ 10% AEP	Channel spills across road
3	Pech Road (Central)	Extreme Flood Hazard	18% AEP	Channel spills across road
4	Stock Route Road	Extreme Flood Hazard	18% AEP	Pine Creek channel spills over road
5	Tom Catt Hill Road	High/Extreme Flood Hazard	18% AEP/ 5% AEP	Channel spills across road
6	West Terrace	High/Extreme Flood Hazard	18% AEP/ 5% AEP	Channel spills across road
7	Pech Road (Northeast)	High/Extreme Flood Hazard	18% AEP/ 5% AEP	Channel spills across road
8	Appila-Laura Road	Extreme Flood Hazard	5% AEP	Flow along levee spills over road
9	Lots on corner of West Terrace/White Street	High Flood Hazard	2% AEP	High flood hazard through residential lots
10	Switchback Road	High/Extreme Flood Hazard	5% AEP/ 2% AEP	Pine Creek overflow spills over road
11	Pech Road (West)	High/Extreme Flood Hazard	5% AEP/ 2% AEP	Flow along levee spills over road
12	Possum Park Road	High/Extreme Flood Hazard	2% AEP/ 1% AEP	Channel spills across road
13	West Terrace between Samuel St/White St	High/Extreme Flood Hazard	1% AEP/ 0.2% AEP	Flooding along road
14	Laura-Beetaloo Road west of Hughes Street	Extreme Flood Hazard	1% AEP	Floodplain spills across road
15	West Terrace south of South Terrace	High Flood Hazard	2% AEP	Flooding along road
16	Lots on West Terrace opposite Samuel St	High Flood Hazard	1% AEP	High flood hazard through residential lots
17	Lots on West Terrace between Sawley Close and North Terrace	High Flood Hazard	1% AEP	High flood hazard through residential lots
18	Lots on Stock Route Road north of Pine	High Flood	0.2% AEP	High flood hazard through

ID	Location	Type of Deficiency	AEP Occurring	Comment
	Creek channel	Hazard		residential lots
19	Horrocks Highway	Extreme Flood Hazard	1% AEP	Floodplain spills across road
20	Victoria Street east of Mill Street	Low Freeboard /Upwelling	10% AEP/ 1% AEP	
21	Victoria Street west of Mill Street	Low Freeboard /Upwelling	10% AEP/ 0.2% AEP	
		Inlet Capacity	18% AEP	
22	Intersection of Victoria Street and Campbell Street	Low Freeboard	2% AEP	
		Inlet Capacity	18% AEP	
23	Victoria Street between Campbell Street and Cleggett Close	Low Freeboard	2% AEP	
		Inlet Capacity	18% AEP	
		Gutter Flow Depth/Width	18% AEP	
24	Intersection of Victoria Street and Cleggett Close	Low Freeboard	5% AEP	
		Inlet Capacity	18% AEP	
		Gutter Flow Depth/Width	18% AEP	
25	Victoria Street between Cleggett Close and Olsen Street	Low Freeboard	1% AEP	
		Inlet Capacity	18% AEP	
26	Victoria Street between Mill Street and West Terrace	Low Freeboard	10% AEP	
27	Corner Victoria Street and West Terrace	Upwelling	18% AEP	Very large contributing subcatchment
		Inlet Capacity	18% AEP	
		Gutter Flow Depth/ Width	18% AEP	
28	West Terrace	Low Freeboard /Upwelling	10% AEP/ 0.2% AEP	
		Inlet Capacity	18% AEP	
29	Sawley Close	Low Freeboard	0.2% AEP	
30	Sawley Close	Low Freeboard	0.2% AEP	

ID	Location	Type of Deficiency	AEP Occurring	Comment
31	Mill Street near Victoria Street	Low Freeboard /Upwelling	18% AEP/ 10% AEP	
		Inlet Capacity	18% AEP	
32	Corner Victoria Street and Mill Street	Low Freeboard	18% AEP	
		Inlet Capacity	10% AEP	
33	West Terrace	Low Freeboard	0.2% AEP	
34	Herbert Street between North Terrace and South Terrace	Gutter Flow Depth/Width	18% AEP	
35	West Terrace between Alexander Street and South Terrace	Gutter Flow Depth	18% AEP	
36	Corner Samuel Street and Booyoolie Street	Gutter Flow Depth/Width	18% AEP	
37	Booyoolie Street between O'Halloran Street and South Terrace	Gutter Flow Depth/Width	18% AEP	
38	Corner East Terrace and O'Halloran Street	Gutter Flow Depth/Width	18% AEP	

The table demonstrates the impact of climate change and development on flooding throughout the township. Several locations with identified high or extreme hazard in Scenario A occur in a more frequent storm event in Scenario B, demonstrating the impact of the increased watercourse flows as a result of climate change. Additionally, in Scenario B the flood event causing low freeboard or upwelling at some stormwater pits is more frequent than in Scenario A as a result of future development within the township and climate change. Low freeboard in the 0.2% AEP flood was observed at one pit in Scenario B that performed well in Scenario A. As in Scenario A, inlet capacity was an issue at several stormwater pits, and gutter flows were excessive along a number of roads.

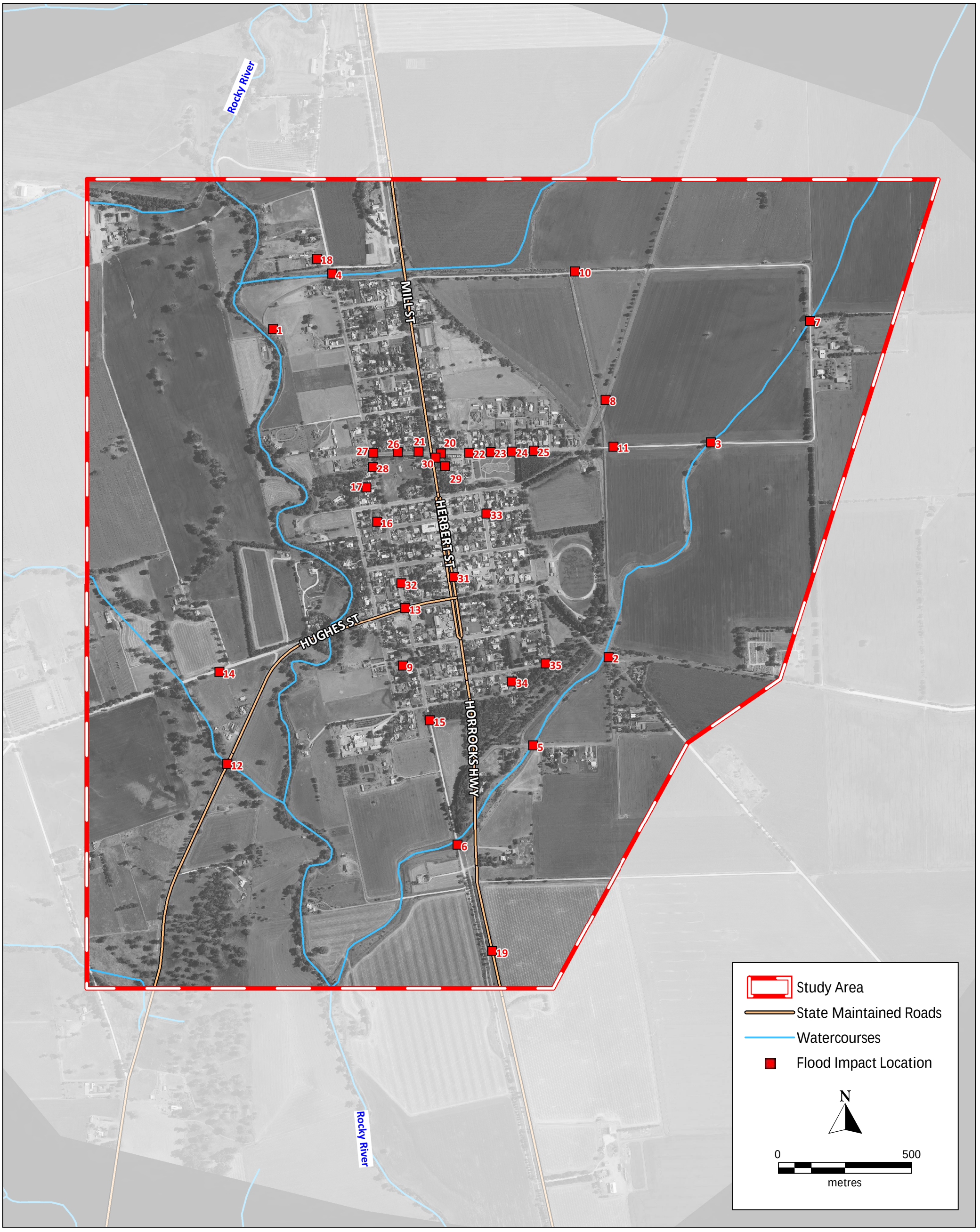
3.3.7 Key Location Peak Flows

Peak flow rates at key locations along the various watercourses and urban stormwater network have been determined for the 18% AEP and 1% AEP flood events, for both Scenario A and Scenario B, and are presented in Table 3.3 below. These locations have also been marked on the 18% AEP and 1% AEP flood maps alongside critical duration information.

Table 3.3 Key Location Peak Flow Rates (m³/s)

Watercourse	Location	Scenario A		Scenario B	
		18% AEP	1% AEP	18% AEP	1% AEP
Pine Creek	Upstream Catchment Inflow[1]	16.2	215.0	29.7	283.7
Rocky River	Upstream Catchment Inflow[1]	37.1	283.5	48.7	335.9
Rocky River	Hughes Street bridge crossing	44.2	188.1[2]	61.7	190.0[2]
Pine Creek	Horrocks Highway bridge (north) crossing	14.3	141.4	24.4	164.9
Unnamed Watercourse east of Laura	Laura-Caltowie Road overflow	9.8	73.1	12.3	118.1
Unnamed Watercourse east of Laura	Horrocks Highway bridge (south)	15.4	73.1	19.4	110.0[3]
N/A	Victoria Street drain into detention basin	0.7	1.0	0.8	1.0
N/A	Outfall channel to Rocky River	1.0	1.3	1.1	1.4

[1]These inflows are applied at the upstream model boundary.
[2]The Rocky River channel spills upstream of the bridge in 2% AEP and larger floods.
[3]This channel spills upstream of the bridge in the Scenario B 1% AEP and larger floods.



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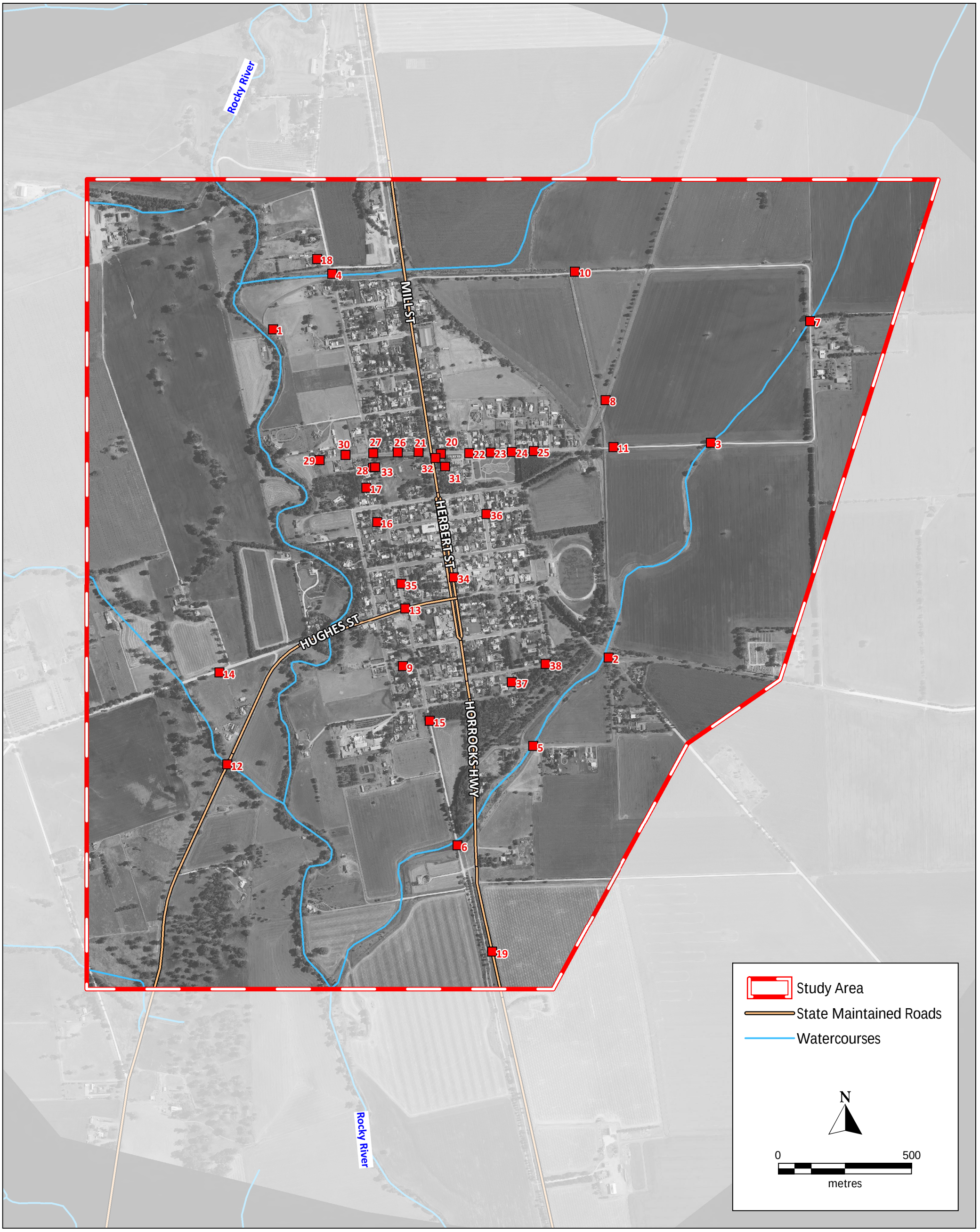
Data Sources:
Southfront (Flood Impacts)
Northern Areas Council (Aerial Photography)
Data SA (State Maintained Roads, Watercourses)

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LAURA STORMWATER MANAGEMENT PLAN

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FIGURE 4.1 - SCENARIO A FLOOD IMPACTS LOCATION MAP



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Data Sources:
Southfront (Flood Impacts)
Northern Areas Council (Aerial Photography)
Data SA (State Maintained Roads, Watercourses)

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FIGURE 4.2 - SCENARIO B FLOOD IMPACTS LOCATION MAP

3.4 Flood Impacts and Characteristics

Flood and hazard maps for the required scenarios and AEPs have been prepared and are attached in Appendix C and Appendix D for Scenario A and in Appendix E and Appendix F for Scenario B. The flood and hazard maps have been reviewed to determine a range of flood impacts and characteristics within the study area. These maps highlight areas where life and property may be in danger in a given flood, and show key vulnerabilities throughout the study area. General commentary on key flow pathways, high risk locations and other relevant points has been provided for Scenario A for the range of AEP events. It should be noted that surveyed floor levels were unavailable, and therefore it was uncertain if individual dwellings were inundated.

18% AEP Flood Event

Flooding in the 18% AEP flood event is largely confined to the road reserve within the town and the major channels outside of it. There was some shallow property inundation surrounding the underground drainage in Victoria Street, and also at the southern end of town on the corner of White Street and West Terrace and between O'halloran Street and South Terrace. Water flowing along West Terrace causes inundation of several properties surrounding William Street. Outside of the town, properties on Laura-Beetaloo Road and Possum Park Road are inundated. All identified critical infrastructure is outside of the 18% AEP floodplain.

The northern levee along Kingston Street, which separates Pine Creek from the hospital, performs well. The levee on the eastern side of town between Switchback Road and Laura-Caltowie Road is engaged and performs well. There is flooding over Laura-Caltowie Road of up to 400 mm, potentially restricting vehicle access. There is shallow flooding across Appila-Laura Road of up to 150 mm, and shallow flow over Laura-Beetaloo Road of up to 100 mm.

10% AEP Flood Event

Flood behaviour in the 10% AEP flood is largely similar to the 18% AEP flood, albeit with slightly deeper flooding throughout the study area. Key areas of private property where the flood extent has increased are along Herbert Street between Samuel Street and Bristow Street, and along West Terrace. The detention basin on the corner of Victoria Street and West Terrace was found to spill in the 10% AEP event. All identified critical infrastructure is outside of the 10% AEP floodplain.

The northern levee and the eastern levee both perform well. Flood depths across Laura-Caltowie Road reached 440 mm, across Appila-Laura Road reached 250 mm, and across Laura-Beetaloo Road reached 150 mm, potentially restricting vehicle access.

5% AEP Flood Event

Flood behaviour in the 5% AEP flood is largely similar to the 10% AEP flood, with deeper flooding observed throughout the study area. Key areas of private property where the flood extent has increased are along Samuel Street and West Terrace. All identified critical infrastructure is outside of the 5% AEP floodplain.

The northern levee and the eastern levee again both perform well. Flood depths across Laura-Caltowie Road reached 580 mm, across Appila-Laura Road reached 320 mm, and across Laura-Beetaloo Road reached 170 mm. Water also overtops Possum Park Road, flowing at a shallow depth over the crown.

2% AEP Flood Event

Compared to the smaller flood events, flood behaviour in the 2% AEP flood has changed significantly, with the Rocky River breaking its banks and flowing through the town. Water overtops the eastern bank to the west of West Terrace, and flows south through undeveloped land towards Sawley Close, largely avoiding buildings. The overland flows then move along West Terrace, causing widespread property inundation on both sides of the road from North Terrace all the way to South Terrace. Parts of Laura to the east of Herbert Street become a flood island, with vehicles needing to traverse shallow ponding along roads to leave, however these areas are considered very low flood hazard and traversable. Elsewhere within the town, the flood behaviour is similar to the smaller flood events, but with slightly greater depths observed. All identified critical infrastructure is outside of the 2% AEP floodplain.

The Rocky River also overtops its western banks, spilling towards a shallow, informal channel resulting in a wide floodplain across the undeveloped land as flows move south to Laura-Beetaloo Road. This channel meanders to the south, spilling across Laura-Beetaloo Road before overwhelming the capacity of the small crossing beneath Possum Park Road. Water depths reach over 700 mm downstream of Laura-Beetaloo Road, with a maximum floodplain width of over 400 m.

The eastern levee performed well, diverting flows around the township. The northern levee protects the northern section of the town and the hospital, but diverts water to the west where the river breaks its banks. Flood depths across Laura-Caltowie Road reached 870 mm, across Appila-Laura Road reached 420 mm, across Laura-Beetaloo Road reached 300 mm and across Possum Park Road reached 420 mm, likely restricting vehicle access.

1% AEP Flood Event

Flood behaviour in the 1% AEP flood event is largely similar to the 2% AEP flood, however the volume of water breaking the banks of the Rocky River has increased substantially. There is much deeper and more widespread inundation of property throughout Laura, centred on West Terrace, and properties between William Street and Victoria Street being flooded. Many properties are flooded to a depth of over 250 mm, compared to the 2% AEP flood where this was far less common. Elsewhere within the town, the flood behaviour is similar to the smaller events but with greater depths. All identified critical infrastructure is outside of the 1% AEP floodplain, however the western side of Herbert Street at the location of the CFS and SES buildings is flooded to depths of over 150 mm and widths of over 5 m, potentially restricting emergency vehicle movement to and from the site.

The floodplain to the west of Rocky River is substantially wider and deeper than in the 2% AEP flood event, reaching a width of over 500 m downstream of Laura-Beetaloo Road with depths in excess of 1000 mm.

The eastern levee and the northern levee again performed well. Flood depths across Laura-Caltowie Road reached 1550 mm, across Appila-Laura Road reached 530 mm, across Laura-Beetaloo Road reached 390 mm and across Possum Park Road reached 680 mm, restricting vehicle access.

0.2% AEP Flood Event

Finally, flood behaviour in the 0.2% AEP flood event was similar to the 1% AEP flood, but again the volume of water breaking the banks of the Rocky River has increased substantially. Flood depths throughout private property along West Terrace frequently exceed 500 mm, and many further properties see water depths of over 250 mm. Elsewhere within the town, flood behaviour is similar to the smaller events but with greater depths. All identified critical

infrastructure is outside of the 0.2% AEP floodplain, and as in the 1% AEP flood, access to and from the CFS and SES emergency services buildings may be restricted, with 10 m wide flooding on the road with a maximum depth of 220 mm.

The floodplain to the west of Rocky River is substantially wider and deeper than in the 1% AEP flood event, reaching widths of over 700 m downstream of Possum Park Road with depths of over 1300 mm, restricting vehicle access.

The eastern levee performed well, however there was some spill over the northern levee at Horrocks Highway affecting several properties along Mill Street. Flood depths across Laura-Caltowie Road reached 2600 mm, across Appila-Laura Road reached 890 mm, across Laura-Beetaloo Road reached 610 mm and across Possum Park Road reached 880 mm.

Horrocks Highway to the south of Laura is overtopped, with water breaking the banks of the channel and flowing across the highway. The flood hazard over the road was found to reach category H5 due to velocities in excess of 2 m/s, thus rendering the road unsafe for all vehicles. While the Hughes Street bridge over Rocky River was found to be flood immune up to the 0.2% AEP event, the wide, deep floodplain further west means this crossing would not be useful in an evacuation. However, the Horrocks Highway crossing over the Pine Creek to the north of town was found to be just outside of the 0.2% AEP floodplain, with 200 mm of freeboard to the bridge road surface, and therefore could be used for evacuation.

Impact of Climate Change and Future Development

In general, climate change and future development have increased the flood risk facing Laura. Increased rainfall associated with climate change has resulted in significantly larger flows in both Rocky River and Pine Creek, exacerbating the extent of flooding observed across all AEPs. Future development has had a comparatively smaller impact on flooding, with the impacts centralised on the township.

The performance of the levee separating Pine Creek from the hospital was of critical importance, and it was important to consider the impact of climate change and future development through Scenario B. Table 3.4 below summarises the freeboard to the top of the levee across the range of AEPs and scenarios.

Table 3.4 Levee Freeboard Adjacent to Laura Hospital

Annual Exceedance Probability	Freeboard (mm)	
	Scenario A	Scenario B
18%	2100	1810
10%	1730	1570
5%	1310	950
2%	750	600
1%	480	390
0.2%	270	190

The results of the table indicate that in all floods up to the 1% AEP, there is at least 300 mm freeboard to the top of the levee even in the future scenario. However the significant increase in flow rate for the 0.2% AEP flood results in less than 300 mm freeboard in both scenarios.

3.5 Flood Damages

3.5.1 Background

Estimates of flood damages provide important information that can be used to prioritise flood mitigation works. Flood damages are typically split into the following categories:

- Direct tangible damages, which includes material damage caused by the flood;
- Indirect tangible damages, which mostly consists of damages caused by disruptions due to the flood;
- Direct intangible damages, which considers direct damages that cannot be objectively quantified; and
- Indirect intangible damages, which considers indirect damages that cannot be objectively quantified.

Estimating intangible damages is difficult, and minimal guidance is available for these categories, and therefore they have not been included. However, similar studies have noted that these damages may match or even exceed the tangible damage cost. Flood damages have been calculated for all modelled scenarios across all modelled AEPs.

The adopted methodology also does not consider the following items:

- Damage to public infrastructure
- Damage to crops and stock losses
- Damage to vehicles

3.5.2 Evaluation Approach

Direct tangible flood damages have been estimated with reference to the Investment Framework For the Economics of Water Sensitive Cities (INFFEWS) Value Tool, developed by the Cooperative Research Centre for Water Sensitive Cities (CRCWSC). The INFFEWS is a package of tools and documents for economic analysis of urban water and green infrastructure projects. The INFFEWS Value Tool is designed to assist users to estimate non-market values for the benefits arising from these projects.

INFFEWS provides stage-damage curves for a range of residential and commercial buildings which have been used to estimate flood damages. These curves were developed for the *Brisbane River Strategic Floodplain Management Plan* (State of Queensland, 2018) in 2018, and are based on a survey undertaken to determine stage-damage curves for properties affected by the Brisbane River flooding in late 2010 to early 2011. The stage-damage curves have been adjusted to account for inflation since the development of the curves.

As the stage-damage curves used were developed for the *Brisbane River Strategic Floodplain Management Plan*, this means they are based on properties in and around Brisbane. To account for this, the curves have been adjusted to suit Laura based on information from *Rawlinsons Australian Construction Handbook* (Rawlinsons, 2022). This document provides costs for various building types in the major cities, and regional index maps which provide an expected increase in cost associated with distance from the major city. The stage-damage curves from INFFEWS were scaled by the difference in costs between Brisbane and Adelaide, and then increased by 10% according to the regional index.

Indirect tangible damages have been estimated as 15% of the direct tangible damages for residential buildings, and 55% of the direct tangible damages for commercial and industrial buildings, in line with recommendations of *INFFEWS Value Tool: Guidelines (Version 4)* (Iftekhar, Gunawardena, Fogarty, Pannell, & Rogers, 2022)

Residential Properties

Residential stage-damage curves are provided for three building sizes, small (<140 m²), medium (140-210 m²) and large (>210 m²). To determine an appropriate building size to use, an analysis of residential building sizes was undertaken. The sample-sub areas developed to determine subcatchment runoff coefficients for the DRAINS model were used, as these were considered representative of urban development in the study area. Building sizes within the sub-areas were determined, as summarised in Table 3.5.

Table 3.5 Residential Building Size Analysis

Sample Sub-Area	Average Building Size (m²)
Herbert Street / North Terrace	303.8
Victoria Street / West Terrace	193.2
Hughes Street / East Terrace	271.0

As can be seen, two of the three sub-areas had an average residential building size of over 210 m², with the third being at the upper end of the range classified as 'medium'. Therefore, direct tangible flood damages for residential properties were calculated using the stage-damage curves for 'large' residential properties, as this was considered a suitable representation of the residential properties throughout the study area.

For each building size, stage-damage curves are provided for six different house types:

- Fully detached single storey (slab on the ground);
- Fully detached single storey (on stumps);
- Fully detached single storey (highset);
- Fully detached double storey;
- Multi-unit single storey; and
- Multi-unit double storey.

Given the lack of available house type information, all residential properties were assumed to be fully detached single storey houses with a slab on the ground. This is broadly consistent with site visit observations during the project.

For residential properties, INFFEWS provides three separate stage-damage curves, representing internal damage, structural damage and external damage. Internal damage refers to the damage to the contents of the main building of a property, and includes furniture, appliances and other internal contents. Structural damage refers to the damage sustained by the fabric of a building, and includes foundations, floors, walls, doors and permanently fixed objects such as cupboard and benches. External damage refers to damage to objects outside of the main building such as cars, fences, gardens and sheds.

The total residential damage to each property was determined by summing the values of the three curves at the corresponding flood depth range as determined in the TUFLOW model. The flood depth used for each property has been taken at the location of the dwelling. For allotments with no building, no flood damage has been calculated as the curves primarily consider structural damage associated with a building. Where a curve did not have a damage value for a required flood depth, it has been linearly interpolated from the surrounding values. Table 3.6 below shows the adopted residential stage-damage curve.

Table 3.6 Residential Stage-Damage Curve

Flood Depth Range (m)	Flood Damage Cost
0-0.15	0
0.15-0.25	$94,895
0.25-0.5	$212,876
0.5-1.0	$285,720
1.0-1.5	$314,260
1.5-2.5	$374,673
2.5-5.0	$388,780

The flood damage curves provided by INFFEWS start at floor level, and therefore when an assumed 150 mm slab height is factored in, the curves show no damage for the first 150 mm. The curves show that flooding of just 100 mm above the floor can have a substantial cost, with damage increasing to almost $400,000 for flooding over 2.5 m deep.

Commercial Buildings

Stage-damage curves for commercial buildings are provided for three building sizes, small (<186 m²), medium (186-650 m²) and large (>650 m²). Given the lack of building footprint information, it has been assumed that all commercial buildings are 'medium' in size due to the wide range of building sizes that would fit into this category.

For each building size, stage-damage curves have been provided for five 'value classes', which classify the relative value of the type of business being flooded. These are summarised in Table 3.7 below.

Table 3.7 Commercial Building Value Classes

Value Class	Example Businesses
VC1 (Very Low)	Florists, Garden Centres, Vehicle Sales Areas, Schools, Churches
VC2 (Low)	Offices, Cafes, Restaurants, Service Stations, Pubs, Clubs
VC3 (Medium)	Chemists, Musical Instruments, Printing, Clothing
VC4 (High)	Bottle Shops, Cameras
VC5 (Very High)	Pharmaceuticals, Electronics

For the purposes of flood damage estimation, it has been assumed that all commercial buildings are Value Class 2 (Low). This was considered a reasonable assumptions as the majority of

commercial businesses could be considered either Value Class 1 or Value Class 2. The adopted commercial stage-damage curve is shown in Table 3.8 below.

Table 3.8 Commercial Stage-Damage Curve

Flood Depth Range (m)	Flood Damage Cost
0-0.1	$54,682
0.1-0.15	$74,547
0.15-0.25	$116,988
0.25-0.5	$168,860
0.5-1.0	$270,857
1.0-1.5	$346,836
1.5-2.5	$407,868
2.5-5.0	$438,097

Unlike residential properties, the stage-damage curve for commercial properties shows significant costs even for flooding below 150 mm, as it is assumed the floor level for these properties is at ground level. Compared to the residential stage-damage curves, the damage for commercial flooding is much greater at smaller depths, lower at moderate depths and greater at higher depths.

Industrial Buildings

The INFFEWS Value Tool does not provide stage-damage curves for industrial properties, and therefore the curves used for commercial properties have been used to calculate industrial property damages. This is consistent with the *Brisbane River Strategic Floodplain Management Plan* (State of Queensland, 2018) where the stage-damage curves were originally developed. Like commercial properties, all industrial properties were assumed to be 'medium' size, and Value Class 2 (Low).

Limitations of Approach

The adopted approach comes with several limitations which affect the accuracy of the results, however it has been successfully adopted in previous flood studies. Key limitations of the method are discussed below.

A single damage curve has been adopted for each of residential, commercial and industrial building types. Not all properties are the same, and these curves attempt to represent the average property of each type. It is likely that a more in-depth, nuanced investigation to develop multiple curves based on property size and value would provide more accurate results.

All commercial buildings have been assumed to be of the same value class. As discussed, the value class describes the relative value of a commercial building, and there is quite a substantial difference between the lower and higher classes. Value Class 2 was adopted for all commercial buildings as this value class was thought to best represent the typical commercial buildings in the study area, however a more thorough investigation would likely result in more accurate damages.

The damage estimates prepared with this approach consider only structural damage to buildings and their surroundings, and not damages to public assets such as roads and open space features. This has the effect of producing lower benefit-cost ratios than would be determined if these assets were monetised. However research on determining flood damages for public assets is comparatively underdeveloped, with INFFEWS providing no guidance in this area, and therefore this approach was considered suitable.

The adopted damage curves for this study are based on curves developed for Brisbane that have been scaled according to property prices in Adelaide, factored to account for the distance from Adelaide and finally factored once more to bring the curves to the current year. In reality, the damage curves for a property in Laura would be significantly different to those for a property in Brisbane, and this has not been accounted for with the adopted approach. However there is minimal guidance available for calculating flood damages, and the adopted methodology was considered the best available information at the time of the study.

3.5.3 Scenario A Flood Damages

Number of Properties Affected

Flood levels within each property were determined from the flood grids produced by the TUFLOW model, and these have been used to determine the number of affected properties in Scenario A. In this instance, an affected property is defined as a property with any depth of water at the location of the building. Table 3.9 below summarises the total number of properties affected by each stage-damage curve range for all modelled AEPs.

Table 3.9 Scenario A Inundated Properties by Flood Depth

Flood Depth Range (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0-0.1	12	15	21	40	62	48
0.1-0.15	0	1	5	7	12	24
0.15-0.25	0	0	0	10	22	34
0.25-0.5	0	0	0	3	23	38
0.5-1.0	0	0	0	0	3	10
1.0-1.5	0	0	0	0	0	0
1.5-2.5	0	0	0	0	0	0
2.5-5.0	0	0	0	0	0	0
Total	12	16	26	60	122	154

The table demonstrates the increase in affected properties between AEP events, with substantial increases observed between the 5% AEP flood and the 1% AEP flood. In general, property flooding remains relatively shallow, only exceeding 150 mm in the 2% AEP and rarer flood events.

Table 3.10 below categorises the affected properties by land use, being residential, commercial and industrial.

Table 3.10 Scenario A Inundated Properties by Land Use

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	12	16	25	57	115	143
Commercial	0	0	1	3	5	9
Industrial	0	0	0	0	2	2
Total	12	16	26	60	122	154

Residential land use makes up the vast majority of affected property, followed by commercial and finally industrial.

Direct Tangible Flood Damages

Direct tangible flood damages for Scenario A have been estimated. The flood level determined for each property was compared with the appropriate stage-damage curve to determine a damage cost for each property, and these have been summed across the study area. Table 3.11 below shows the resulting flood damage by land use as well as the total flood damage for the range of modelled AEPs.

Table 3.11 Scenario A Direct Tangible Flood Damage

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.0m	$1.6m	$7.7m	$13.9m
Commercial	$0.0m	$0.0m	$0.1m	$0.2m	$0.3m	$0.6m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.1m	$0.2m
Total	$0.0m	$0.0m	$0.1m	$1.8m	$8.2m	$14.7m

Although residential properties were considered flood-affected in the 18% AEP and 10% AEP flood event, because the water depth was below 150 mm this resulted in no damage. The residential flood damage increased substantially between the 5% AEP and 2% AEP events. This can be attributed to spill from the Rocky River through the township, which did not occur in the 5% AEP flood but did in the 2% AEP and larger floods, with water flowing through widespread regions of residential land. The Rocky River breaking its banks is also the major cause of the increase in flood damages in the 1% AEP and 0.2% AEP floods.

Indirect Tangible Flood Damages

As discussed, INFFEWS recommends indirect tangible flood damages of 15% for residential buildings and 55% for commercial and industrial buildings. This results in the total tangible flood damages summarised in Table 3.12.

Table 3.12 Scenario A Total Tangible Flood Damage

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.0m	$1.8m	$8.9m	$15.9m
Commercial	$0.0m	$0.0m	$0.1m	$0.3m	$0.5m	$1.0m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.2m	$0.3m
Total	$0.0m	$0.0m	$0.1m	$2.1m	$9.6m	$17.2m

Average Annual Damages

An average annual damage value, representing the damage that would occur in any given year if flood damages from all AEPs were spread out equally over time, was calculated for the study area, giving a value of $234,645.

3.5.4 Scenario B Flood Damages

Number of Properties Affected

Flood levels within each property were determined from the flood grids produced by the TUFLOW model, and these have been used to determine the number of affected properties in Scenario B. Table 3.13 below summarises the total number of properties affected by each stage-damage curve range for all modelled AEPs.

Table 3.13 Scenario B Inundated Properties by Flood Depth

Flood Depth Range (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0-0.1	13	19	35	42	50	53
0.1-0.15	0	3	4	16	24	19
0.15-0.25	0	0	3	13	18	41
0.25-0.5	0	0	0	11	32	45
0.5-1.0	0	0	0	0	4	12
1.0-1.5	0	0	0	0	0	0
1.5-2.5	0	0	0	0	0	0
2.5-5.0	0	0	0	0	0	0
Total	13	22	42	82	128	170
Change from Scenario A	+8.3%	+37.5%	+61.5%	+36.7%	+4.9%	+10.4%

As in Scenario A, the number of inundated properties increased significantly between the 2% AEP and 1% AEP flood events. In all events the number of affected properties increased, with the largest increases observed in the 10%, 5% and 2% AEP floods. Again the majority of property flooding was relatively shallow in nature, only exceeding 250 mm in the 2% AEP and rarer floods.

Table 3.14 below categorises the affected properties by land use.

Table 3.14 Scenario B Inundated Properties by Land Use

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	13	21	40	79	120	157
Commercial	0	1	2	3	6	11
Industrial	0	0	0	0	2	2
Total	13	22	42	82	128	170

The distribution of land use in the affected properties was found to be very similar to that of Scenario A.

Direct Tangible Flood Damages

Direct tangible flood damages for Scenario B have been estimated. The flood level determined for each property was compared with the appropriate stage-damage curve to determine a damage cost for each property, and these have been summed across the study area. Table 3.15 below shows the resulting flood damage by land use as well as the total flood damage for the range of modelled AEPs.

Table 3.15 Scenario B Direct Tangible Flood Damage

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.3m	$3.6m	$9.5m	$16.5m
Commercial	$0.0m	$0.1m	$0.1m	$0.2m	$0.4m	$0.8m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.1m	$0.2m
Total	$0.0m	$0.1m	$0.4m	$3.8m	$10.0m	$17.5m

Although a large number of additional properties were inundated in Scenario B, this has not necessarily resulted in an equivalent increase in flood damage. This is because the vast majority of inundated properties up until the 5% AEP event were only flooded to a depth of under 150 mm, and therefore were assigned no damage. A large increase in flood damage from Scenario A was observed in the 2% AEP flood, due to the substantially greater spill from the Rocky River flowing through Laura along West Terrace.

Indirect Tangible Flood Damages

As discussed, INFFEWS recommends indirect tangible flood damages of 15% for residential buildings and 55% for commercial and industrial buildings. This results in the total tangible flood damages summarised in Table 3.16.

Table 3.16 Scenario B Total Tangible Flood Damage

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.3m	$4.1m	$10.9m	$19.0m
Commercial	$0.0m	$0.1m	$0.2m	$0.3m	$0.7m	$1.2m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.2m	$0.4m
Total	$0.0m	$0.1m	$0.5m	$4.4m	$11.7m	$20.5m

Average Annual Damages
The resulting average annual damages value was found to be $342,694, which is a 46% increase from the Scenario A value.

3.6 Water Quality Performance

3.6.1 Background

Details of the water quality modelling work undertaken for this assessment, including software selection, determination of key input parameters and model configuration, are provided in the modelling report. Key results from the water quality modelling are presented below for the required locations across the range of required water quality scenarios.

3.6.2 Scenario 1 Water Quality Modelling

Scenario 1 consists of existing development with no WSUD infrastructure.

Total Urban Catchment
A summary of the average annual pollutant loads and stormwater runoff generated by the urban catchment is provided in Table 3.17 below.

Table 3.17 Scenario 1 Urban Catchment Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	116
Total Suspended Solids (kg/yr)	18,100
Total Phosphorous (kg/yr)	42
Total Nitrogen (kg/yr)	308
Gross Pollutants (kg/yr)	2,290

Rocky River
The water quality performance for the upstream Rocky River catchment, including the major tributary Pine Creek to the east, has been reported downstream of the township contributions as per the requirements of the brief. The water quality model for the Rocky River catchment has been developed by aggregating recorded land use within the catchment, and has not been benchmarked against water quality testing. Instead, the parameters within the model have been adjusted such that the ratio between catchment area and annual flow was similar to that reported for the Broughton River in *A River Management Plan for the Broughton Catchment* (Department of Water, Land and Biodiversity Conservation, 2004). Therefore, the resulting pollutant loads should be considered very approximate estimates at best. Table 3.18 below summarises the results.

Table 3.18 Scenario 1 Rocky River Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	6,670
Total Suspended Solids (kg/yr)	2,360,000
Total Phosphorous (kg/yr)	2,620
Total Nitrogen (kg/yr)	15,600

Gross Pollutants (kg/yr)	2,290

While 100% of gross pollutants were generated within the urban catchments of the Laura township, the majority of the other pollutants were produced within the upstream Rocky River catchment. Just 0.6% of the TSS, 1.1% of the TP and 1.4% of the TN within the Rocky River channel downstream of Laura was generated within the township.

3.6.3 Scenario 2 Water Quality Modelling

Scenario 2 consists of future development with no WSUD infrastructure.

Total Urban Catchment
A summary of the average annual pollutant loads and stormwater runoff generated by the urban catchment is provided in Table 3.19 below.

Table 3.19 Scenario 2 Urban Catchment Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	132
Total Suspended Solids (kg/yr)	21,800
Total Phosphorous (kg/yr)	48
Total Nitrogen (kg/yr)	360
Gross Pollutants (kg/yr)	3,450

Rocky River
The water quality performance for the upstream Rocky River catchment has been reported downstream of the township contributions. Table 3.20 below summarises the results.

Table 3.20 Scenario 2 Rocky River Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	6,690
Total Suspended Solids (kg/yr)	2,410,000
Total Phosphorous (kg/yr)	2,650
Total Nitrogen (kg/yr)	15,700
Gross Pollutants (kg/yr)	3,450

3.6.4 Scenario 3 Water Quality Modelling

Scenario 3 consists of future development with existing WSUD infrastructure.

Total Urban Catchment
A summary of the average annual pollutant loads and stormwater runoff generated by the urban catchment is provided in Table 3.21 below.

Table 3.21 Scenario 3 Urban Catchment Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	120
Total Suspended Solids (kg/yr)	11,000
Total Phosphorous (kg/yr)	31
Total Nitrogen (kg/yr)	289
Gross Pollutants (kg/yr)	1,470

Rocky River

The water quality performance for the upstream Rocky River catchment has been reported downstream of the township contributions. Table 3.22 below summarises the results.

Table 3.22 Scenario 3 Rocky River Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	6,690
Total Suspended Solids (kg/yr)	2,430,000
Total Phosphorous (kg/yr)	2,570
Total Nitrogen (kg/yr)	15,700
Gross Pollutants (kg/yr)	1,470

3.7 Risk Assessment

The flood impacts registers presented in Section 3.3 have been expanded to form risk registers. Risk registers have been prepared for Scenario A and Scenario B, identifying the flooding hotspots which are most affected by future development and climate change.

In the preparation of the risk registers, a risk classification framework has been developed with reference to Council's Risk Management Plan, which considers the following categories:

- General
- Flooding
- Health & Safety
- Cost
- Environmental
- Social/Stakeholder

Traditionally risk is defined as a combination of likelihood and consequence. However, given that likelihood and consequence are inherently related for flooding, with less frequent events having a larger impact than more frequent events, it was necessary to define risk in relation to consequence. Table 3.23 below shows the adopted relationship between consequence and risk, with the full risk consequence matrix including definitions provided in Appendix A.

Table 3.23 Adopted Consequence Risk Relationship

Consequence Level	Risk Definition
1 Insignificant	Low
2 Minor	Moderate
3 Moderate	High
4 Major	Extreme
5 Catastrophic	Extreme

The flood impact registers developed in Section 3.3 have been expanded upon to consider the type of risks and the level of consequence associated with each flood hotspot, and are attached below as Table 3.24 for Scenario A and Table 3.25 for Scenario B. The consequence level adopted represents the greatest impact experienced across the various risk categories.

Table 3.24 - Scenario A Flood Risk Register

ID	Location	Type of Deficiency	1% AEP Impact Details	Risk Category	Consequence	Risk
1	Rocky River channel west of Walter Street	N/A	Widespread property and road flooding throughout Laura	Flooding, Health & Safety, Social/Stakeholder	4	Extreme
2	Laura-Caltowie Road	High/Extreme Flood Hazard	Flooding over 1500mm deep across major road	Flooding, Health & Safety	4	Extreme
3	Pech Road (Central)	Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
4	Stock Route Road	Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
5	Tom Catt Hill Road	High/Extreme Flood Hazard	Flooding over 1000mm deep across the road	Flooding, Health & Safety	3	High
6	West Terrace	High/Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
7	Pech Road (Northeast)	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
8	Appila-Laura Road	High/Extreme Flood Hazard	Flooding over 250mm deep across the road	Flooding, Health & Safety	1	Low
9	Lots on corner of West Terrace/White Street	High Flood Hazard	Many properties flooded over 250mm deep, with some over 500 mm	Flooding, Health & Safety, Social/Stakeholder	3	High
10	Switchback Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
11	Pech Road (West)	Extreme Flood Hazard	Flooding over 250mm deep across the road	Flooding, Health & Safety	1	Low
12	Possum Park Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
13	West Terrace between Samuel St/White St	High/Extreme Flood Hazard	Flooding over 500mm deep on the road, surrounding properties inundated over 250mm deep	Flooding, Health & Safety, Social/Stakeholder	3	High
14	Laura-Beetaloo Road west of Hughes Street	Extreme Flood Hazard	Flooding over 250mm deep across the road	Flooding, Health & Safety	1	Low
15	West Terrace south of South Terrace	High Flood Hazard	Flooding over 500mm deep along the road, shallow inundation of surrounding properties	Flooding, Health & Safety	2	Moderate
16	Lots on West Terrace opposite Samuel St	High Flood Hazard	Many properties flooded over 250mm deep, with some over 500 mm	Flooding, Health & Safety, Social/Stakeholder	3	High
17	Lots on West Terrace between Sawley Close and North Terrace	High Flood Hazard	Properties flooded over 250mm deep	Flooding, Health & Safety, Social/Stakeholder	3	High
18	Lots on Stock Route Road north of Pine Creek channel	High Flood Hazard	Shallow inundation of one property	Flooding, Health & Safety, Social/Stakeholder	1	Low
19	Horrocks Highway	Extreme Flood Hazard	No flooding in 1% AEP flood	Flooding, Health & Safety	1	Low
20	Victoria Street east of Mill Street	Low Freeboard /Upwelling	Minor ponding on road	Flooding	1	Low
21	Victoria Street west of Mill Street	Low Freeboard, Inlet Capacity	Minor ponding on road	Flooding	1	Low

22	Intersection of Victoria Street and Campbell Street	Low Freeboard, Inlet Capacity	Minor ponding on road	Flooding	1	Low
23	Victoria Street between Campbell Street and Cleggett Close	Low Freeboard, Inlet Capacity and Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
24	Corner of Victoria Street and Cleggett Close	Low Freeboard, Inlet Capacity and Gutter Flow Depth/Width	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
25	Victoria Street between Cleggett Close and Olsen Street	Low Freeboard, Inlet Capacity	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
26	Victoria Street between Mill Street and West Terrace	Low Freeboard	Minor ponding on road	Flooding	1	Low
27	Corner Victoria Street and West Terrace	Upwelling, Inlet Capacity, Gutter Flow Depth/ Width	Flooding over 250 mm deep on side of road	Flooding	1	Low
28	West Terrace	Low Freeboard, Inlet Capacity	Flooding over 250 mm deep on side of road	Flooding	1	Low
29	Mill Street near Victoria Street	Low Freeboard /Upwelling, Inlet Capacity	Minor ponding on road	Flooding	1	Low
30	Corner Victoria Street and Mill Street	Low Freeboard, Inlet Capacity	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
31	Herbert Street between North Terrace and South Terrace	Gutter Flow Depth/Width	Wide flow pathway over 250 mm deep on road	Flooding	1	Low
32	West Terrace between Alexander Street and South Terrace	Gutter Flow Depth	Wide flow pathway over 500 mm deep on road	Flooding	2	Moderate
33	Corner Samuel Street and Booyoolie Street	Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
34	Booyoolie Street between O'Halloran Street and South Terrace	Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
35	Corner East Terrace and O'Halloran Street	Gutter Flow Depth/Width	Flooding over 250 mm deep on road	Flooding	1	Low
36	Various locations along levee	Levee overtopping/failure	Risk of major flooding	Flooding, Health & Safety, Social/Stakeholder, Reputational/Political	4	Extreme
37	Receiving waters	Water quality of town runoff	Risk of ecological harm	Environmental, Social/Stakeholder, Reputational/Political	2	Moderate

Table 3.25 - Scenario B Flood Risk Register

ID	Location	Type of Deficiency	1% AEP Impact Details	Risk Category	Consequence	Risk
1	Rocky River channel west of Walter Street	N/A	Widespread property and road flooding throughout Laura	Flooding, Health & Safety, Social/Stakeholder	4	Extreme
2	Laura-Caltowie Road	High/Extreme Flood Hazard	Flooding over 1500mm deep across major road	Flooding, Health & Safety	4	Extreme
3	Pech Road (Central)	Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
4	Stock Route Road	Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
5	Tom Catt Hill Road	High/Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
6	West Terrace	High/Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
7	Pech Road (Northeast)	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
8	Appila-Laura Road	Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
9	Lots on corner of West Terrace/White Street	High Flood Hazard	Many properties flooded over 250mm deep, with some over 500 mm	Flooding, Health & Safety, Social/Stakeholder	3	High
10	Switchback Road	High/Extreme Flood Hazard	Flooding over 1000mm deep across the road	Flooding, Health & Safety	3	High
11	Pech Road (West)	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
12	Possum Park Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
13	West Terrace between Samuel St/White St	High/Extreme Flood Hazard	Flooding over 500mm deep on the road, surrounding properties inundated over 250mm deep	Flooding, Health & Safety, Social/Stakeholder	3	High
14	Laura-Beetaloo Road west of Hughes Street	Extreme Flood Hazard	Flooding over 250mm deep across the road	Flooding, Health & Safety	1	Low
15	West Terrace south of South Terrace	High Flood Hazard	Flooding over 500mm deep along the road, shallow inundation of surrounding properties	Flooding, Health & Safety	2	Moderate
16	Lots on West Terrace opposite Samuel St	High Flood Hazard	Many properties flooded over 250mm deep, with some over 500 mm	Flooding, Health & Safety, Social/Stakeholder	3	High
17	Lots on West Terrace between Sawley Close and North Terrace	High Flood Hazard	Properties flooded over 250mm deep	Flooding, Health & Safety, Social/Stakeholder	3	High
18	Lots on Stock Route Road north of Pine Creek channel	High Flood Hazard	Several properties inundated to a shallow depth	Flooding, Health & Safety, Social/Stakeholder	1	Low
19	Horrocks Highway	Extreme Flood Hazard	Shallow flooding across major road	Flooding, Health & Safety	1	Low
20	Victoria Street east of Mill Street	Low Freeboard /Upwelling	Minor ponding on road	Flooding	1	Low
21	Victoria Street west of Mill Street	Low Freeboard /Upwelling, Inlet Capacity	Minor ponding on road	Flooding	1	Low

22	Intersection of Victoria Street and Campbell Street	Low Freeboard, Inlet Capacity	Minor ponding on road	Flooding	1	Low
23	Victoria Street between Campbell Street and Cleggett Close	Low Freeboard, Inlet Capacity and Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
24	Corner of Victoria Street and Cleggett Close	Low Freeboard, Inlet Capacity and Gutter Flow Depth/Width	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
25	Victoria Street between Cleggett Close and Olsen Street	Low Freeboard, Inlet Capacity	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
26	Victoria Street between Mill Street and West Terrace	Low Freeboard	Minor ponding on road	Flooding	1	Low
27	Corner Victoria Street and West Terrace	Upwelling, Inlet Capacity, Gutter Flow Depth/ Width	Flooding over 250 mm deep on side of road	Flooding	1	Low
28	West Terrace	Low Freeboard /Upwelling, Inlet Capacity	Flooding over 250 mm deep on side of road	Flooding	1	Low
29	Sawley Close	Low Freeboard	Minor ponding on road	Flooding	1	Low
30	Sawley Close	Low Freeboard	Minor ponding on road	Flooding	1	Low
31	Mill Street near Victoria Street	Low Freeboard /Upwelling, Inlet Capacity	Minor ponding on road	Flooding	1	Low
32	Corner Victoria Street and Mill Street	Low Freeboard, Inlet Capacity	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
33	West Terrace	Low Freeboard	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
34	Herbert Street between North Terrace and South Terrace	Gutter Flow Depth/Width	Wide flow pathway over 250 mm deep on road	Flooding	1	Low
35	West Terrace between Alexander Street and South Terrace	Gutter Flow Depth	Wide flow pathway over 500 mm deep on road	Flooding	2	Moderate
36	Corner Samuel Street and Booyoolie Street	Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
37	Booyoolie Street between O'Halloran Street and South Terrace	Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
38	Corner East Terrace and O'Halloran Street	Gutter Flow Depth/Width	Flooding over 250 mm deep on road	Flooding	1	Low
39	Various locations along levee	Levee overtopping/failure	Risk of major flooding	Flooding, Health & Safety, Social/Stakeholder, Reputational/Political	4	Extreme
40	Receiving waters	Water quality of town runoff	Risk of ecological harm	Environmental, Social/Stakeholder, Reputational/Political	2	Moderate

4 Stormwater Management Objectives and Targets

4.1 Introduction

The stormwater management objectives and targets adopted for this Stormwater Management Plan have been developed with reference to the recommendations of several government departments including the Stormwater Management Authority, the Department for Environment and Water and the Northern and Yorke Landscape Board. While documents from these entities formed the basis of the objectives and targets, they have been adjusted based on the community values determined during community consultation, ensuring they are relevant to the local context.

4.2 Stormwater Management Authority Guidelines

When developing a catchment-based Stormwater Management Plan, it is required to identify specific and measurable objectives and targets that are relevant to the local context. The *Stormwater Management Planning Guidelines* (Stormwater Management Authority, 2007) stipulates that:

As a minimum, the objectives are to set goals for:

- *An acceptable level of protection of the community and both private and public assets from flooding;*
- *Management of the quality of runoff and effect on the receiving waters, both terrestrial and marine where relevant;*
- *Extent of beneficial use of stormwater runoff;*
- *Desirable end-state values for watercourses and riparian ecosystems;*
- *Desirable planning outcomes associated with new development, open space, recreation and amenity; and*
- *Sustainable management of stormwater infrastructure, including maintenance.*

The objectives and targets developed for this SMP will address the above criteria, and be classified as either absolute or aspirational, with the performance requirement tailored to suit the local context and community expectations.

4.3 Northern and Yorke Landscape Plan

The *Northern and Yorke Landscape Plan 2021-26* (Northern and Yorke Landscape Board, 2021) was developed in partnership with the community and key stakeholders following extensive consultation undertaken over a ten year time frame. The plan seeks to inspire, educate and work with the community to sustainably manage natural resources in the region.

The plan has identified 5 priorities to address over the 5 year period ending in 2026, being communities, biodiversity, water management, sustainable agriculture and pest plant and animal control. The priorities most relevant to the management of stormwater are biodiversity and water management, with the key focus areas summarised in Table 4.1.

Table 4.1 Northern and Yorke Landscape Plan Priorities

Priority	Focus Areas
Biodiversity	Coordinate programs to improve climate change resilience and adaptive capacity. Improve ecosystems through conservation and restoration.
Water management	Sustainably manage the region's prescribed water resources. Protect and rehabilitate watercourses and wetlands. Promote the sustainable use of water for environmental, cultural, social and industry outcomes.

The above priorities have been considered in the development of the Stormwater Management Plan Objectives and Targets, ensuring the outcomes of the plan align with the goals of the Northern and Yorke Landscape Board.

The plan also references *Conservation Action Planning Summary: Mid North Agricultural Districts* (Berkinshaw & McGregor, 2016), which lists objectives for the conservation of assets in the Mid North Agricultural Districts. Those relating to the management of stormwater are summarised in Table 4.2 below.

Table 4.2 Mid North Agricultural Districts Conservation Objectives

Asset	Objective
Rivers, Creeks and Waterhole Assets	By 2030, critical threats to high priority river reaches are strategically managed and abated across all catchments to maintain and improve condition. By 2030, maintain viable populations and sustainable habitat for native fish species (Common Galaxias, Blue Spot Goby) in priority subcatchments.

These objectives relating to rivers, creeks and watercourses have been considered during the development of objectives and targets for the SMP.

4.4 State Government WSUD Guidelines

Several documents have been published which provide guidance for water quality improvements and water sensitive urban design principles in new development. The document *Water sensitive urban design – creating more liveable and water sensitive cities in South Australia* sets out the South Australian Government's position on WSUD in a local context, provides State-wide WSUD 'targets' for new developments and details the role that Government will play in collaboration with other stakeholders to maximise the use of WSUD approaches (Department of Environment, Water and Natural Resources, 2013). Table 4.3 below summarises these across the range of principles.

Table 4.3 State-wide WSUD Performance Principles

Principle	Performance Target
Water Conservation	Demonstrated compliance with South Australian residential building requirements for water efficiency. Non-residential: evidence demonstrating reasonable effort in promoting water efficient techniques in commercial, industrial and other non-residential urban settings. Irrigated open spaces: evidence demonstrating reasonable effort in promoting best practice irrigation management in outdoor irrigated open spaces.
Runoff Quality	The state-wide performance target in this report for improving runoff quality is to achieve the following minimum reductions in total pollutant load, compared with that in untreated stormwater runoff, from the developed part of the site: • Total suspended solids: 80% • Total phosphorus: 60% • Total nitrogen: 45% • Gross pollutants: 90%
Runoff Quantity	**For waterway protection:** Manage the rate of runoff discharged from the site so that it does not exceed the pre-urban development 1 year average recurrence interval (ARI) peak flow. **For flood management:** For development and other relevant infrastructure that will drain runoff to an existing publicly managed drainage system or to a drainage system such as a creek or watercourse on privately-owned land: • The capacity of the existing drainage system is not exceeded; and • There is no increase in the 5 year ARI peak flow and no increase in flood risk for the 100 year ARI peak flow, compared to existing conditions.
Integrated Design	Evidence that relevant stakeholders are engaged at appropriate stages of planning, designing, constructing and managing WSUD measures so as to maximise the potential for WSUD to contribute to 'green infrastructure' and other relevant State, regional, and local objectives.

The WSUD performance principles are recommendations only, meaning there is no legal obligation to meet the requirements, however they will form the basis for the objectives and targets of the SMP.

4.5 Community Consultation

4.5.1 Background

Following the completion of Stage 4 of the Stormwater Management Plan with the State of the Catchment report, a first round of community consultation was held. The purpose of this consultation was to seek feedback from the community on the baseline assessment and the identified stormwater risks and issues, and to identify any community values regarding stormwater management within the town.

4.5.2 Consultation Process

Consultation on the first four stages of the Stormwater Management Plan took place in September and October 2023. Consultation activities undertaken include:

- A presentation to Council elected members on the 5th of September 2023 outlining the work undertaken to date on the Stormwater Management Plan and identifying the areas of elevated flood risk; and
- Open house sessions held in Laura, Gladstone and Spalding on the 24th of October 2023.

At the open house sessions, members of the public were invited to come along and discuss any aspect of the stormwater management plan, provide details of stormwater issues and have conversations with Southfront and Council staff. The sessions were promoted on the Council website and social media accounts 2 weeks prior.

Staff from Council and Southfront were present at all open house sessions. Posters were displayed providing information about the State of the Catchment report including an explanation of the purpose of an SMP, the tasks required, the study area and topography, 1% AEP flood maps and identified flood impacts.

Online and paper feedback forms were developed and made available at the open house sessions and on the Council website, allowing respondents to describe their priorities for the management of stormwater and provide details of any stormwater issues they are aware of.

4.5.3 Community Consultation Feedback

In total over 20 people and one Council Elected Member attended the open house drop in sessions across the three towns. At the drop in session in Laura, the following feedback was provided informally by session attendees (i.e. verbally to staff, not via a feedback form):

- The current management of overland flows along roads is insufficient;
- There are concerns about the levees around the town, and their ability to perform during a major flow event;
- There is frequent build-up of silt along the eastern side of Mill Street; and
- The dense vegetation at the confluence of Pine Creek and Rocky River is thought to pose a flood risk.

In addition, four online feedback forms and twelve paper feedback forms were submitted. Within the forms, respondents were asked to rank the importance of a range of factors, including major flooding, nuisance flooding, water quality, stormwater capture/reuse and climate change. Table 4.4 below summarises the responses across the online and paper feedback forms, which have also been attached to this report in Appendix B.

Table 4.4 Community Response Form Summary

Factor	Number of Responses				
	1 (High Priority)	2	3	4	5 (Low Priority)
Major flooding	12	0	2	1	1
Nuisance flooding	6	5	2	1	2
Water quality	4	1	6	3	2
Stormwater capture and reuse	6	1	5	3	1
Climate change	3	1	1	6	4

The highest priority issue for the community was major flooding, followed by nuisance flooding and stormwater capture and reuse, with water quality and climate change being perceived as lower priorities.

Considering only responses from residents of Laura, major flooding and nuisance flooding were again the highest priorities, followed by stormwater capture and reuse, water quality and climate change. In addition to the rankings above, residents were asked to provide details of any stormwater related concerns, local flooding problems or ways in which they thought stormwater should be managed within Laura. These comments are summarised below.

- Water does not flow along West Terrace due to there being no proper drains.
- Debris including leaves and branches frequently clogs the gutters causing ponding water.
- Existing drains need to be cleaned more regularly to allow water to run.

The community feedback provided for Laura, and more broadly across the four towns as summarised above, has been considered in the development of the objectives and targets for the Stormwater Management Plan, as discussed below.

4.6 Stormwater Management Plan Objectives and Targets

Having considered the range of guidelines from the various government bodies and the outcomes from the community consultation, a set of objectives and targets was formulated addressing a range of factors, as summarised in Table 4.5 below.

Table 4.5 SMP Objectives and Targets

ID	Objective		Target	Absolute (Abs) or Aspirational (Asp)
1	**Provide an acceptable level of flood protection for the community and both private and public assets**	a	No above floor inundation of dwellings in a 1% AEP flood event.	Asp
		b	Where appropriate, no above floor inundation of dwellings in a 5% AEP flood event. In some locations, the cost of flood proofing would likely exceed the value of property being protected, and therefore non-structural	Abs

			measures may need to be considered.	
		c	Safe vehicle access (maximum hazard class H1) along major evacuation routes in a 1% AEP flood event.	Asp
		d	Council provide flood risk information to the community and assist with the creation of flood action plans.	Abs
		e	Effective emergency management arrangements are in place and engage all relevant agencies, staff and affected communities.	Abs
2	**Manage the quality of runoff and its effect on receiving waters**	a	Compared to untreated runoff, achieve the following pollutant reductions: • Total suspended solids: 80% • Total phosphorus: 60% • Total nitrogen: 45% • Gross pollutants: 90%	Asp
		b	Educate the community on the importance of water quality within the receiving waters.	Abs
3	**Make beneficial use of stormwater**	a	Opportunities to increase use of recycled stormwater are to be identified and investigated where viable.	Asp
		b	Where possible Council will strive for new developments to retain peak flows to pre-development levels.	Asp
4	**Planning for new developments provides for open space, recreation and amenity**	a	Identify planning and design policies and procedures to be implemented by Council, where they have authority to do so, that could contribute to effectively manage development to minimise the impact of flooding on new and existing development.	Asp
		b	Identify design principles for Council to implement, where they have the authority to do so, which promote integrated planning, design and management of stormwater systems to maximise the potential to achieve multiple outcomes for water management in new development, as well as redevelopment, retrofits, upgrades and extensions.	Asp
		c	Identify design principles for Council to champion which provide for protection and enhancement of natural features and systems where possible, and increase biodiversity, stormwater treatment and passive reuse.	Asp
5	**Improve the condition of receiving watercourses**	a	All new and upgraded stormwater outlets discharging to receiving watercourses are to be designed to control silt deposits and discharging velocities, and mitigate any adverse effects to the physical conditions of the immediate receiving environment.	Abs
6	**Sustainable asset management of stormwater infrastructure**	a	All stormwater assets are identified and recorded in an asset management system and/or asset management plan.	Asp
		b	All proposed stormwater infrastructure is to be designed with consideration of the likely impacts of climate change.	Abs
7	**Effective communication and consultation with catchment stakeholders,**	a	Effectively engage with the community on stormwater management issues and proposed strategies including WSUD and stormwater reuse opportunities where	Abs

	businesses and community members		possible.	
		b	Raise awareness to enable businesses and the community to respond efficiently to extreme weather flood warnings.	Abs
		c	Identify opportunities for partnerships with the community and government bodies in the development and implementation of strategies.	Abs

5 Stormwater Management Responses

5.1 Structural Management Measures

Having investigated the stormwater performance of the Study Area, management responses have been developed to meet the stormwater management objectives and targets discussed in Section 4. These are designed to address stormwater management issues identified through the development of this plan.

5.1.1 Flood Mitigation Strategies

Flood mitigation strategies are outlined in this section. These strategies have been developed with a view to maximising the level of flood protection that can be achieved within practical constraints. All flood mitigation strategies have been developed using the hydrology from Scenario B, which incorporates future development and climate change.

In accordance with the Plan's objectives outlined in Section 4, these strategies have aspired to achieve no above floor inundation of properties for all events up to and including the 1% AEP storm. An absolute target of achieving no above floor inundation in the 5% AEP storm was adopted, however it is likely that in some locations, the cost of providing flood immunity would far exceed the value of the property being protected. In these situations, non-structural measures could also be considered.

Each of the proposed works packages has been assigned a project ID which corresponds to the project location. Flood depth and hazard maps have been prepared for each AEP event to demonstrate the performance of the flood mitigation strategies, and are presented in Appendix G and Appendix H. Figure 5.8 and Figure 5.9 below provides side by side comparisons of the pre-mitigation and post-mitigation scenarios in the 5% AEP and 1% AEP flood events respectively, demonstrating the impact of the strategies.

The recommended mitigation strategies have been developed holistically considering the stormwater performance of the entire Study Area. While some of the strategies have primarily localised impacts, others also reduce the demand on separate areas. The upgrades should be viewed collectively as a strategic solution to various identified stormwater issues.

Budget cost estimates have also been prepared for the proposed flood mitigation works and are included in Appendix J. These are exclusive of GST and include allowances of:

- 10% for design;
- 5% for modification to existing services;
- 15% for construction preliminaries; and
- 20% for contingencies on construction.

Note that these allowances have at times been adjusted to reflect the location of the works. These cost estimates are based upon historical cost information and experience, and do not allow for latent or market conditions (i.e. competition, escalation) or land acquisition.

The potential cost of soil remediation and/or disposal of contaminated material has not been considered in preparing these cost estimates. Council may elect to undertake environmental testing of project sites during the design development phase to assist in managing this risk.

D1: Rocky River Flood Protection
The strategy to reduce flooding from the Rocky River consists of two components, labelled D1-A and D1-B as described in detail below.

D1-A: Flood Protection Levee Upgrade
It is recommended that the existing levee along the northern side of town is extended south along the eastern bank of the Rocky River. In major flood events, the Rocky River was found to break its eastern bank and cause widespread flooding through the town. By extending the levee, the major overland flow pathways through the town can be cut off, significantly reducing flood risk. Additionally, the western end of the existing levee grades down towards the surrounding ground levels, and should be raised to match in with the new section of levee.

The alignment of such a levee would need to pass through many residential properties, which would require agreements with affected landowners. Several dwellings and structures are located very close to the banks of the river, leaving minimal room for a levee. Further investigation will be required in these instances to determine a suitable levee alignment. The adopted alignment can be seen in Figure 5.1 below.

The 5% AEP future scenario flood does not break the banks of the Rocky River and threaten the town, however in larger events this occurs. In general a levee height ranging from 0.5 m to 1 m will be sufficient to provide 300 mm of freeboard to the 1% AEP flood. A higher levee may be required at some pinch points where properties are close to the creek, however this would need to be investigated further during design once the alignment of the levee has been determined. The impact of the levee in the 1% AEP flood event can be seen in Figure 5.9.

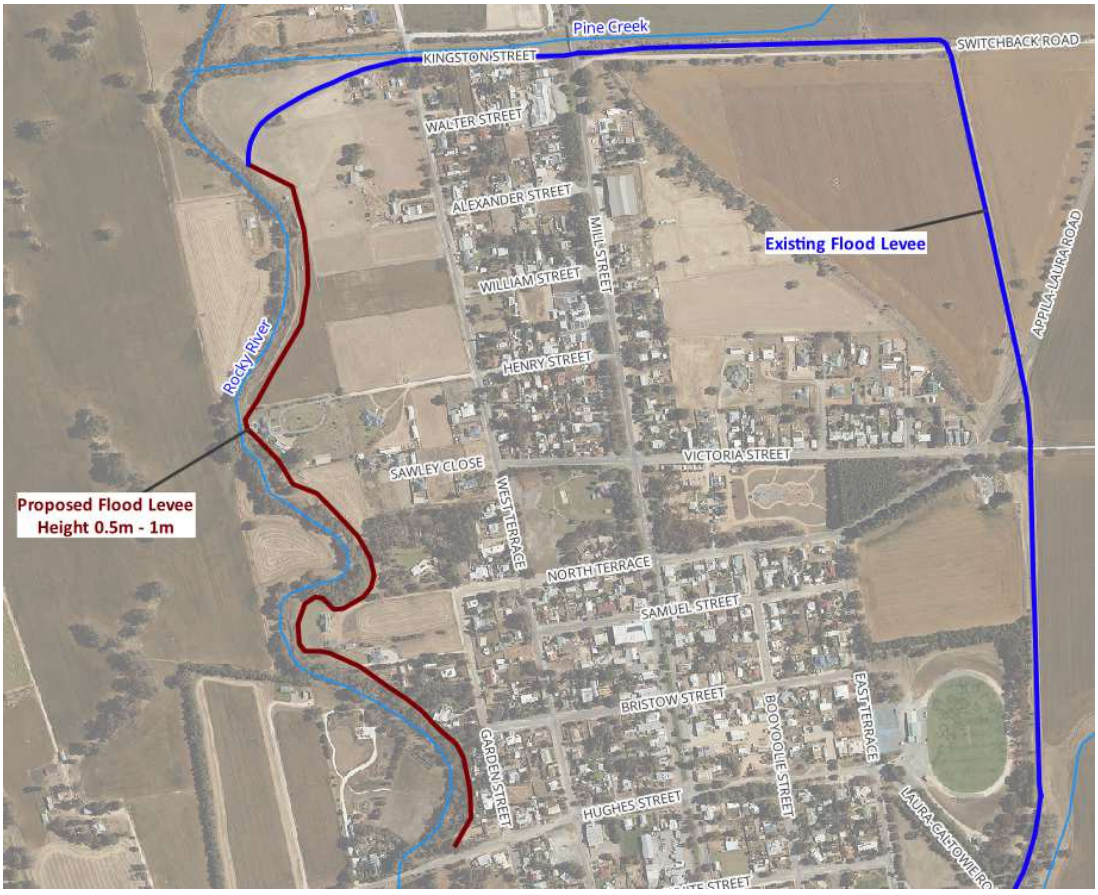


Figure 5.1 Flood Mitigation Strategy D1-A Adopted Levee Alignment

D1-B: Open Channel Outlet Pipe Flap Gate
An open channel takes water from the detention basin on the corner of West Terrace and Victoria Street into an outlet pipe taking water to the Rocky River channel. It was determined that in major flood events, water from the Rocky River flows back up this pipe, resulting in widespread property inundation of the surrounding area including many properties. This issue is further exacerbated by the construction of the levee in D1-A, which results in higher water levels in the channel. It is recommended that a flap gate is installed on the existing outlet pipe, preventing water from flowing back towards the town during high flow events.

D2: Laura Parkland Stormwater Upgrade
Upgrades to stormwater infrastructure within Laura Parkland consist of two components, labelled D2-A and D2-B as described below.

D2-A: Detention Basin Volume Increase
It is recommended that the existing detention basin within the Laura Parkland be upsized to increase flood storage during major storm events. The existing basin footprint occupies a small corner of the park, and there is a large area of undeveloped open space to the south which could be excavated to provide additional flood storage. A detention volume of approximately 10,300 m³ is recommended to contain runoff in the 5% AEP flood event.

D2-B: Detention Basin Outlet Upgrade
Alongside the detention basin upgrade, it is recommended that the outlet connecting the basin to the open channel is upsized, allowing water to leave the town more quickly during major storm events. The existing outlet is a 1200 mm x 600 mm box culvert, and it is recommended to add a second 1200 mm x 600 mm box culvert. As the existing outlet is connected to a gross pollutant trap, it is recommended that the second box culvert be set at a higher level so that low flows are treated.

The upgrades from D1-B and D2 are shown in Figure 5.2 below.

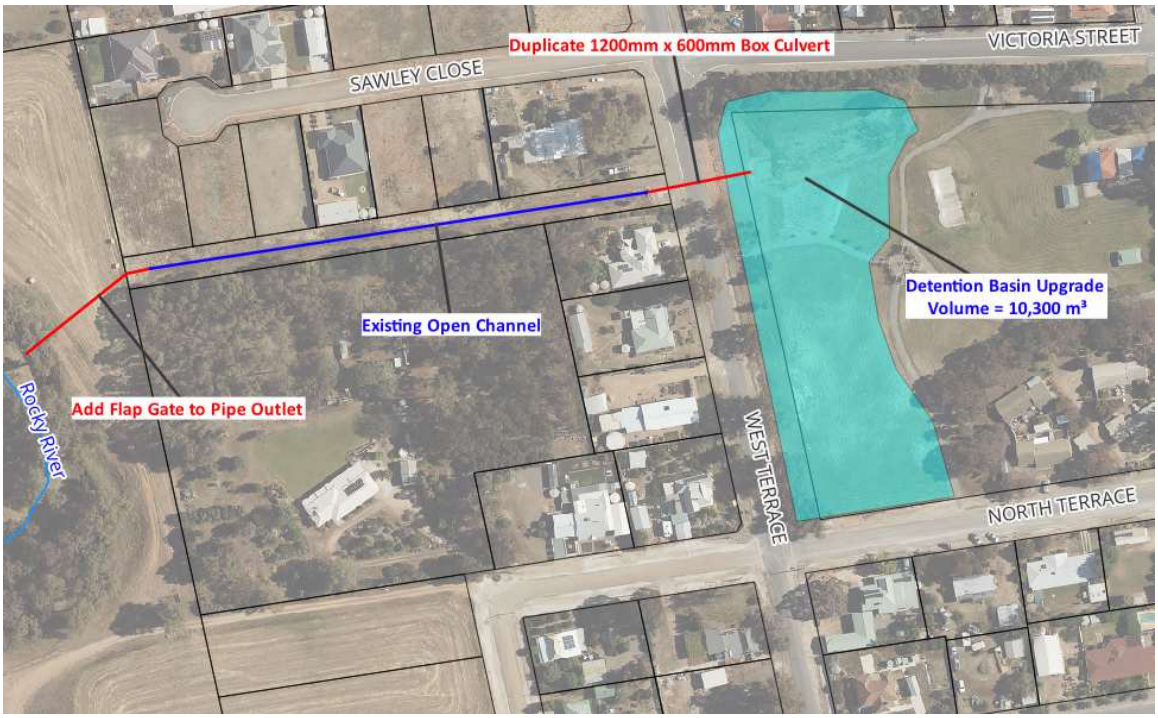


Figure 5.2 Flood Mitigation Strategy D1-B/D2 Overview

D3: Hughes Street Drainage

Following heavy rainfall residents have reported that water ponds at the intersection of Hughes Street and West Terrace where there is no existing stormwater infrastructure, affecting road trafficability and properties further south. It is recommended that a new stormwater network be constructed to drain this intersection. The proposed upgrade has been designed to prevent property inundation in the surrounding area in up to a 5% AEP flood event, and consists of:

- New stormwater inlets and pipes on the corners of Hughes Street and West Terrace
- A new 750 mm diameter stormwater drain running from this intersection along Hughes Street to the Rocky River
- A new outlet into the Rocky River with a flap gate

Figure 5.3 below provides an overview of the proposed system.

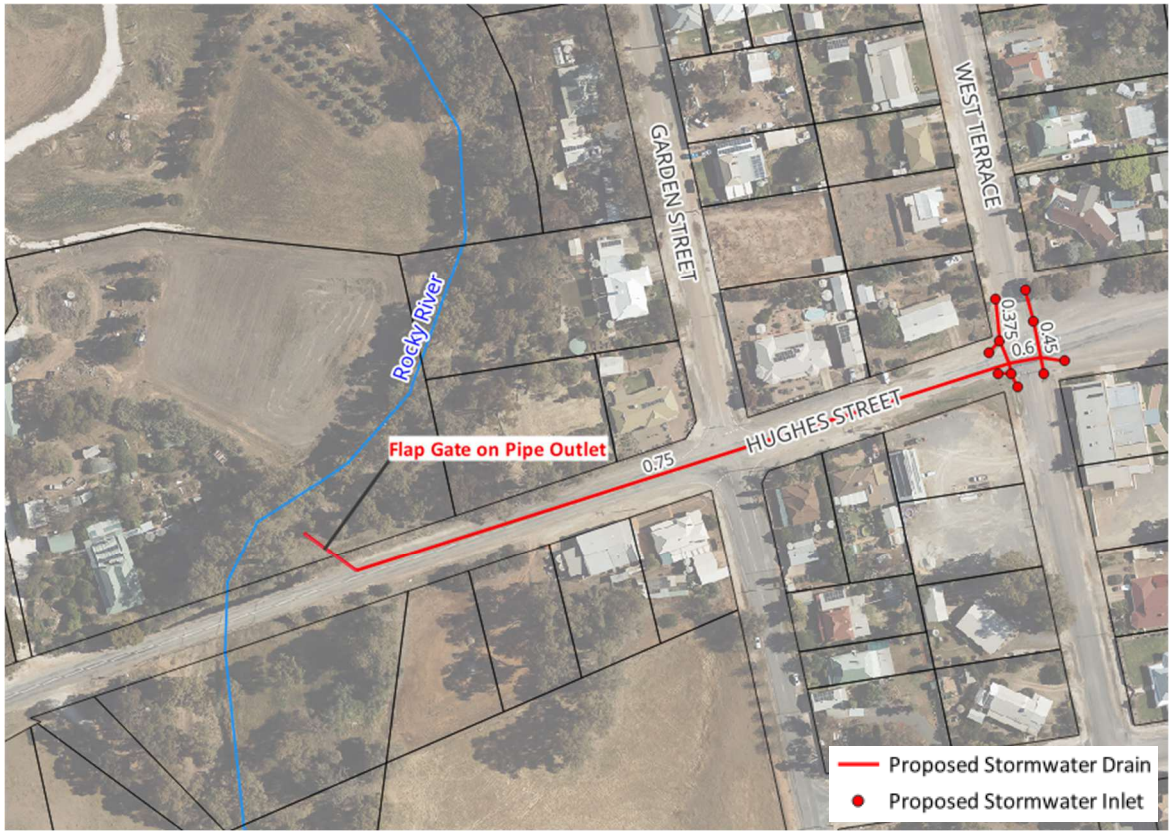


Figure 5.3 Flood Mitigation Strategy D3 Overview

D4: Northern Catchment Diversion Works

The northern catchment, bounded by Switchback Road to the north, the levee to the east and the old railway line corridor to the southwest, heavily contributes towards ponding along Herbert Street. Works to mitigate ponding consist of several components as described below.

D4-A: Mill Street Drainage Upgrade

In the community consultation undertaken for this plan, a resident on Mill Street reported that their property is inundated with stormwater following heavy rainfall. It is recommended that a new stormwater drain and inlets are constructed along Mill Street north of Victoria Street, capturing overland flows from the large catchment to the north. This drain is also to extend to the east into the northern catchment, allowing this large rural catchment to drain. The system

in Mill Street is to connect to the Laura Parkland detention basin via a new 1200 mm x 600 mm box culvert parallel to the existing culvert of the same size in Victoria Street. This strategy therefore relies upon the upgrades in strategy D2 having been constructed, which increase the volume of the detention basin and its outlet capacity.

This upgrade could be constructed in stages, with the first stage upsizing the existing run of pipes in Victoria Street to Mill Street, and the second stage consisting of the lateral drain up Mill Street towards the proposed embankment in the undeveloped land. This would allow Council to construct the strategy more flexibly, considering funding and resourcing limitations.

D4-B: Northern Catchment Earthworks and Culvert
Currently, runoff from the northern catchment is guided to the southeast by the raised embankment of the historic railway line, where it spills south towards Victoria Street before reaching Herbert Street in the centre of town.

It is recommended to extend the existing embankment to the southeast and lower the ground surface, directing runoff towards a new 1200 mm x 600 mm box culvert beneath Appila-Laura Road and Pech Road away from the town. Detailed design will be required to determine how best to grade the land towards this new culvert, which would need to be set significantly below the current surface level in order to pass beneath Appila-Laura Road. The proposed works are also located almost entirely within private land, so Council would need to negotiate with the landowner in order to have them constructed.

The works contained in strategies D4-A and D4-B will provide two separate outlets for the large northern catchment, and significantly reduce both the magnitude and frequency of overland flows along Mill Street and Herbert Street. The works were found to significantly reduce both the depth and extent of inundation along the two roads, with very little impact to properties in up to a 5% AEP event. Figure 5.4 provides an overview of the proposed strategies.

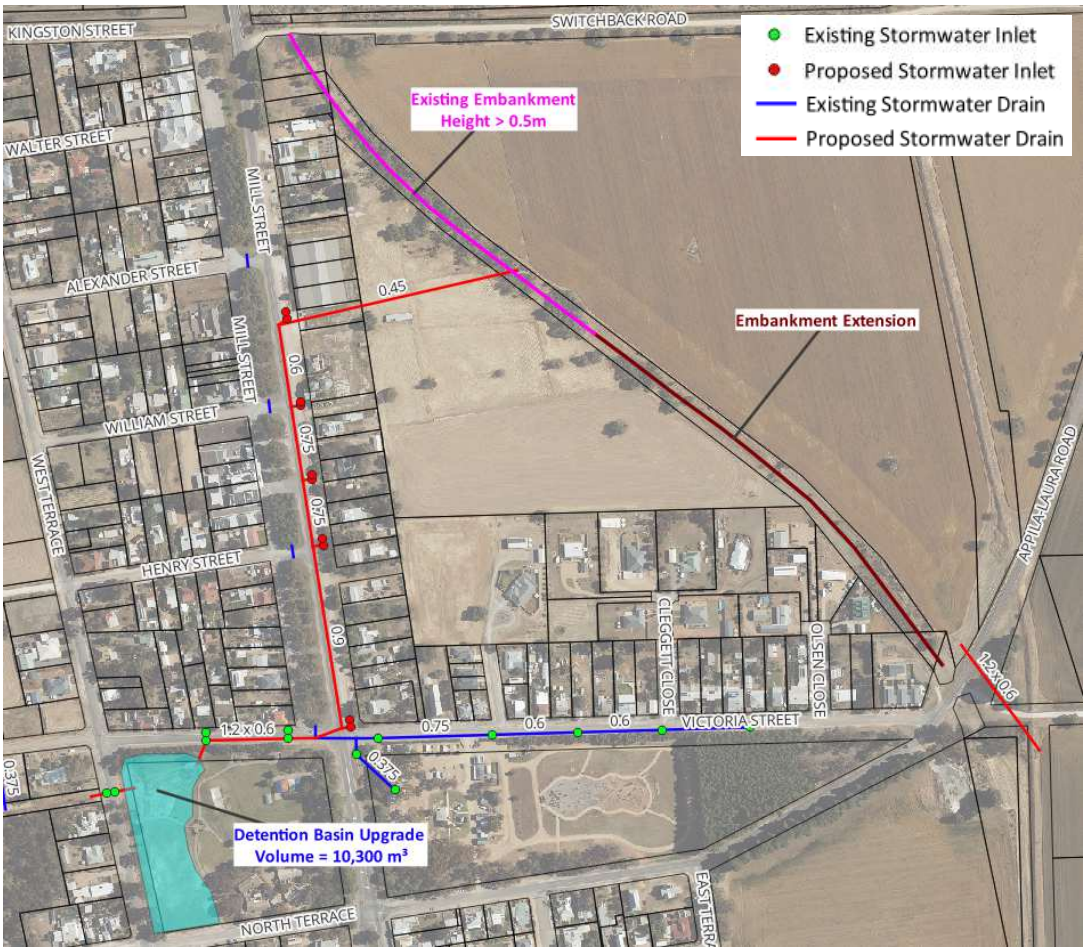


Figure 5.4 Flood Mitigation Strategy D4 Overview

D5: William Street Open Channel

Through the community consultation, residents highlighted that West Terrace is subject to frequent gutter flows and road ponding. This is caused by the large catchment north of Victoria Street and Sawley Close, for which there is insufficient stormwater infrastructure. It is recommended that this catchment is split through the construction of an open channel to the Rocky River, together with a small underground stormwater system at the intersection of William Street and West Terrace. The exact alignment and dimensions of the channel will need to be confirmed in detailed design following discussions with the affected landowners, however the channel should be designed such that it can safely convey the maximum 5% AEP flow rate of approximately 0.8 m³/s.

The open channel is to connect to the Rocky River via a 600 mm diameter pipe. Due to high water levels in the river in longer duration storms, a flap gate should be installed on the outlet. To prevent spill from the channel at times where the water level in the river prevents the channel from draining, a flood levee should be constructed along the southern edge of the channel, holding water within the currently undeveloped land to the north. A levee height of 0.5 m to 0.8 m would be required, depending on adjacent surface and flood levels, providing 300 mm freeboard to the 5% AEP flood level.

The proposed strategy is located mostly within private land, and therefore Council would need to enter into discussions with the landowners prior to progressing the works.

Figure 5.5 below provides an overview of the strategy.

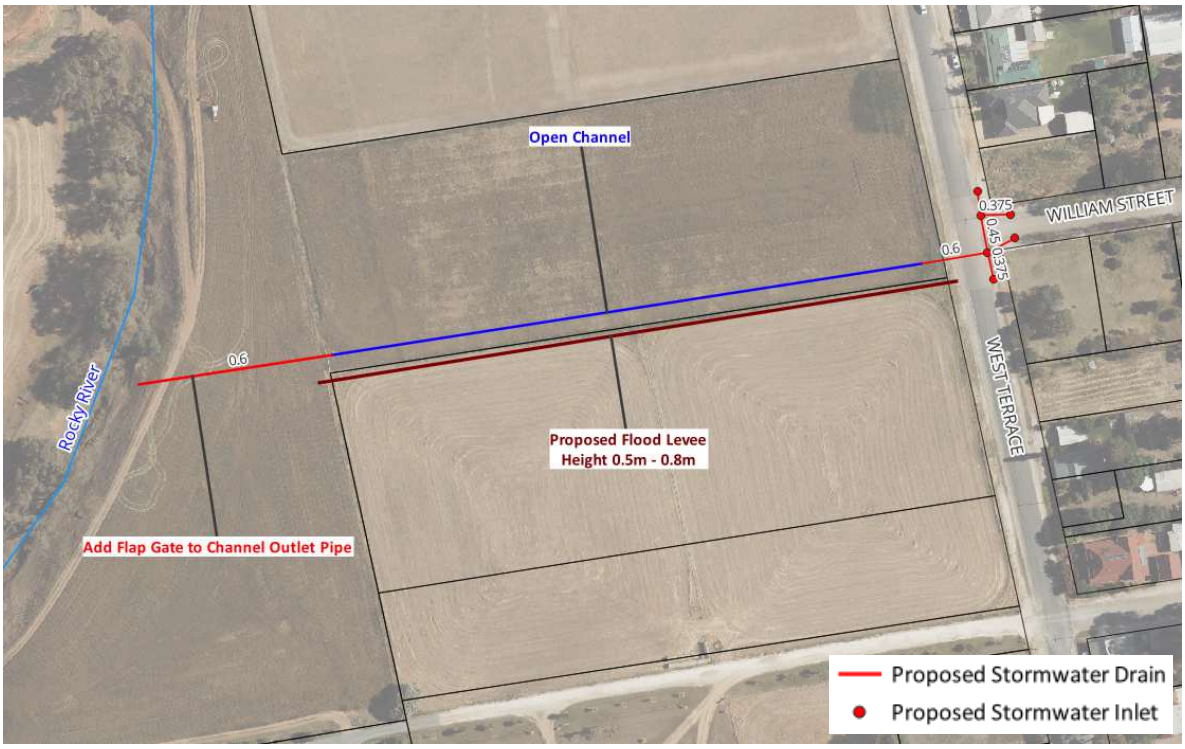


Figure 5.5 Flood Mitigation Strategy D5 Overview

D6: West Terrace Flow Path Works

Flood mapping indicates several properties along West Terrace north of Victoria Street are vulnerable to inundation in a 18% AEP flood event. This confirms comments by a resident during community consultation suggesting their property is inundated following heavy rain.

It is recommended to undertake surface level works within the eastern verge along West Terrace to increase the flow capacity of the verge and prevent water spilling into properties. This could take a range of forms including increasing the levels along the verge, installing a kerb or excavating the verge to create a small swale. The exact method will need to be determined during detailed design, to ensure property access is maintained. Within the TUFLOW model, this has been achieved through raising the verge by 200 mm surrounding Alexander Street, William Street, and Henry Street, cutting off key spill pathways. These works have previously been investigated between Henry Street and Victoria Street in *West Terrace, Laura Investigation and Design* (Southfront, 2024).

These works increase the gutter flow approaching the corner of West Terrace and Victoria Street, where a single stormwater inlet and a 450 mm x 300 mm box culvert take flows into the Laura Parkland detention basin. It is recommended that the box culvert is duplicated, and the existing inlet replaced with a double side entry pit, resulting in less water ponding at this intersection and spilling to the south along West Terrace. Figure 5.6 provides an overview of the works recommended in this strategy.

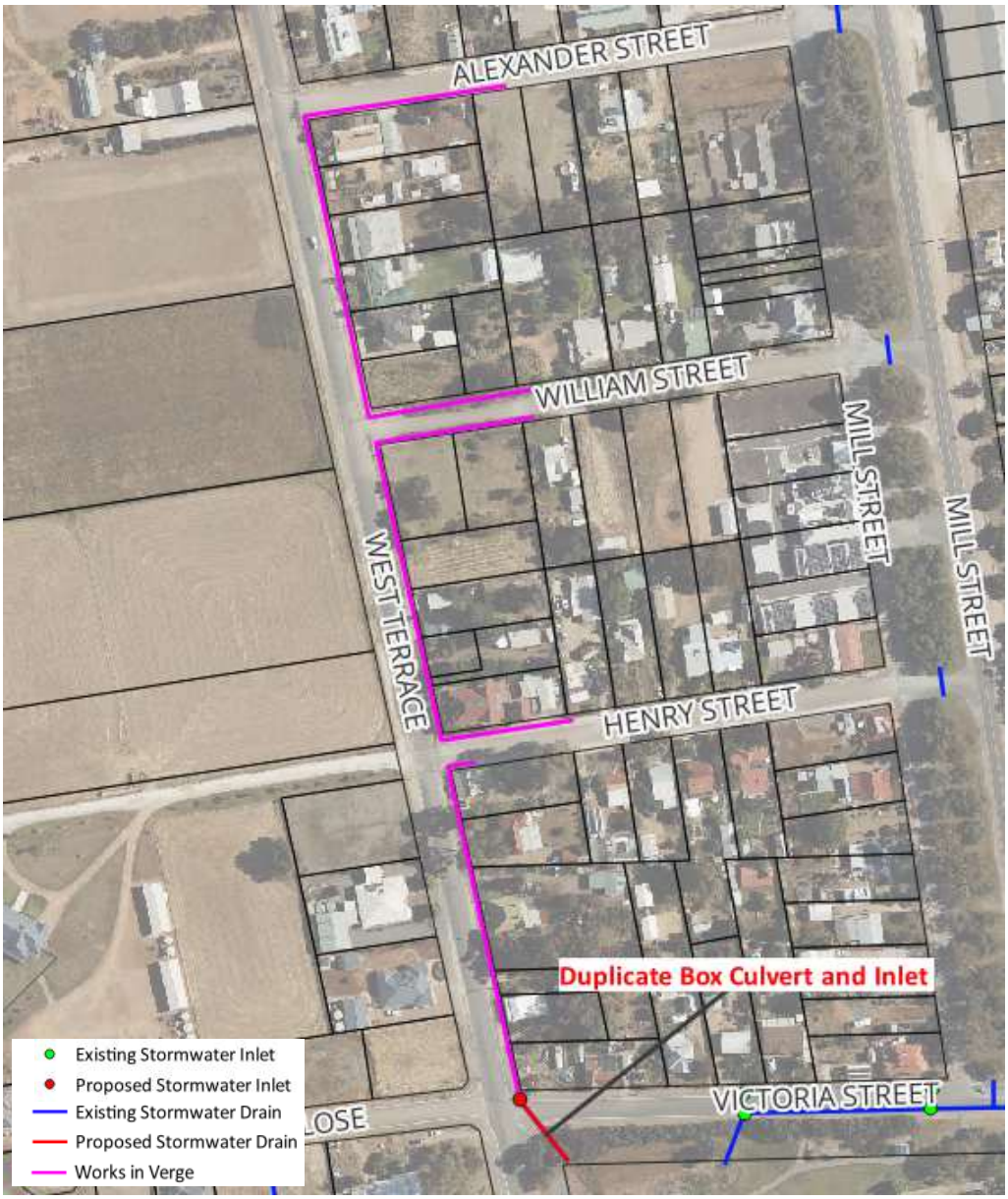


Figure 5.6 Flood Mitigation Strategy D6 Overview

D7: Verge Works throughout Laura

As with strategy D6, there are four additional sections of verge where works are recommended to keep flows on the road and out of properties. In these four locations along West Terrace and Herbert Street, it is recommended to undertake works to increase the capacity of the verge. From discussions with Council, it is understood that due to economic factors, surface drainage works are generally favoured over underground drainage works. As with strategy D6, the exact nature of works will need to be determined during detailed design to ensure property access is maintained. Within the TUFLOW model, this has been achieved by raising the verge by 200 mm, cutting off key spill pathways through properties.

This strategy could be constructed in stages, focussing on the most critical verges for flood protection such as the West Terrace verge between White Street and South Terrace, or those which are reported as flood affected by residents.

Figure 5.7 below shows the location of the proposed verge works.

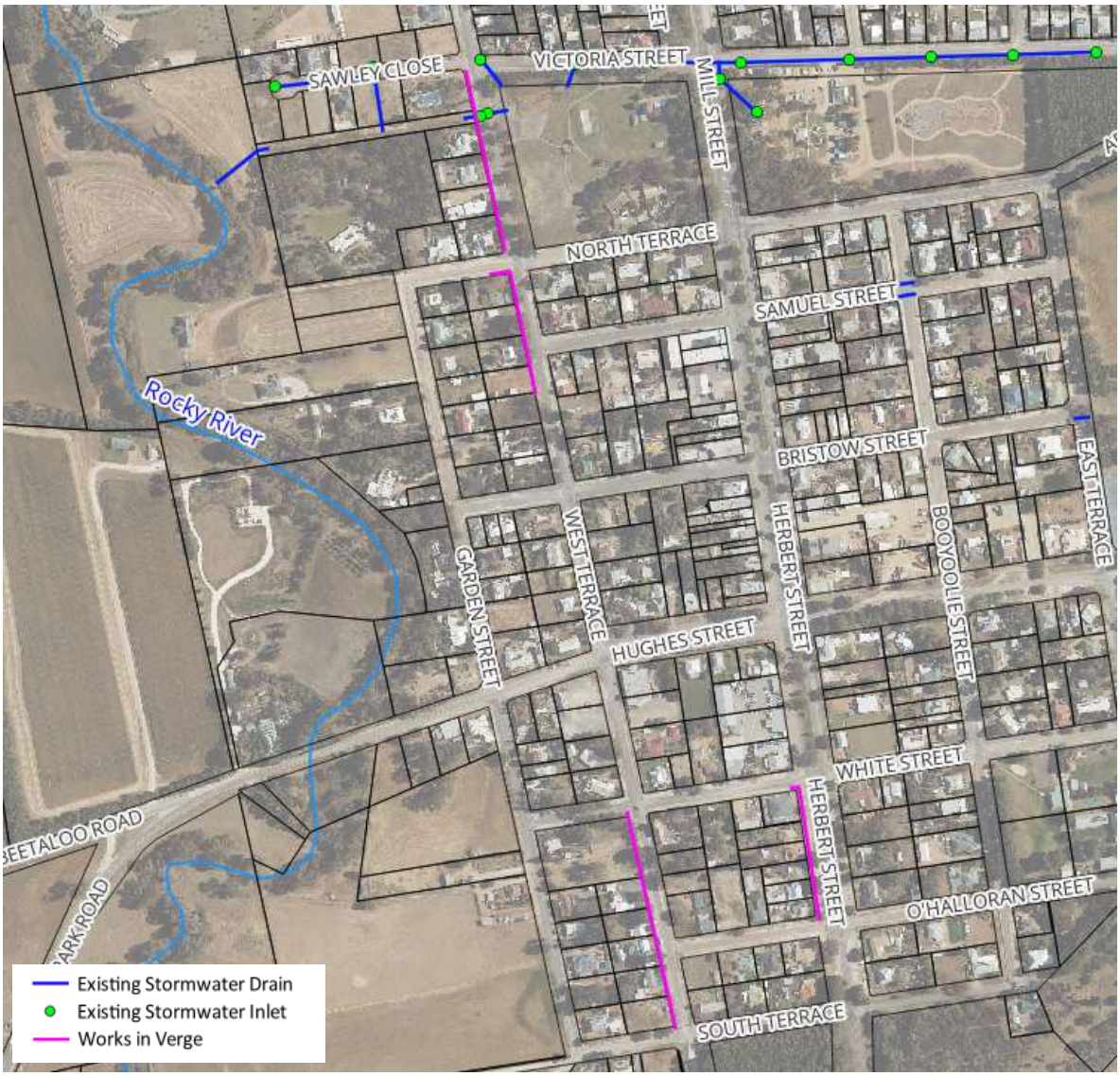


Figure 5.7 Flood Mitigation Strategy D7 Overview

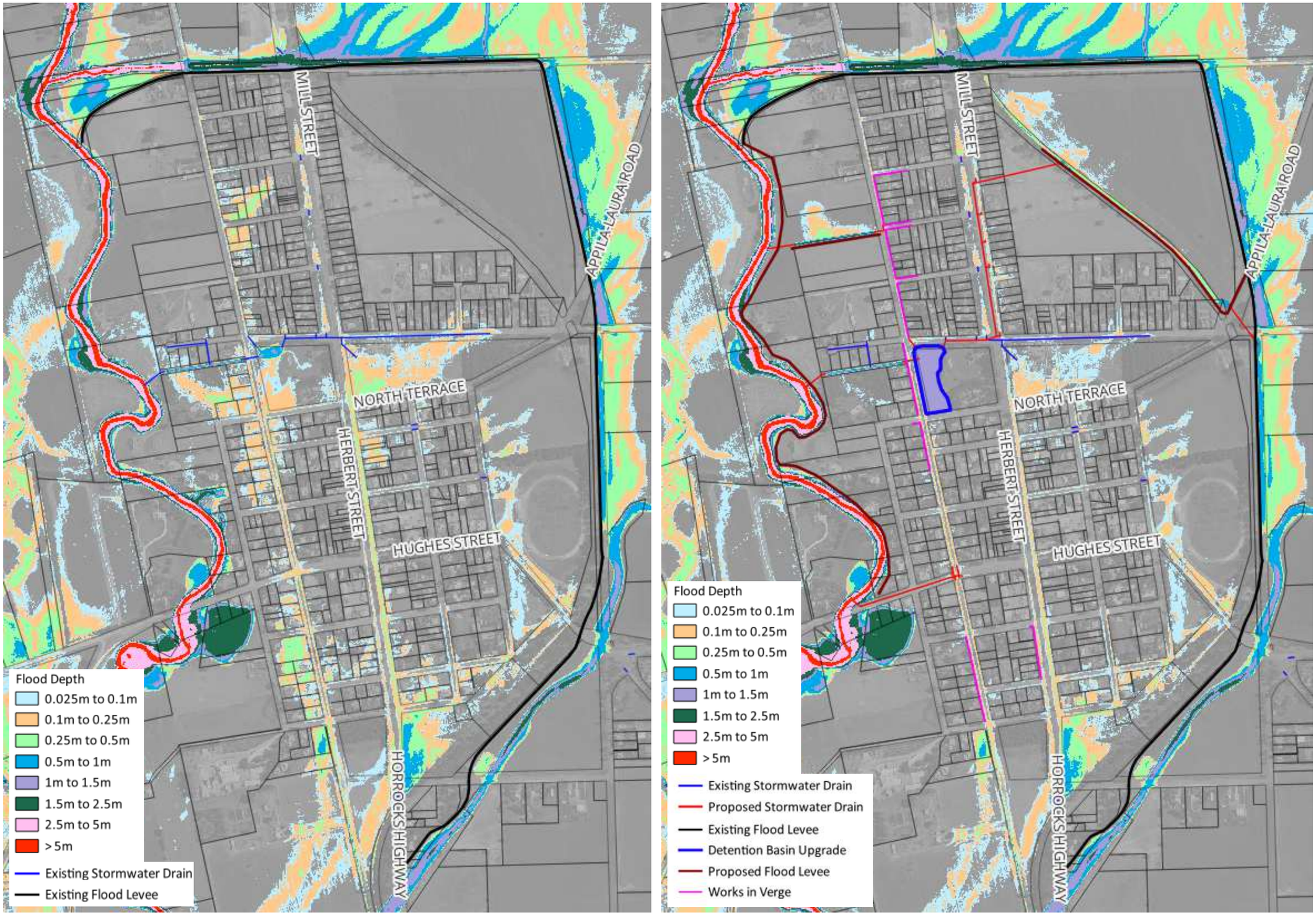


Figure 5.8 Laura Pre-Mitigation (Left) and Post-Mitigation (Right) 5% AEP Flood Maps

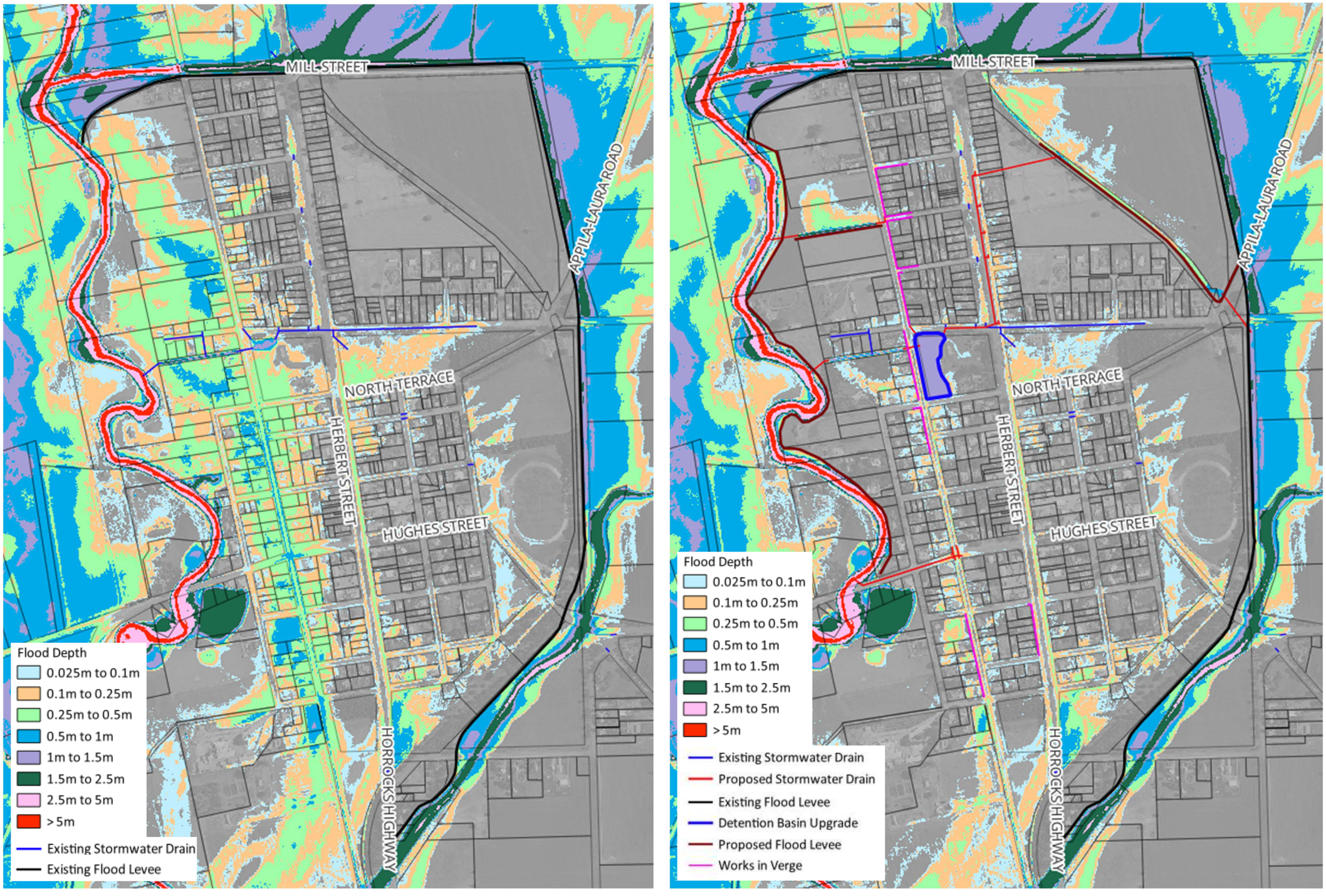


Figure 5.9 **Laura Pre-Mitigation (Left) and Post-Mitigation (Right) 1% AEP Flood Maps**

5.1.2 Flood Mitigation Benefits

The benefits associated with the reduction in flooding due to the construction of the recommended structural mitigation strategies have been assessed. This assessment considers the number of affected properties as well as the expected damages in flood events of varying frequency, and the average annual damages value.

Number of Properties Affected

Flood levels at the centroid of each property were determined from the flood grids produced by the TUFLOW model, and these levels have been used to determine the number of affected properties in Scenario C. Table 5.1 below summarises the total number of properties affected by each stage-damage curve range for all modelled AEPs.

Table 5.1 Scenario C Affected Properties by Flood Depth

Flood Depth Range (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0-0.1	3	3	4	19	29	58
0.1-0.15	0	1	2	1	3	6
0.15-0.25	0	0	0	4	2	10
0.25-0.5	0	0	0	1	4	3
0.5-1.0	0	0	0	0	1	6
1.0-1.5	0	0	0	0	0	0
1.5-2.5	0	0	0	0	0	0
2.5-5.0	0	0	0	0	0	0
Total	3	4	6	25	39	83
Change from Scenario B	-76.9%	-81.8%	-85.7%	-69.5%	-69.5%	-51.2%

The table demonstrates the significant reductions in flooding achieved by the proposed flood mitigation strategies. In flood events up to and including the 5% AEP which the strategies have been designed for, all property flooding is shallower than 150 mm and unlikely to cause above floor inundation of dwellings. The reduction in affected properties in larger floods is smaller, however still significant even up until the 0.2% AEP event. The extension of the flood levee along the western side of Laura, which targets major floods rarer than the 5% AEP, is responsible for the majority of reductions in these rare events.

Table 5.2 below breaks down the number of affected properties by land use type for each modelled AEP flood event.

Table 5.2 Scenario C Affected Properties by Land Use

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	3	4	6	25	37	77
Commercial	0	0	0	0	0	4
Industrial	0	0	0	0	2	2
Total	3	4	6	25	39	83

The distribution of affected properties is largely similar to the previously considered scenarios, with a majority of affected properties being residential, and very few commercial and industrial properties impacted. The upgrades were found to protect commercial properties in up to a 0.2% AEP event, where in Scenario B they were affected in a 10% AEP flood.

Direct Tangible Flood Damages

Direct tangible flood damages have been estimated for Scenario C, which considers future development and climate change, in conjunction with the proposed strategies. The flood level determined for each property was compared with the appropriate stage-damage curve to determine a damage cost for each property. Table 5.3 shows the resulting direct tangible flood damages by land use as well as the total flood damage for each modelled AEP.

Table 5.3 Scenario C Direct Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.0m	$0.6m	$1.3m	$3.2m
Commercial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.2m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.1m	$0.2m
Total	$0.0m	$0.0m	$0.0m	$0.6m	$1.4m	$3.6m

Indirect Tangible Flood Damages

INFFEWS recommends considering indirect tangible flood damages of 15% for residential buildings and 55% for commercial and industrial buildings. Applying these factors results in the total tangible flood damages summarised in Table 5.4.

Table 5.4 Scenario C Total Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.0m	$0.7m	$1.5m	$3.7m
Commercial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.3m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.2m	$0.3m
Total	$0.0m	$0.0m	$0.0m	$0.7m	$1.7m	$4.3m

Table 5.5 below demonstrates the improvements provided by the recommended flood mitigation strategies across the range of modelled AEPs.

Table 5.5 Reduction in Flood Damages Due to Flood Mitigation Strategies

Model Scenario	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Scenario B (Future)	$0.0m	$0.1m	$0.5m	$4.4m	$11.7m	$20.5m
Scenario C (Future/Upgrades)	$0.0m	$0.0m	$0.0m	$0.7m	$1.7m	$4.3m
Change in Flood Damages	No Change	-$0.1m **(-100%)**	-$0.5m **(-100%)**	-$3.7m **(-84.1%)**	-$10m **(-85.5%)**	-$16.2m **(-79.0%)**

The table demonstrates the significant reduction in property inundation achieved through the recommended flood mitigation strategies. Although not every property is flood proofed in up to the 5% AEP flood event, there is no recorded flood damage as no property is inundated deeper than 150 mm, meaning no flood damage value is applied in line with the adopted methodology.

Although the flood mitigation strategies were primarily designed for the 5% AEP flood event (with the exception of the flood levee to the west of town), there are still significant reductions in flood damages in larger events, owing largely to the proposed flood levee but also to the other more localised upgrades. The lower inundation depths through the town in the larger events is the main reason for the large flood damages reductions, as many properties are still affected, albeit to a much shallower depth.

Average Annual Damages

The resulting average annual damages value was found to be $54,830, which is a $287,864 reduction from the Scenario B value.

5.1.3 Water Sensitive Urban Design Strategies

A Water Sensitive Urban Design (WSUD) strategy has been developed for the town. The recommended measures will improve the quality of stormwater entering the receiving waters and, where possible, enable stormwater harvesting and reuse. The measures aim to achieve the aspirational water quality improvement targets outlined in Section 4, being an 80% reduction in TSS, a 60% reduction in TP, a 45% reduction in TN and a 90% reduction in gross pollutants.

The proposed measures have been modelled within MUSIC to allow for preliminary sizing of components and budget cost estimation. The Scenario 3 MUSIC model, considering future development and existing WSUD infrastructure, has been used as the basis for the upgrades. In addition to the identified measures, it is expected that further WSUD opportunities will be explored over time, particularly alongside land developments and road reconstruction works.

The WSUD measures considered are described in detail in the sections below. Many of the strategies are interconnected with the flood mitigation strategies discussed in Section 5.1.1. Each of the proposed works packages has been assigned a project ID which corresponds to the project location. As with the flood mitigation strategies, budget cost estimates have been prepared for the proposed works and are included in Appendix J.

WQ1: Laura Parkland Bioretention Basin
Bioretention basins are engineered depressions designed to detain and treat stormwater runoff. Following rainfall events, stormwater runoff pools in the basin and infiltrates through a prescribed soil media surface, removing sediment and nutrients from the water. Pollutants are retained in the system through enhanced sedimentation, fine filtration and biological uptake in the vegetation. An example of a bioretention basin is shown in Figure 5.10 below.



Figure 5.10 Bioretention Basin (Water Sensitive SA)

A bioretention component is recommended within the detention basin in Laura Parkland, which is proposed to be expanded in the flood mitigation strategies. This bioretention system is to be lined and include a submerged zone that will provide moisture storage to support the vegetation during prolonged periods without rainfall. This bioretention system will provide an opportunity for high quality landscaping and integration with the surrounding reserve.

Within the MUSIC model this has been represented as a 9600 m² basin with an extended detention depth of 0.3 m. The filter area size of 500 m² was determined using the MUSIC model, ensuring that water leaving the bioretention node achieves a suitable water quality improvement. Other parameters have been adopted in line with *South Australia MUSIC Guidelines* (Water Sensitive South Australia, 2021).

Figure 5.11 below shows the location of the proposed bioretention basin.

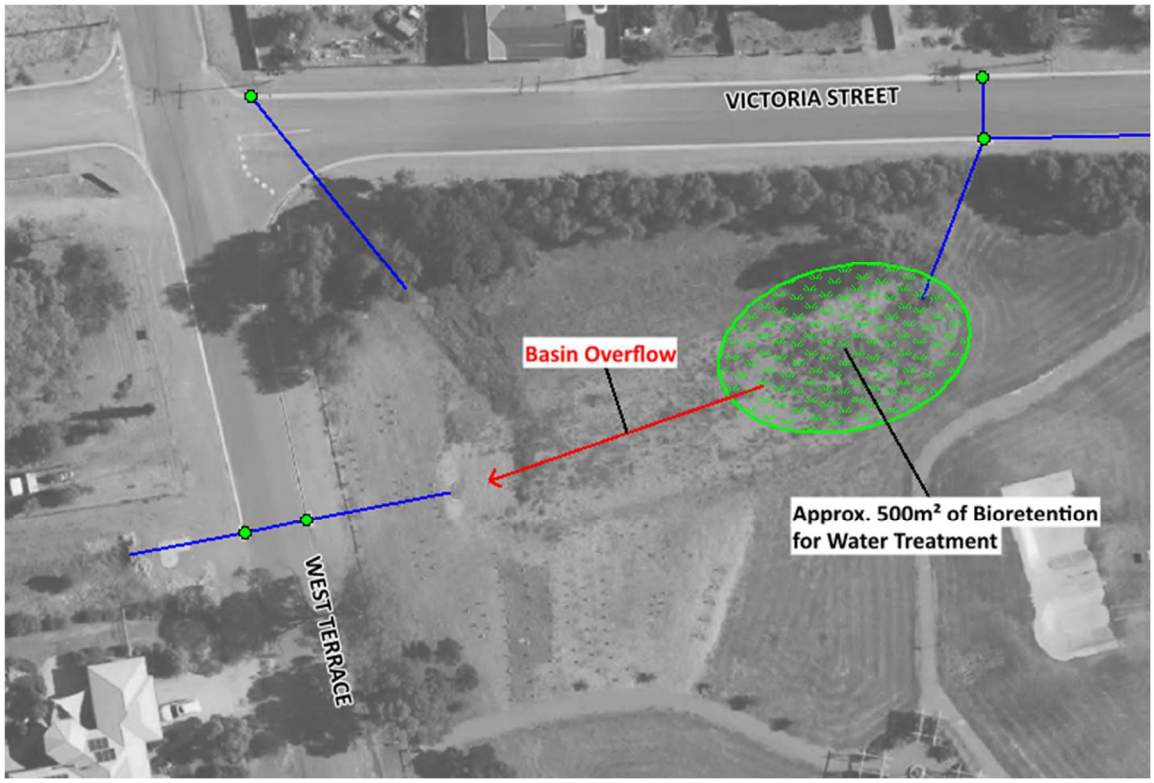


Figure 5.11 WSUD Strategy WQ1 Overview

WQ2: South Terrace Bioretention Basin

A large scale bioretention system was recommended in the undeveloped land on the corner of South Terrace and Horrocks Highway in *Laura Stormwater Management Plan* (Wallbridge & Gilbert, 2010). The design, which is attached to this report in Appendix I, is still valid and therefore has been implemented as part of the water quality strategy. The report recommends a 1 hectare area of biofiltration be constructed within this undeveloped land. This strategy has been added to the MUSIC model, providing water quality improvement for the runoff coming from the north along West Terrace and Herbert Street.

In the report this strategy was costed at approximately $400,000, plus an annual maintenance cost of $12,500. Adjusting for inflation brings this to approximately $585,000 with an annual maintenance cost of $18,300.

WQ3: Streetscape Raingardens

Raingardens are garden beds that use carefully selected native plants and soil to capture and biologically treat stormwater runoff from roofs and roads. Water ponds on the surface of the raingarden, where it soaks through the filter media, leaving sediments and rubbish behind. The plant roots in the soil absorb the nutrients in the stormwater, resulting in cleaner water leaving the raingarden. An example of a raingarden is shown in Figure 5.12.



Figure 5.12 Raingarden During a Rain Event (Resilient East)

It is essential that raingardens are properly maintained in order to ensure they function as intended over a long period of time. This involves promoting healthy vegetation, removing excess collected sediments, ensuring the surface can drain freely and removing any material blocking hydraulic structures. A schematic view of a raingarden is shown in Figure 5.13.

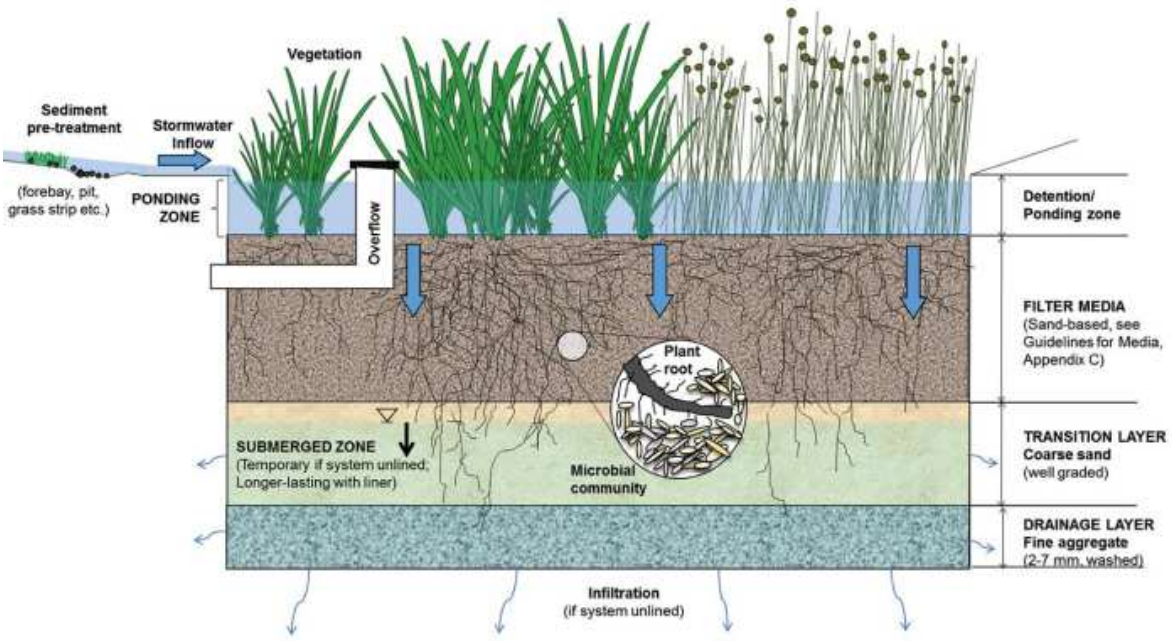


Figure 5.13 Typical Raingarden Composition

Within the MUSIC model, a 15 m² bioretention system has been assumed for each raingarden. Adopted MUSIC modelling parameters for the proposed streetscape bioretention systems are listed in Table 5.6.

Table 5.6 Adopted Raingarden System Properties

Parameter	Adopted Value
Filter Area (m²)	15
Extended Detention Depth (m)	0.15
High Flow Bypass (L/s)	125
Filter Depth (m)	0.5

Raingardens are proposed where new stormwater inlets are recommended through the various flood mitigation strategies, along West Terrace north of Victoria Street and at the intersection of Hughes Street and West Terrace. Raingardens have not been proposed along Victoria Street or Mill Street where there is existing and proposed stormwater infrastructure, as this system drains to the proposed Laura Parkland bioretention basin where treatment will occur. The figures below show the proposed locations of raingardens throughout Laura. The proposed raingardens equate to a filter area of 180 m² (they are not drawn to scale in the below figures). These locations will need to be refined during detailed design to consider the most appropriate location and form for the raingardens to take.

It is anticipated that the raingardens will be constructed alongside the corresponding flood mitigation strategy in order to provide cost efficiencies and prevent additional road reconstructions and works.

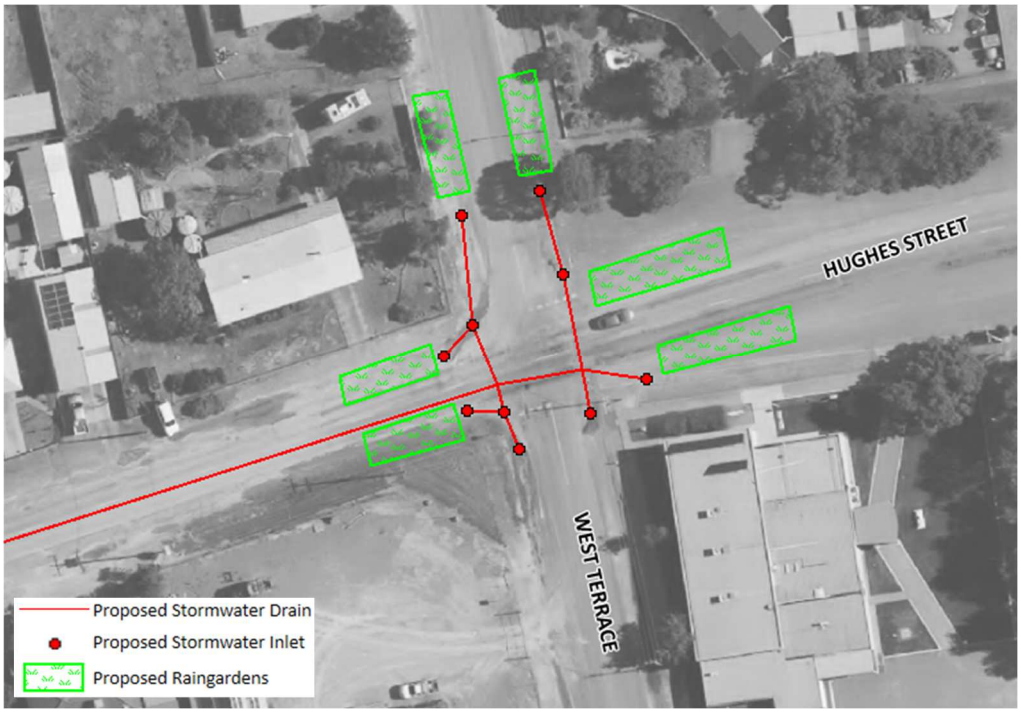


Figure 5.14 Proposed Hughes Street/West Terrace Raingardens

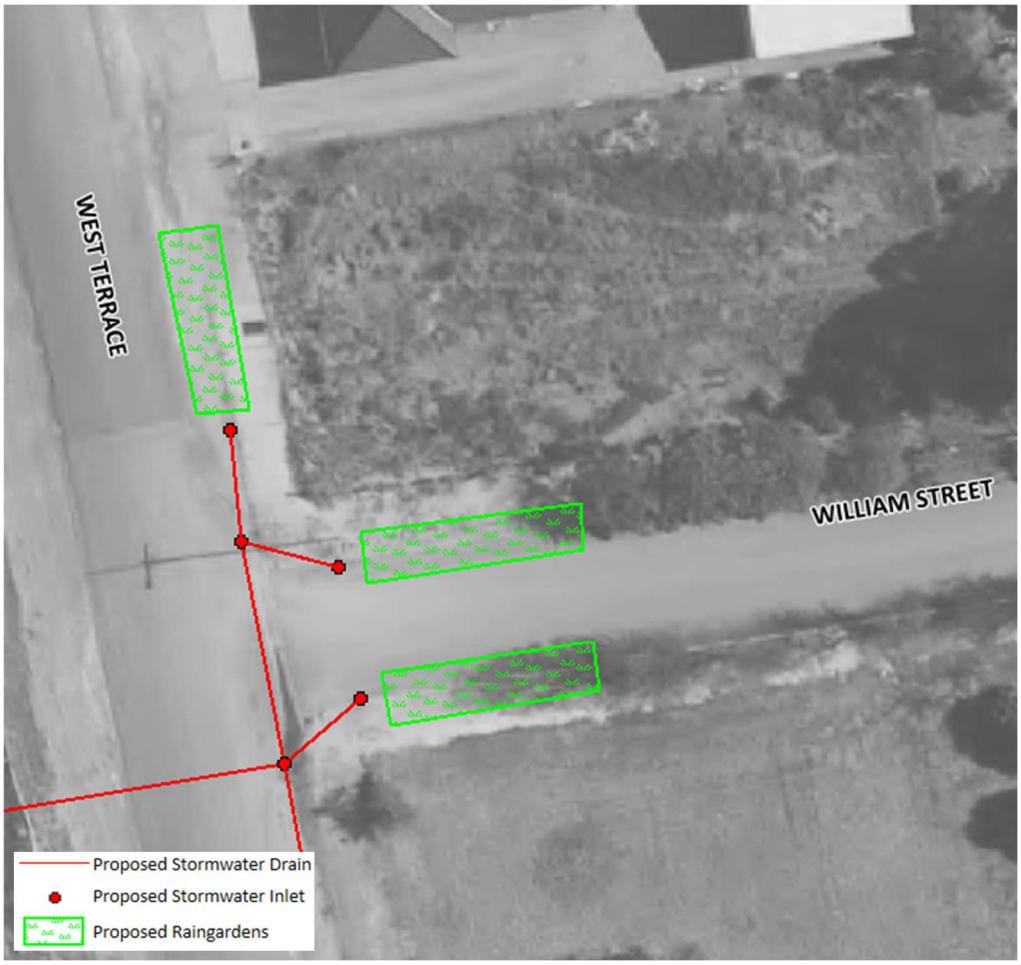


Figure 5.15 Proposed West Terrace/William Street Raingardens

WQ4: Stormwater Harvesting and Reuse Scheme

Opportunities for implementing large-scale stormwater harvesting and reuse within Laura have been investigated. A desktop assessment has been undertaken to determine the water demand of various reserves and green spaces in the town, using the methodology outlined in *Code of Practice – Irrigated Public Open Space* (SA Water, 2015). This document provides demand estimates for four turf quality visual standard categories:

- Category 1: Elite sports turf, used for passive recreation, site of national significance
- Category 2: Premier sports turf, used for passive recreation/tourism, site of state/regional significance
- Category 3: Local sports turf, used for passive recreation, site of local community significance
- Category 4: Local neighbourhood park, used for passive recreation

The irrigation requirement of each turf category, assuming Couch or Kikuyu grass is planted, is summarised in Table 5.7 below.

Table 5.7 Long-term Average (30yr) Irrigation Demand

Turf Category	Irrigation Demand (ML/ha/yr)
1 (Elite Sports Turf)	8.8
2 (Premier Sports Turf)	4.7
3 (Local Sports Turf)	3.7
4 (Local Neighbourhood Park)	2.7

While these irrigation demands are provided for metropolitan Adelaide, for the purposes of estimating irrigation requirements at a concept level, they are considered appropriate. This information has been used to quantify the estimated annual irrigation demand of the various green spaces in Laura, as quantified in Table 5.8 below.

Table 5.8 Laura Estimated Irrigation Demand

Location	Adopted Turf Category	Total Grassed Area (ha)	Irrigation Demand (ML/yr)
Bowling Club	3	0.2	0.6
Caravan Park	4	2.5	6.7
Herbert Street Median	3	0.4	1.4
Laura Parkland	4	2.2	5.8
School Grounds	3	0.7	2.5
Town Oval	3	2.1	7.8
Total	N/A	7.9	24.7

From *Laura Stormwater Management Plan* (Wallbridge & Gilbert, 2010), it is understood that the existing CWMS wastewater treatment scheme supplies up to 15 ML/yr, therefore

approximately 11 ML/yr of additional stormwater harvesting would be required to meet the total demand.

The basin scheme proposed by Wallbridge & Gilbert on the corner of South Terrace and Horrocks Highway also includes a stormwater harvesting and reuse component. The report recommends 1 hectare of biofiltration and 10 ML of surface storage for treated stormwater, and suggests this will supply 16 ML/yr of usable water. The design will require a small stormwater network to direct flows from the east side of Herbert Street into the basin. The design also includes a pump and a rising main for recycled water along the eastern side of town, connecting to the existing recycled effluent rising main from the wastewater treatment ponds on Laura-Beetaloo Road to the west of town. Offtake pipes from this rising main can be used to irrigate key green areas throughout the town listed in Table 5.8.

This basin and surface storage recommended by Wallbridge & Gilbert was modelled in MUSIC in order to produce an updated estimate of annual yield, accounting for changes in climate variables since 2010. MUSIC modelling indicates that a 2m deep surface storage with an area of 1 hectare, in line with the previous concept, will be capable of supplying 10.5 ML/yr. This together with the 15 ML/yr from the CWMS scheme provides a total of 25.5 ML/yr, above the estimated total demand of the green space in Laura of 24.7 ML/yr.

In the report this strategy was costed at approximately $150,000, plus an annual maintenance cost of $5,000. Adjusting for inflation brings this to approximately $220,000 with an annual maintenance cost of $7,300.

This strategy could be implemented using a staged approach, for example first constructing the basin and then implementing the stormwater harvesting and reuse scheme at a later date when funding becomes available.

It is recommended that Council undertake a stormwater harvesting and reuse feasibility study ahead of implementing any works. While high-level modelling has been undertaken to estimate water demand and potential supply, a more detailed analysis would be required to determine the overall feasibility of the scheme.

It should be noted that the opportunity to harvest stormwater in Laura Parkland alongside the proposed bioretention basin was also considered, through storing treated water in an underground tank constructed in the reserve. While there was sufficient open space to irrigate the reserve, water balance calculations undertaken in MUSIC suggested 2.5 ML/yr could be supplied from the contributing catchment, compared to an irrigation demand of 5.8 ML/yr. Considering the town demand is less than the total supplied by the CWMS scheme and the proposed South Terrace system, a reuse scheme within Laura Parkland is not recommended.

WQ5: Gross Pollutant Traps

Gross pollutant traps (GPTs) are primary treatment devices that are designed to remove anthropogenic waste, organic matter and coarse sediment from stormwater flows. There are many different proprietary makes and models of GPT, ranging from below ground ‘wet sump’ devices to above ground trash racks and capture nets on pipe outlets.

The parameters adopted in MUSIC for GPTs have been based on Civilmart Cleansall GPTs. Following the guidance of *South Australian MUSIC Guidelines* (Water Sensitive South Australia, 2021), all GPTs are assumed to only provide effective reductions in gross pollutants and total

suspended solids, and have assumed to result in no reduction in total phosphorus and total nitrogen loads.

For all new outlets to the watercourses surrounding the town, it is recommended for a gross pollutant trap to be included. This includes the new drain in Hughes Street to Rocky River (strategy D3) and the new drain from William Street to Rocky River (strategy D5). Velocity dissipation measures should also be implemented at any new outlet structure to minimise erosion of the channel.

Depending on the system being installed and the details surrounding its installation, Council may need to apply for a water affecting permit from the Northern and Yorke Landscape Board prior to installing gross pollutant traps. Council should refer to their Water Affecting Activities Best Practice Operating Procedure agreement with the Board when determining if a permit will be required for the works.

WQ6: Rainwater Tanks and Allotment Level Reuse

It has been assumed that for each new house, a 10 kL rainwater tank will be used to irrigate the garden, as discussed in *Laura Stormwater Management Plan Modelling Report* (Southfront, 2025). This is considered to be a conservative approach, as aerial photography shows the majority of houses in Laura contain at least one large rainwater tank.

Further to rainwater tanks, it is recommended Council explore the addition of other allotment scale reuse practises as part of its development approval process. This includes encouraging passive irrigation of gardens, such as use of buffer strips, infiltration systems, pervious pavement and green roofs. These elements will reduce the use of potable water for irrigation, reduce the overall volume of stormwater runoff to receiving environments, provide additional opportunities for greening and cooling of the catchment and potentially assist with flood mitigation measures by limiting allotment runoff volumes.

Aquifer Storage and Recovery

As part of *Laura Stormwater Management Plan* (Wallbridge & Gilbert, 2010), a review of aquifer storage and recovery potential for Laura was conducted. As discussed in Section 2.3.4, the report found that there was limited potential for ASR within the region, with a moderate to high risk that the aquifer systems are not suitable. Due to this and also the economic cost of such a scheme, ASR was not considered suitable for Laura.

5.1.4 Water Quality Improvement

The Scenario 3 MUSIC model was modified, incorporating the various WSUD features described above. The results of the Scenario 4 MUSIC model are compared with the untreated runoff pollutant loads determined in Scenario 2 for the total urban catchment in Table 5.9.

Table 5.9 Total Urban Catchment Water Quality Improvement

Parameter	Sources	Residual Load	Reduction	Aspirational Target
Flow (ML/yr)	132	87.6	34%	N/A
Total Suspended Solids (kg/yr)	21,800	1,610	93%	80%
Total Phosphorus (kg/yr)	48	13.3	72%	60%
Total Nitrogen (kg/yr)	360	120	67%	45%
Gross Pollutants (kg/yr)	3,450	0.3	99%	90%

The pollutant reductions were found to exceed the aspirational targets for all pollutant types. Under the adopted water quality strategy, the vast majority of urban runoff is sent to some form of bioretention treatment, providing effective removal of all recorded pollutant types.

Rocky River

The water quality performance for the upstream Rocky River catchment has been reported downstream of the township contributions. Table 5.10 below summarises the results.

Table 5.10 Scenario 4 Rocky River Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	6,640
Total Suspended Solids (kg/yr)	2,430,000
Total Phosphorous (kg/yr)	2,610
Total Nitrogen (kg/yr)	15,400
Gross Pollutants (kg/yr)	0.3

5.2 Non-structural Measures

To complement the proposed structural options, a number of non-structural options are also recommended. Non-structural options are typically low cost (relative to structural measures) and hence are extremely cost effective with respect to the benefits that they provide.

N1: Flood Warning Systems
It is recommended that Council implement flood warning systems for the major watercourses of Rocky River and Pine Creek upstream of the town. These catchments are very large in size and have long critical durations ranging from 12 hours to 36 hours, meaning that with the appropriate warning systems in place there will be time to alert the community ahead of a major flood event.

National Arrangements for Flood Forecasting and Warning (Bureau of Meteorology, 2018) provides a summary of how flood forecasting and warning services are arranged nationally. This document discusses various funding programs available at national and state/territory levels, which can include flood warning investments. Arrangements vary across jurisdictions and can involve a shared contribution between Council and the government. Opportunities for one-off funding are also available either following a significant flood event or a major review exercise.

Having flood gauges on the upstream catchments will also provide a better understanding of the flow patterns and volumes for these large watercourses, for which there is currently no flow data available. Over time, this will enable more accurate estimates of peak flow to be produced, therefore giving a better understanding of flood risk within the town.

N2: Levee Tenure and Structural Assessment Program
As highlighted in this report, the levees surrounding the town are vital to protecting it during major flood events. Through the development of this stormwater management plan, it has become apparent that there is uncertainty with regard to land tenure of the levees. It is recommended that Council undertake investigations to determine levee ownership, and develop a levee structural assessment and maintenance program to ensure they are capable of protecting the town during floods.

N3: Rezoning Flood-prone Land
Council should consider rezoning vacant land that is currently shown to be inundated in up to a 1% AEP flood event, or where considered necessary for the storage of stormwater. It is also recommended that Council obtains easements over all levees and proposed open channels for long-term access and maintenance.

N4: SES Community FloodSafe Program
The State Emergency Service (SES) deliver their FloodSafe and StormSafe programs in schools and the community, to help build community resilience and understanding about flood risk. Community FloodSafe is a partnership between local Councils and State and Federal governments. The FloodSafe program uses existing SES volunteers, as well as new community volunteers with good presentation skills, to reach into communities to raise awareness in flood-prone areas. Initiatives include articles in Council newsletters, street corner meetings, community group meetings, internet sites, brochures and school education.

The volunteers talk to community groups, local residents, businesses and schools about what they can do to reduce the risk of flood damage and improve the resilience of their community if a flood should occur. FloodSafe volunteers typically address communities on:

- Local risks and historic flooding in the area;
- Having a flood plan to reduce the risk to business equipment, stock and staff;
- Protecting family and property;
- Understanding BOM Flood Watch and flood warnings;
- Having a home emergency kit; and
- How to call for SES response.

Since its inception in 2009, many metropolitan and regional South Australian councils have joined the FloodSafe program. Council may also elect to make the floodplain mapping of the town available via their website, along with advice to residents on measures they can take to reduce their flood risk and steps to preparing a Personal Flood Action Plan.

N5: Council's Emergency Management Plan
It is recommended that Council develop an Emergency Management Plan, with the purpose of collectively developing skills which provide the community with:

- Knowledge of the emergency risks that exist in the local area;
- Information to support the role that each member of the community can have in an emergency;
- A platform to connect with each other and Council before, during and after an emergency; and
- The ability to support each other to become resilient in an emergency event or disaster.

N6: New Building Floor Levels
It is recommended that Council ensure all new development has a floor level that provides at least 300 mm freeboard to the 1% AEP floodplain. This will mean that over time, the level of flood risk affecting properties will gradually decrease as new development occurs.

N7: Ongoing Maintenance and Monitoring of Council Assets
It is recommended that Council develop a Stormwater Asset Management Plan. The goal of such a plan is to ensure processes are in place for the required maintenance, monitoring and capital renewal of Council assets and to ensure it is done in a financially sustainably way. It is also recommended that Council develop a record of all of their stormwater assets in GIS form, and continually update this with any new infrastructure as it is constructed. It may also be worthwhile for Council to reconcile any drainage easements through private property.

N8: Education and Promotion of WSUD Measures
It is recommended that Council seek to increase uptake of WSUD measures on private property through community education and promotion of WSUD demonstration sites. Council staff and volunteers should seek to educate businesses, community groups, schools and local residents about options for managing the stormwater runoff generated from their property in an environmentally responsible manner. Suitable WSUD measures may include permeable paving, rainwater tanks, raingardens and soakage systems. These could be promoted through Council newsletters, street corner meetings, community group meetings, website and social median updates, brochures and school education.

N9: Development Controls – Beneficial Use of Stormwater

It is recommended that Council seek to increase uptake of WSUD measures on private property through community education and promotion of WSUD demonstration sites. Council staff and volunteers should seek to educate businesses, community groups, schools and residents about options for managing the stormwater runoff generated from their property in an environmentally responsible manner. Suitable WSUD measures may include permeable paving, rainwater tanks, raingardens and soakage systems. These could be promoted through Council newsletters, street corner meetings, community group meetings, website and social media updates, brochures and school education.

5.4 Risk Reduction Assessment

The flood risk assessment undertaken for Scenario A and Scenario B in Section 3.7 has been reviewed and updated following the modelling of the recommended stormwater management responses. The updated risk register is shown in Table 5.13.

Table 5.11 below summarises the identified risk ratings for Scenario B and Scenario C.

Table 5.11 Distribution of Risk Ratings across Model Scenarios

Model Scenario	Low Risk	Moderate Risk	High Risk	Extreme Risk
Scenario B	21	8	8	3
Scenario C	24	9	5	2

The table shows the risk reduction provided by the stormwater management measures. It should be noted that many of the high and extreme risk locations are associated with flooding across roads outside of the town, and were not targeted by flood mitigation strategies.

5.5 Social and Political Capital Requirements

The level of 'social and political capital' that would be required to implement each of the proposed management responses has been investigated. A rating system has been developed to define the levels of social and political capital, as presented in Table 5.12 below.

Table 5.12 Definitions of Social and Political Capital Levels

Rating	Structural Measure	Non-Structural Measure
Low	Small, simple works being undertaken in low-traffic areas such as local roads, undeveloped reserves or vacant land.	Simple to implement measure unlikely to require behavioural change.
Medium	Moderately sized works being undertaken outside of areas of social, economic or environmental importance.	Moderately complicated measure requiring behavioural change.
High	Complex, expensive or sensitive works requiring land acquisition, or being centred around areas of social, economic or environmental importance.	Complex measure requiring policy changes, significant behavioural change or significant financial investment.

A rating has been assigned for each management response, and these have been incorporated into the summary table provided in the following section.

5.6 Overview of Stormwater Management Responses

The full range of recommended management responses, including those targeting flooding and water quality as well as non-structural measures, have been combined into a single overview table, summarising the key information relating to each. The table presents the management responses in a way which allows for easy comparison of the merits of each option, and is shown in Table 5.14 below.

Table 5.13 - Scenario C Flood Risk Register

ID	Location	Type of Deficiency	1% AEP Impact Details	Risk Category	Consequence	Risk
1	Rocky River channel west of Walter Street	N/A	Rocky River floodwaters contained by flood levee	Flooding, Health & Safety, Social/Stakeholder	1	Low
2	Laura-Caltowie Road	High/Extreme Flood Hazard	Flooding over 1500mm deep across major road	Flooding, Health & Safety	4	Extreme
3	Pech Road (Central)	Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
4	Stock Route Road	Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
5	Tom Catt Hill Road	High/Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
6	West Terrace	High/Extreme Flood Hazard	Flooding over 1500mm deep across the road	Flooding, Health & Safety	3	High
7	Pech Road (Northeast)	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
8	Appila-Laura Road	Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
9	Lots on corner of West Terrace/White Street	High Flood Hazard	Properties flooded over 250mm deep	Flooding, Health & Safety, Social/Stakeholder	3	High
10	Switchback Road	High/Extreme Flood Hazard	Flooding over 1000mm deep across the road	Flooding, Health & Safety	3	High
11	Pech Road (West)	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
12	Possum Park Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
13	West Terrace between Samuel St/White St	High/Extreme Flood Hazard	Flooding over 250mm deep on the road, surrounding properties inundated over 100mm deep	Flooding, Health & Safety, Social/Stakeholder	2	Moderate
14	Laura-Beetaloo Road west of Hughes Street	Extreme Flood Hazard	Flooding over 250mm deep across the road	Flooding, Health & Safety	1	Low
15	West Terrace south of South Terrace	High Flood Hazard	Flooding over 250mm deep along the road	Flooding, Health & Safety	1	Low
16	Lots on West Terrace opposite Samuel St	High Flood Hazard	Properties flooded over 100mm deep	Flooding, Health & Safety, Social/Stakeholder	2	Moderate
17	Lots on West Terrace between Sawley Close and North Terrace	High Flood Hazard	Properties flooded over 100mm deep	Flooding, Health & Safety, Social/Stakeholder	2	Moderate
18	Lots on Stock Route Road north of Pine Creek channel	High Flood Hazard	Several properties inundated to a shallow depth	Flooding, Health & Safety, Social/Stakeholder	1	Low
19	Horrocks Highway	Extreme Flood Hazard	Shallow flooding across major road	Flooding, Health & Safety	1	Low
20	Victoria Street east of Mill Street	Low Freeboard /Upwelling	Minor ponding on road	Flooding	1	Low
21	Victoria Street west of Mill Street	Low Freeboard /Upwelling, Inlet Capacity	Minor ponding on road	Flooding	1	Low
22	Intersection of Victoria Street and Campbell Street	Low Freeboard, Inlet Capacity	Minor ponding on road	Flooding	1	Low

23	Victoria Street between Campbell Street and Cleggett Close	Low Freeboard, Inlet Capacity and Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
24	Corner of Victoria Street and Cleggett Close	Low Freeboard, Inlet Capacity and Gutter Flow Depth/Width	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
25	Victoria Street between Cleggett Close and Olsen Street	Low Freeboard, Inlet Capacity	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
26	Victoria Street between Mill Street and West Terrace	Low Freeboard	Minor ponding on road	Flooding	1	Low
27	Corner Victoria Street and West Terrace	Upwelling, Inlet Capacity, Gutter Flow Depth/ Width	Flooding over 250 mm deep on side of road	Flooding	1	Low
28	West Terrace	Low Freeboard /Upwelling, Inlet Capacity	Flooding over 250 mm deep on side of road	Flooding	1	Low
29	Sawley Close	Low Freeboard	Minor ponding on road	Flooding	1	Low
30	Sawley Close	Low Freeboard	Minor ponding on road	Flooding	1	Low
31	Mill Street near Victoria Street	Low Freeboard /Upwelling, Inlet Capacity	Minor ponding on road	Flooding	1	Low
32	Corner Victoria Street and Mill Street	Low Freeboard, Inlet Capacity	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
33	West Terrace	Low Freeboard	Wide flow pathway over 100 mm deep on road	Flooding	1	Low
34	Herbert Street between North Terrace and South Terrace	Gutter Flow Depth/Width	Wide flow pathway over 250 mm deep on road	Flooding	1	Low
35	West Terrace between Alexander Street and South Terrace	Gutter Flow Depth	Wide flow pathway over 250 mm deep on road	Flooding	1	Low
36	Corner Samuel Street and Booyoolie Street	Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
37	Booyoolie Street between O'Halloran Street and South Terrace	Gutter Flow Depth/Width	Minor ponding on road	Flooding	1	Low
38	Corner East Terrace and O'Halloran Street	Gutter Flow Depth/Width	Flooding over 250 mm deep on road	Flooding	1	Low
39	Various locations along levee	Levee overtopping/failure	Risk of major flooding	Flooding, Health & Safety, Social/Stakeholder, Reputational/Political	4	Extreme
40	Receiving waters	Water quality of town runoff	Risk of ecological harm	Environmental, Social/Stakeholder, Reputational/Political	2	Moderate

Table 5.14 - Summary of Stormwater Management Responses

ID	Description	Objectives Addressed	Structural?	Type of Action	Benefit Provided	Capital Cost	Estimated Annual Operating Cost	Social/Political Capital Required	Stakeholder Responsible for Funding/Implementing	Post-measure Residual Risk
D1	Rocky River Flood Protection	1,6	Yes	Works, land acquisition	Flood mitigation, drainage service	$1,530,000	-	High	Northern Areas Council	Low
D2	Laura Parkland Stormwater Upgrade	1,6	Yes	Works	Flood mitigation, drainage service	$1,160,000	-	High	Northern Areas Council	Moderate
D3	Hughes Street Drainage	1,6	Yes	Works	Flood mitigation, drainage service	$660,000	-	Medium	Northern Areas Council	Moderate
D4	Northern Catchment Diversion Works	1,6	Yes	Works, land acquisition	Flood mitigation, drainage service	$2,280,000	-	High	Northern Areas Council	Moderate
D5	William Street Open Channel	1,6	Yes	Works, land acquisition	Flood mitigation, drainage service	$360,000	-	High	Northern Areas Council	Moderate
D6	West Terrace Flow Path Works	1,6	Yes	Works	Flood mitigation, drainage service	$360,000	-	Medium	Northern Areas Council	Moderate
D7	Verge Works throughout Laura	1,6	Yes	Works	Flood mitigation	$350,000	-	Low	Northern Areas Council	Moderate
WQ1	Laura Parkland Bioretention Basin	2,6	Yes	Works, integrated program	Water quality improvement	$210,000	$8,000	Low	Northern Areas Council	N/A
WQ2	South Terrace Bioretention Basin	2,6	Yes	Works, land acquisition, integrated program	Water quality improvement	$585,000	$18,300	High	Northern Areas Council	N/A
WQ3	Streetscape Raingardens	2,6	Yes	Works, integrated program	Water quality improvement, amenity improvement	$300,000	$8,400	Low	Northern Areas Council	N/A
WQ4	Stormwater Harvesting and Reuse Scheme	3,6	Yes	Works, integrated program	Stormwater reuse	$220,000	$7,300	Medium	Northern Areas Council	N/A
WQ5	Gross Pollutant Traps	2,5,6	Yes	Works, integrated program	Water quality improvement	$270,000	$4,000	Low	Northern Areas Council	N/A
WQ6	Rainwater Tanks and Allotment Level Reuse	2,3,4,6,7	No	Community education program	Stormwater reuse, water quality improvement, information and knowledge	N/A	N/A	Medium	Northern Areas Council	N/A
N1	Flood Warning Systems	1,7	No	Policy change	Flood mitigation, information and knowledge, administration efficiency	N/A	N/A	High	Northern Areas Council, State/Federal Governments	N/A
N2	Levee Tenure and Structural Assessment Program	1,6,7	No	Investigation	Flood mitigation, information and knowledge	N/A	N/A	Medium	Northern Areas Council	N/A
N3	Rezoning Flood-prone Land	4,7	No	Policy change, community education program	Flood mitigation, information and knowledge	N/A	N/A	High	Northern Areas Council	N/A
N4	SES Community FloodSafe Program	7	No	Community education program	Flood mitigation, information and knowledge	N/A	N/A	Medium	Northern Areas Council, State Emergency Service	N/A
N5	Council's Emergency Management Plan	1,7	No	Investigation, policy change	Flood mitigation, information and knowledge, administration efficiency	N/A	N/A	Medium	Northern Areas Council	N/A

N6	New Building Floor Levels	4,7	No	Policy change	Flood mitigation	N/A	N/A	Medium	Northern Areas Council, Developers	N/A
N7	Ongoing Maintenance and Monitoring of Council Assets	6	No	Policy change	Flood mitigation, drainage service, information and knowledge, administration efficiency	N/A	N/A	High	Northern Areas Council	N/A
N8	Education and Promotion of WSUD Measures	2,4,7	No	Community education program	Stormwater reuse, water quality improvement, ecological improvement, information and knowledge	N/A	N/A	Medium	Northern Areas Council, Businesses, Organisations, Communities	N/A
N9	Development Controls – Beneficial Use of Stormwater	3,4,7	No	Policy change	Stormwater reuse, water quality improvement	N/A	N/A	Medium	Northern Areas Council, Businesses, Organisations, Communities	N/A

5.7 Prioritisation of Management Responses

The recommendations outlined in this Stormwater Management Plan will require implementation to be scheduled over many years, in order to be accommodated sustainably within the Northern Areas Council's budget and the budgets of other potential funding partners.

Each of the actions within the SMP has been assigned one of five priority levels, each of which have an associated time frame:

- Very High (0-2 years);
- High (2-5 years);
- Moderate (5-10 years);
- Low (10-20 years); and
- Very Low (20-30 years).

A Multi-Criteria Analysis (MCA) approach has been followed to assign priorities to all proposed stormwater management responses. This approach allows relative priorities to be assigned to all recommended structural works, taking into account financial, environmental and social factors. The criteria and weightings adopted have been developed with consideration of the stormwater management objectives and targets developed for this SMP, which were developed following discussions with key stakeholders.

A diverse range of stormwater management strategies have been recommended in this plan to cater to the unique requirements of the town. Having regard to the diversity of these strategies and the need for a flexible and optimal decision making framework for this plan, a separate MCA approach has been developed for the flood mitigation strategies and for the water sensitive urban design strategies.

The two MCA approaches are linked through the inclusion of a criterion that recognises flood mitigation projects that are required as a precursor to the implementation of WSUD actions. Consolidation of scores from the two MCA approaches has also been undertaken to inform the prioritisation of works and reinforce the value of achieving multiple objectives for stormwater management projects in the town.

The priority rating of responses is flexible and likely to change over time. It is anticipated that certain responses will be 'brought forward', particularly when opportunities for external grant funding arise. A number of flood mitigation projects eligible for funding from the Stormwater Management Authority have been identified. It is recommended that Northern Areas Council liaise with the Stormwater Management Authority to identify a time frame for the delivery of these projects that meets the forward budget limitations of both parties.

The SMP brief asks for a reasonable and credible estimate of the benefit provided by each response, quantified where possible. Considering the nature of flooding in the town, with urban runoff being the dominant flooding mechanism in the more frequent events and major watercourses governing flooding in the rarer events, this was not considered possible. As the strategies have been developed holistically looking at both urban and rural flooding mechanisms, no single strategy can be attributed all of the flood reduction achieved in a given area across the range of modelled AEPs. The overall benefit provided by the entire strategy is described in Section 5.1.2.

In lieu of considering the economic benefit of each individual strategy, alternative metrics have been adopted to assess the benefit provided by each. This includes a metric looking at residual nuisance flooding along roads in minor storm events and a metric looking at the reduction in major flood risk in rare storm events. These are qualitative, and have been assessed by comparing the pre-mitigation and post-mitigation flood maps for a range of storm events.

It should be noted that the non-structural measures are not included within the assessment as they do not necessarily fit within the MCA criteria.

5.7.1 Flood Mitigation Strategies Multi-Criteria Analysis

The criteria and weightings used in the MCA to prioritise the flood mitigation strategies are summarised in Table 5.15.

Table 5.15 Flood Mitigation Strategies MCA Performance Matrix

Criterion	Weighting	Performance Score				
		5	4	3	2	1
Capital Cost	20	<$100k	$100-500k	$500k-1m	$1m-2m	>$2m
Reduced Street Drainage Nuisance	20	Very High	High	Moderate	Low	Very Low
Reduced Major Flooding Risk	30	Very High	High	Moderate	Low	Very Low
Precursor to WSUD Strategy	10	Multi-objective WSUD	-	Water Quality Only	-	None
Community Buy-In	20	Very High	High	Moderate	Low	Very Low
Total	100					

Performance values used in the assessment of proposed stormwater management responses have been defined as follows:

- Capital Cost

Reference has been made to the construction cost estimates outlined in this plan to determine this value. Projects with a greater capital cost are assigned lower scores than projects with a smaller capital cost.

- Reduced Street Drainage Nuisance

This value was assigned based on judgement of the improvements demonstrated by the 18% AEP floodplain mapping of the flood mitigation strategies. Projects that limit property and roadway ponding in the vicinity to a depth of less than 0.1 metres were assigned the highest value, with progressively lower values assigned where the residual impact was larger.

- Reduced Major Flooding Risk

This value was assigned based on judgement of the improvements demonstrated by the 5% AEP and rarer floodplain mapping of the flood mitigation strategies. This criterion has been assigned

a higher weighting due to the significant social, financial and environmental impacts associated with major flooding.

➤ Precursor to WSUD Strategy

Several of the recommended flood mitigation strategies are required as a precursor to, or directly facilitate, the implementation of a water sensitive urban design strategy. Projects that facilitate multi-objective WSUD outcomes have been assigned higher values than projects that provide only water quality improvement (e.g. gross pollutant traps). This criterion has been assigned a lower weighting as WSUD strategies are considered separately.

➤ Community Buy-In

All projects were assigned a default maximum rating for this criteria, then revised down for projects that require acquisition of land or easements through private property, and for projects that impact the existing use of public open space. Projects which address issues raised in the community consultation have been assigned higher ratings. Projects that negatively impact existing sites of high recreational value or that support organised sport were assigned the lowest ratings.

Performance values input into the MCA can be found in Appendix K.

Weighted scores for each stormwater management response have been determined using the above MCA framework, and are presented in Table 5.16 from highest to lowest. Note that each strategy can achieve a maximum score of 5 and a minimum score of 1.

Table 5.16 Flood Mitigation Strategies MCA Results

Strategy ID	Description	Weighted Score
D3	Hughes Steet Drainage	3.4
D1	Rocky River Flood Protection	3.0
D2	Laura Parkland Stormwater Upgrade	2.8
D6	West Terrace Flow Path Works	2.8
D7	Verge Works throughout Laura	2.6
D5	William Street Open Channel	2.6
D4	Northern Catchment Diversion Works	2.5

5.7.2 WSUD Strategies Multi-Criteria Analysis

The criteria and weightings used in the MCA to prioritise the WSUD strategies are summarised in Table 5.17.

Table 5.17 WSUD Strategies MCA Performance Matrix

Criterion	Weighting	Performance Score				
		5	4	3	2	1
Capital Cost	20	<$50k	$50-250k	$250-500k	$500k-1m	>$1.0m
Annual Maintenance Cost	20	<$5k	$5-10k	$10-15k	$15-20k	>$20k
Pollutant (TSS) Reduction (average annual load)	20	>5 tonnes	2-5 tonnes	1-2 tonnes	0.5-1 tonnes	<0.5 tonnes
Stormwater Capture and Reuse	20	Capture and Reuse	-	Capture Only	-	None
Community Buy-In	20	Very High	High	Moderate	Low	Very Low
Total	100					

Performance values used in the assessment of proposed stormwater management responses have been defined as follows:

- Capital Cost

Reference has been made to the construction cost estimates outlined in this plan to determine this value. Projects with a greater capital cost are assigned lower scores than projects with a smaller capital cost.

- Maintenance Cost

Values were assigned based on maintenance cost estimates from historical experience and industry sources.

- Pollutant (TSS) Reduction

Projects have been assigned a value that is reflective of their expected pollutant removal performance, as defined by the average annual load reduction of total suspended solids reported by the MUSIC model.

- Stormwater Capture and Reuse

Several of the recommended WSUD strategies result in the capture and/or reuse of stormwater. Projects that facilitate stormwater capture and reuse have been assigned higher performance scores than projects that facilitate stormwater capture only.

- Community Buy-In

All projects were assigned a default maximum rating for this criteria, then being revised down for projects that require acquisition of land or easements through private property, and for

projects that impact the existing use of public open space. Projects that impact existing sites of high recreational value or that support organised sport were assigned the lowest ratings.

Performance values input into the MCA can be found in Appendix K.

Weighted scores for each stormwater management response have been determined using the above MCA framework, and are presented in Table 5.18 from highest to lowest. Note that each strategy can achieve a maximum score of 5 and a minimum score of 1.

Table 5.18 WSUD Strategies MCA Results

Strategy ID	Description	Weighted Score
WQ1	Laura Parkland Bioretention Basin	4.0
WQ3	Streetscape Raingardens	3.6
WQ4*	Stormwater Harvesting and Reuse Scheme	3.6
WQ5	Gross Pollutant Traps	3.2
WQ2	South Terrace Bioretention Basin	3.2

* Strategy WQ4 requires strategy WQ2 having been implemented.

5.7.3 Implementation Plan

An implementation plan for the recommended responses is presented in Table 5.19. This table describes the additional work and investigations that would be required to implement any given response, suggests an implementation time frame based on the MCA analysis, and details the responsible party and any funding sources available.

5.7.4 Responsibilities for Implementation and Funding Opportunities

Northern Areas Council is responsible for the implementation of all actions identified within this Stormwater Management Plan. It is expected that Council will continue to liaise with relevant State Government departments and agencies to satisfy a variety of regulatory requirements.

There may be opportunities to secure funding from the Northern and Yorke Landscape Board and the Department of Environment and Water, particularly for water quality improvement works. The South Australian Environment Protection Authority also occasionally provide grants for Water Sensitive Urban Design projects, such as the Rain Garden 500 program in 2016.

Actions that are potentially eligible for Stormwater Management Authority funding (typically co-funding on a 50/50 basis with Local Government for projects with a contributing catchment area greater than 40 hectares) have been highlighted. Note that the authority has the discretion to contribute more or less than 50% of the cost of certain works and may elect to contribute to the cost of works where the contributing catchment area is less than 40 hectares, provided those works form part of an approved Stormwater Management Plan.

Projects not eligible for funding from the Stormwater Management Authority may still be eligible for other external funding opportunities, such as the National Flood Mitigation Infrastructure Program. This program, established by the National Emergency Management Agency, delivered $100 million across 2020-21 and 2021-22 to state and territory governments for the construction or improvement of flood mitigation infrastructure.

5.7.5 Monitoring Implementation Plan Progress

It is recommended that a structured approach is taken to programming in the proposed strategies and actions in this Stormwater Management Plan. Following the endorsement of the Plan, it is recommended Council review their capital works plan to schedule in the strategies recommended alongside previously identified projects.

It is recommended that Council consolidate and continually update their stormwater GIS layers as new infrastructure is constructed. This will not only ensure that the best available information is recorded for future use, but will also enable Council to effectively plan for the long-term management of their stormwater assets from maintenance to renewal. It is also recommended that where strategies will require ongoing maintenance, such as cleaning GPTs and replacing raingarden filter layer material, Council factor this into their budgeting and planning to ensure these assets continue to perform as designed into the future.

It is recommended that Council develop a strategy for reporting progress on the implementation of recommended strategies to key stakeholders including the local community. This will ensure the community remains informed about flood mitigation and water quality improvement works being undertaken by Council, and can be seen as an opportunity to educate the community on the benefits of these types of works. This could include articles on the Council website, updates in the Council newsletter or posts on Council's social media accounts.

Table 5.19 - Stormwater Management Response Implementation Plan

ID	Description	Further Investigation Required?	Land Acquisition Required?	Planning or Policy Changes Required?	Potential Approvals/ Licences Required	Priority	Nominated Time Frame	Responsible Authority	Potential Funding Sources
D1	Rocky River Flood Protection	Yes	Yes	No	Water Affecting Activity Permit	High	2-5 years	Northern Areas Council	Stormwater Management Authority
D2	Laura Parkland Stormwater Upgrade	Yes	No	No	Water Affecting Activity Permit	Moderate	5-10 years	Northern Areas Council	
D3	Hughes Street Drainage	Yes	No	No	Water Affecting Activity Permit	High	2-5 years	Northern Areas Council	Stormwater Management Authority
D4	Northern Catchment Diversion Works	Yes	Yes	No		Very Low	20-30 years	Northern Areas Council	
D5	William Street Open Channel	Yes	Yes	No	Water Affecting Activity Permit	Low	10-20 years	Northern Areas Council	
D6	West Terrace Flow Path Works	Yes	No	No		Very High	0-2 years	Northern Areas Council	
D7	Verge Works throughout Laura	Yes	No	No		Low	10-20 years	Northern Areas Council	
WQ1	Laura Parkland Bioretention Basin	Yes	No	No		Moderate	5-10 years	Northern Areas Council	
WQ2	South Terrace Bioretention Basin	Yes	Yes	No		Low	10-20 years	Northern Areas Council	
WQ3	Streetscape Raingardens	Yes	No	No		High	2-5 years	Northern Areas Council	
WQ4	Stormwater Harvesting and Reuse Scheme	Yes	No	No		Low	10-20 years	Northern Areas Council	
WQ5	Gross Pollutant Traps	Yes	No	No	Water Affecting Activity Permit	Low	10-20 years	Northern Areas Council	
WQ6	Rainwater Tanks and Allotment Level Reuse	N/A	N/A	Yes		Low	10-20 years	Northern Areas Council	
N1	Flood Warning Systems	N/A	N/A	Yes		High	2-5 years	Northern Areas Council	Stormwater Management Authority, Federal/State Government
N2	Levee Tenure and Structural Assessment Program	N/A	N/A	Yes		Very High	0-2 years	Northern Areas Council	Stormwater Management Authority
N3	Rezoning Flood-prone Land	N/A	N/A	Yes		Moderate	5-10 years	Northern Areas Council, State Emergency Service	
N4	SES Community FloodSafe Program	N/A	N/A	Yes		Very High	0-2 years	Northern Areas Council	Stormwater Management Authority
N5	Council's Emergency Management Plan	N/A	N/A	Yes		High	2-5 years	Northern Areas Council	
N6	New Building Floor Levels	N/A	N/A	Yes		Moderate	5-10 years	Northern Areas Council	
N7	Ongoing Maintenance and Monitoring of Council Assets	N/A	N/A	Yes		Low	10-20 years	Northern Areas Council	
N8	Education and Promotion of WSUD Measures	N/A	N/A	Yes		Low	10-20 years	Northern Areas Council	Stormwater Management Authority
N9	Development Controls – Beneficial Use of Stormwater	N/A	N/A	Yes		Low	10-20 years	Northern Areas Council	Stormwater Management Authority

5.8 Review of SMP Objectives and Targets

Table 5.20 below provides an assessment of the degree to which each of the identified Stormwater Management Plan objectives and targets have been met by the recommended management measures.

Table 5.20 Assessment of SMP Objectives and Targets

Objective /Target	Achieved?	Discussion
Provide an acceptable level of flood protection for the community and both public and private assets		
1a	Partially	The flood mitigation measures were found to reduce the number of dwellings facing above-floor inundation in a 1% AEP flood from 54 to 7 (an 87% reduction). This target was aspirational, and the flood mitigation measures were developed targeting the 5% AEP flood event.
1b	Yes	No above floor inundation of dwellings in a 5% AEP flood event was achieved through the recommended flood mitigation measures.
1c	Yes	The upgrades result in a maximum hazard class H1 (safe for vehicle access) along Herbert Street/Mill Street/Horrocks Highway in the 1% AEP flood event, providing safe evacuation routes out of town to the north and south.
1d	Yes	Council have throughout the project communicated with the community to describe the flood risk racing the town. The recommended FloodSafe program run by SES will enable the community to be prepared for a flood.
1e	Yes	The recommendations of this SMP include for Council to develop a Community Emergency Management Plan.
Manage the quality of runoff and its effects on receiving waters		
2a	Yes	The proposed water quality improvement strategy meets the aspirational pollutant reduction targets.
2b	Yes	The plan recommends for the education and promotion of WSUD measures throughout the wider community.
Make beneficial use of stormwater		
3a	Yes	Opportunities to harvest and reuse stormwater have been investigated in two locations, and recommended in one.
3b	Yes	It has been recommended for Council to promote the use of WSUD measures to reduce the stormwater runoff leaving development sites.
Planning for new developments provides for open space, recreation and amenity		
4a	Yes	This SMP recommends strategies to enforce development control for new development floor levels.
4b	Yes	A campaign to educate the community about the benefits of WSUD infrastructure is recommended as part of this SMP.
4c	Yes	Development controls to improve opportunities to beneficially reuse stormwater have been recommended through this SMP.

Objective /Target	Achieved?	Discussion
Improve the condition of receiving waters		
5a	Yes	All proposed stormwater drains with outlets to the river have gross pollutant traps and scour protection recommended.
Sustainable asset management of stormwater infrastructure		
6a	Yes	A recommendation of this SMP is for Council to develop a Stormwater Asset Management Plan, and develop a GIS database for their stormwater infrastructure.
6b	Yes	All proposed structural management measures have been designed against future development and climate change.
Effective communication and consultation with catchment stakeholders, businesses and community members		
7a	Yes	Through the development of this SMP the community were consulted on the stormwater risks facing the town.
7b	Yes	The SMP recommends the development of a flood warning system, and the SES FloodSafe program recommended will help prepare the community for a potential flood event.
7c	Yes	The stormwater management responses summary table and implementation plan suggest external agencies such as the Stormwater Management Authority that Council may be able to partner with in the development of management measures.

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Appendix A

Flood Risk Consequence Matrix



Flood Risk Consequence Matrix

Consequence						
Level	**General**	**Flooding**	**Health & Safety**	**Cost**	**Environmental**	**Social/Stakeholder**
1 Insignificant	Undetectable or below guidelines, no disruption to normal operation, no increase in normal operation costs	Nuisance road ponding in the 18% AEP flood, negligible property inundation in the 1% AEP flood	Insignificant impact to health & safety	Insignificant loss of assets and resources and insignificant impact on budget	Insignificant impact to the environment & negligible effect on customers	Insignificant damage to Council and stakeholder perception/confidence
2 Minor	Some manageable operation disruption, some increase in operating costs	Shallow road ponding in the 18% AEP flood, properties inundated up to 250mm deep in the 1% AEP flood	Minor impact to health & safety resulting in no injuries	Loss of assets and resources, <5% deviation from program budget	Breach of a control system causing minor environmental impact, minor effect on customers	Minor negative perception and short-term damage to an insignificant audience
3 Moderate	Significant modification to normal operation but manageable, operation costs increased, increased monitoring	Properties inundated over 250mm deep, trafficability of roads limited in the 1% AEP flood	Moderate impact to health & safety resulting in minor injuries requiring medical assistance	Moderate loss of assets and resources, 5% deviation from program budget resulting in limiting project scope	Intermittent non-compliance with regulations causing moderate impacts to the environment, moderate effect on customers	Moderate negative perception and short-term damage to a specific audience in Council or stakeholder agencies
4 Major	Systems significantly compromised and abnormal operation if at all, high level of monitoring required	Many properties inundated over 500mm deep, roads inundated over 1m deep in the 1% AEP flood	Major impacts to health & safety resulting in serious injury and hospitalisation	Major loss of assets and resources, 15% deviation from program budget, resulting in possible closure of the project	Failure to comply with regulations & causing major environmental hard resulting in temporary shutdown of the project, adverse effect on customers	Negative Council and stakeholder perception and short-term damage to Council and stakeholder confidence
5 Catastrophic	Major impact, complete failure of systems, risk to public health & environment	Widespread property inundation over 1m deep, emergency services infrastructure impacted, road access completely cut off in 1% AEP flood	Significant impact to health & safety resulting in death	Significant loss of assets and resources, 30% deviation from program budget, resulting in closure of the project	Sustained non-compliance to regulation & causing significant impact to the environment causing project closure	Significant impact to Council and stakeholder perception and long-term damage to Council and stakeholder confidence

Appendix B

Community Consultation Responses



Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

This feedback form should be read in conjunction with the summary brochure and State of the Catchment reports which explain the work undertaken to date on the Stormwater Management Plans.

1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☑ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding		✓			
Water quality			✓		
Stormwater capture and reuse			✓		
Climate change				✓	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

- CENTRE OF TOWN HAS VERY POOR ABILITY TO CLEAR STORM WATER.
- SIGNIFICANT EVENTS ARE NOT ABLE TO BE CONTROLLED. ESPECIALLY NORTH OF TOWN (DIVERSION)
- CATCH AND RELEASE IN TOWN DAM APPEARS INADEQUATE. TOWN DAM DOES NOT HOLD WATER AND NEED CLEANING OF SILT SO THAT IT COULD BE USED ON THE OVAL.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

OUR PROPERTY (20 ACRES) SW OF TOWN DOES NOT ADD MUCH TO THE STORM WATER IN TOWN. HOWEVER THE NATURAL WATER COARSE CROSSES BLOGAN RD. THIS IS REPAIRED ANNUALLY. I WOULD SUGGEST A CULVERT UNDER THE ROAD AT THE CROSSING POINT.

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name .....

Suburb GEORGETOWN .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ... .

Email: ... .

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

Submissions should be completed by 30 October, 2023. Please return this feedback form to one of the following:

- Northern Areas Council, PO Box 120, 94 Ayr Street Jamestown, SA 5491
- Gladstone District Office, 14 Fifth Street Gladstone, SA 5473
- Spalding District Office, 11 Main Street Spalding, SA 5454
- Via email to admin@nacouncil.sa.gov.au

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☑ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	1				
Nuisance flooding	1				
Water quality					
Stormwater capture and reuse	1				
Climate change					

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

- Ensuring that the stormwater harvesting in gladstone currently in place is not impacted by any changes made, eg. The harvesting point at the railway line.
- Problems occur in regards to the blockages in the Rocky River through Boyodee, which divert the water out of the creek in various locations, changing the true flow of water.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

- I believe these blockages need to be considered and attended to in regards to the plan.

- The floodway along high street does not need to be made larger as it currently acts as a good watering source for the trees and grass along this area in its current ways.

5 To help us understand who participated in the consultation please provide the following details:

Name: ...

Street name: .

Suburb ... Gladstone SA 5473

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

This feedback form should be read in conjunction with the summary brochure and State of the Catchment reports which explain the work undertaken to date on the Stormwater Management Plans.

1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☑ Interest or experience of flooding
- ☑ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding			✓		
Water quality			✓		
Stormwater capture and reuse			✓		
Climate change ?					

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Pisant Creek clearing a
Port Broughton will be Good

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

.....

.....

.....

.....

.....

5 To help us understand who participated in the consultation please provide the following details:

Name: ....

Street name: ....

Suburb .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ....

Email: ....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

Submissions should be completed by 30th October, 2023. Please return this feedback form to one of the following:

- Northern Areas Council, PO Box 120, 94 Ayr Street Jamestown, SA 5491
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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

This feedback form should be read in conjunction with the summary brochure and State of the Catchment reports which explain the work undertaken to date on the Stormwater Management Plans.

1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☑ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☑ Other (please specify) Work being done to help improve the look of our town.

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality	✓				
Stormwater capture and reuse	✓				–
Climate change	✓				–

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

The corner of Cross St + High St dam catchment area has become a continual eyesaw in the centre of our town + visitors to our town plus locals have to drive past it. The project wasn't ever completed as the water has no clear channel to follow down High St + doesn't get harvested for re-use. It is also a safety hazard with no protective guard rails – only flimsy posts which are continually knocked over.

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

Before the project began we were assured that the catchment area would be landscaped but we only have weeds left to grow to a metre or more & only sprayed when we complain. Then they are left to rot down naturally & it's not a very welcoming sight in any town.

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb ..... Gladstone 5473. .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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- ☑ Local resident
- ☐ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality				✓	
Stormwater capture and reuse				✓	
Climate change				✓	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

1) Supporting the call for urgent attention to the flood water problem adjacent my sister's property at 24 West Tce Laura
2) PTO

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

2) The spoondrain adjacent my property needs replacing. It has lifted at joins & is consistantly silted up, which when we have heavy rainfall spreads stormwater into my property

5 To help us understand who participated in the consultation please provide the following details:

Name: ...

Street name: .

Suburb ..... Laura 5480

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ....

Email: .....

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

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- ☑ Local resident
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- ☐ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☑ Other (please specify) toilet sewage/sewers in small towns without systems + drainage/recycling water - better facilities for recycle of garden water.

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest. (Probably more a Gov issue)

	1	2	3	4	5
Major flooding				4	
Nuisance flooding					5
Water quality			3		
Stormwater capture and reuse		2			
Climate change	1				

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

1) Big rains, storms + flooding - All this lovely water is wasted - it just flows out to the rivers + ends up at the sea. Last November there was enough rain to fill all our tanks but it all went out + down the Broughton River. - 2) The rivers need to be cleared of reeds which are blocking up the flow of water.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

I think the Government should give more grants to Regional towns to support more people to be able to afford 1) Solar 2) Sewage recycle systems 3) Rain Water tanks — This would also help with climate change.

5 To help us understand who participated in the consultation please provide the following details:

Name: ..

Street name: ..

Suburb ..... Spalding 5454

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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- ☐ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	1				
Nuisance flooding			1		
Water quality	1				
Stormwater capture and reuse	1				
Climate change				1	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

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5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .... Spalding phone rings twenty

Suburb times (because of scammers) leave a message and we'll get back to you

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- ☑ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality	✓				
Stormwater capture and reuse	✓				
Climate change					✓

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

would like to see proper storm water drainage in the main Street to stop the water flowing through the main st (spalding)

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

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5 To help us understand who participated in the consultation please provide the following details:

Name: .. ..

Street name: ....

Suburb ..... Spalding .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .. ..

Email: ... .

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- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☑ Other (please specify) BECAUSE I WAS TOLD FRESHWATER CREEK COULD FLOOD MY INSURANCE WENT FROM $130 TO $821 PER MONTH

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding					✓
Nuisance flooding					✓
Water quality			✓		
Stormwater capture and reuse					✓
Climate change	✓				

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

FROM THE BOTTOM OF FRESHWATER CREEK IT WOULD HAVE TO RAISE 30 MTRS TO FLOOD OUR HOUSE ACCORDING TO OLD LOCALS IT HASN'T FLOODED IN 100 YEARS PLEASE EXPLAIN?

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

REFER TO N° 3.

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb SPALDING 5454

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

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- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding			✓		
Nuisance flooding		✓			
Water quality			✓		
Stormwater capture and reuse			✓		
Climate change		✓			

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

I'M NOT SURE IF ITS POSSIBLE TO RE-LOOK AT FLOOD MANAGEMENT PLAN, FOR THE MAIN CBD AREA OF THE TOWN OF SPALDING - IT STILL FLOODS BAD EVEN AFTER 1 (1 HOUR) EVENT, AS HAPPENED LAST NOV. 2022 - MAYBE A SECOND DIVERSION CHANNEL (NOT SO BIG AS THE FIRST)

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

MAIN ST (AND TOWN) FLOODING IN TOWN OF SPALDING, EVEN AFTER A 1 HOUR EVENT. (I KNOW ITS HEAVY RAIN IN THAT HOUR, BUT STILL!

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb SPALDING SA 5454

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

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Email: .....

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

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- ☐ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality	✓				
Stormwater capture and reuse	✓				
Climate change				✓	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

We need stormwater pipes (drains).

5 To help us understand who participated in the consultation please provide the following details:

Name: ..

Street name: .....

Suburb ..... Spalding

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ...

Email: ....

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- ☑ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	1				
Nuisance flooding		2			
Water quality					5
Stormwater capture and reuse			3		
Climate change				4	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Main street from shop to Burra turn.
Maintenance program.
Wider channel to run water away quicker at
South End of town.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

Outside of our yard getting flooded I have some ideas but no-one wants to know, whether they are simple or more complex ones.
After last flooding footpath not fixed, still gravel etc in gutters (street sweeping did not remove)
Culvert Bridge never maintained - full of weeds + debris

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb .....Spalding.....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply. *

- [x] Local resident
- [ ] Interest or experience of flooding
- [ ] Interest in local environment
- [ ] Interest in improving water quality
- [ ] Interest in water conservation and/or stormwater harvesting and reuse
- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

○ 1 ○ 2 ◉ 3 ○ 4 ○ 5

Nuisance flooding

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

Water quality

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

Stormwater capture and reuse

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

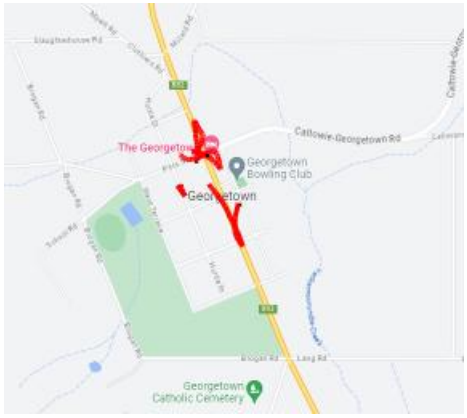
Climate change

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

Please select the town you are a resident of:

- ○ Laura
- ○ Gladstone
- ◉ Georgetown
- ○ Spalding
- ○ Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Poorly designed guttering lower than drains that can not drain. Inadequate drainage for moderate rainfall at Pitts/Fisher st corner leading to the corner flooding.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Greater consideration to what happens with heavy rainfall, and multiple opportunity for water to escape when drains block

Do you have any other comments to make?

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

georgetown

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- [x] Local resident
- [ ] Interest or experience of flooding
- [ ] Interest in local environment
- [ ] Interest in improving water quality
- [ ] Interest in water conservation and/or stormwater harvesting and reuse
- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Nuisance flooding

( ) 1 (●) 2 ( ) 3 ( ) 4 ( ) 5

Water quality

( ) 1 ( ) 2 (●) 3 ( ) 4 ( ) 5

Stormwater capture and reuse

( ) 1 ( ) 2 ( ) 3 (●) 4 ( ) 5

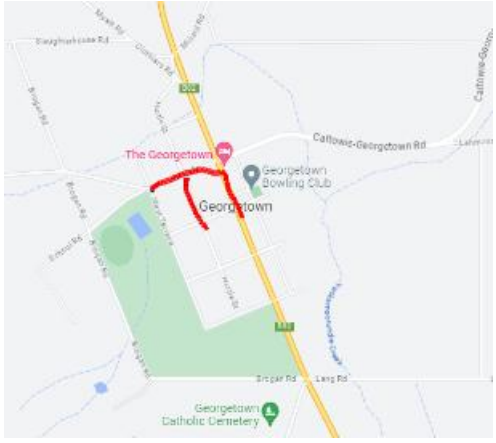
Climate change

( ) 1 ( ) 2 ( ) 3 ( ) 4 (●) 5

Please select the town you are a resident of:

- ( ) Laura
- ( ) Gladstone
- (●) Georgetown
- ( ) Spalding
- ( ) Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Flooding and large volumes of water from the carport behind the community hall, flood Fisher Street and drag dirt from the carpark

blocking drains.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

The gutters on hurtle Street both sides and fisher street western side need replacing. The damaged gutters contribute to standing water and flooding.

Do you have any other comments to make?

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

Georgetown

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- [x] Local resident
- [ ] Interest or experience of flooding
- [ ] Interest in local environment
- [ ] Interest in improving water quality
- [ ] Interest in water conservation and/or stormwater harvesting and reuse
- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Nuisance flooding

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Water quality

( ) 1 (●) 2 ( ) 3 ( ) 4 ( ) 5

Stormwater capture and reuse

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

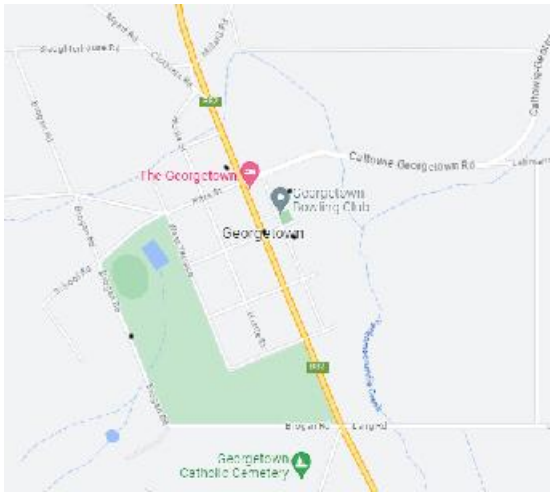
Climate change

( ) 1 ( ) 2 (●) 3 ( ) 4 ( ) 5

Please select the town you are a resident of:

- ( ) Laura
- ( ) Gladstone
- (●) Georgetown
- ( ) Spalding
- ( ) Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Bowls Club entrance is flooded during heavy down pours.
Brogan Road has water flowing over it following a heavy downpour and is following a natural water course.
Parts of Fisher Street has water almost to the gutters and takes a long time to recede.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Do you have any other comments to make?

No

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

Georgetown

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- [x] Local resident
- [ ] Interest or experience of flooding
- [ ] Interest in local environment
- [ ] Interest in improving water quality
- [ ] Interest in water conservation and/or stormwater harvesting and reuse
- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

- (●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Nuisance flooding

- ( ) 1 (●) 2 ( ) 3 ( ) 4 ( ) 5

Water quality

- ( ) 1 ( ) 2 ( ) 3 (●) 4 ( ) 5

Stormwater capture and reuse

- ( ) 1 ( ) 2 (●) 3 ( ) 4 ( ) 5

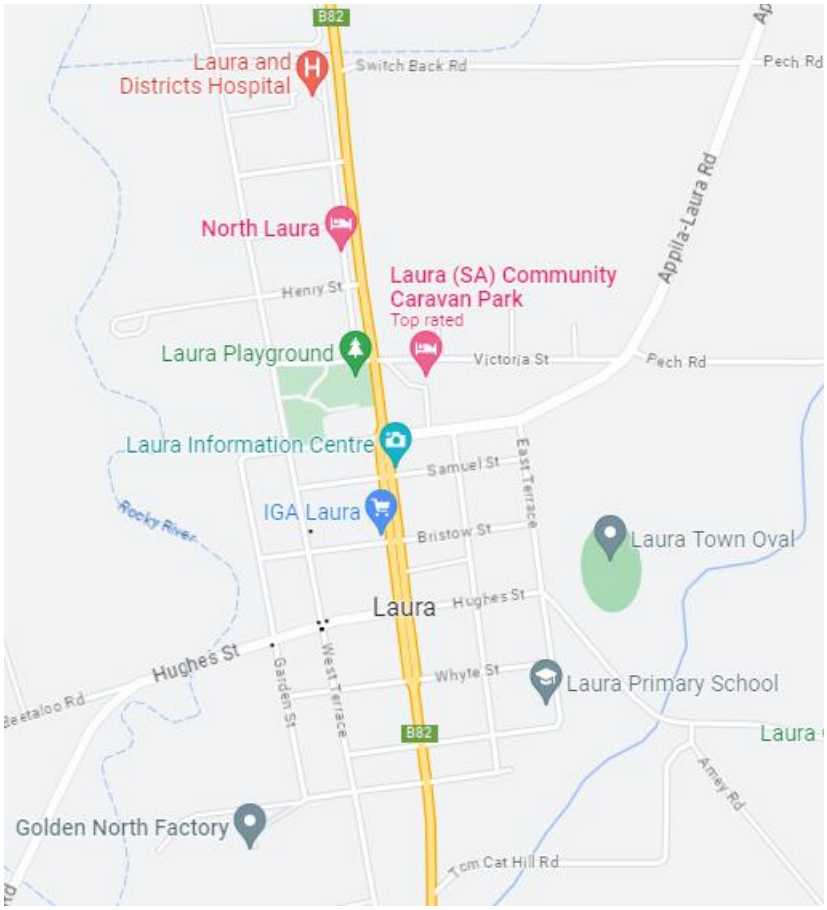
Climate change

- ( ) 1 ( ) 2 ( ) 3 ( ) 4 (●) 5

Please select the town you are a resident of:

- (●) Laura
- ( ) Gladstone
- ( ) Georgetown
- ( ) Spalding
- ( ) Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Water fails to flow on West Terrace due to their being no proper drains. Any drop of leaves/branches/seeds will clog the "gutter"and cause the water to back up. Their needs to be a proper delving of the drains each year to ensure that there is aproper channel which allows the water to run.

The intersection of Hughes Street and West Terrace has large puddles on t least three corners when it rains. Whic is compounded by both heavy and light traffic cutting the corners and creating large potholes, which then fill with water. There needs to be either traffic management systems put in place to prevent corner cutting or the road surface needs ot be extended and strengthened to prevent heavy traffic from tearing up the unprotected surface. Water flows from both West Terrace and Highes Street into this intersection so it may be necessary to have drainage along Hughes Street into the Rocky River.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

As above

Do you have any other comments to make?

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

Laura

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Appendix C

Scenario A Flood Mapping



Appendix D

Scenario A Flood Hazard Mapping



Appendix E

Scenario B Flood Mapping



Appendix F

Scenario B Flood Hazard Mapping



Appendix G

Scenario C Flood Mapping



Appendix H

Scenario C Flood Hazard Mapping



Appendix I

Wallbridge & Gilbert Stormwater Harvesting Concept Plan



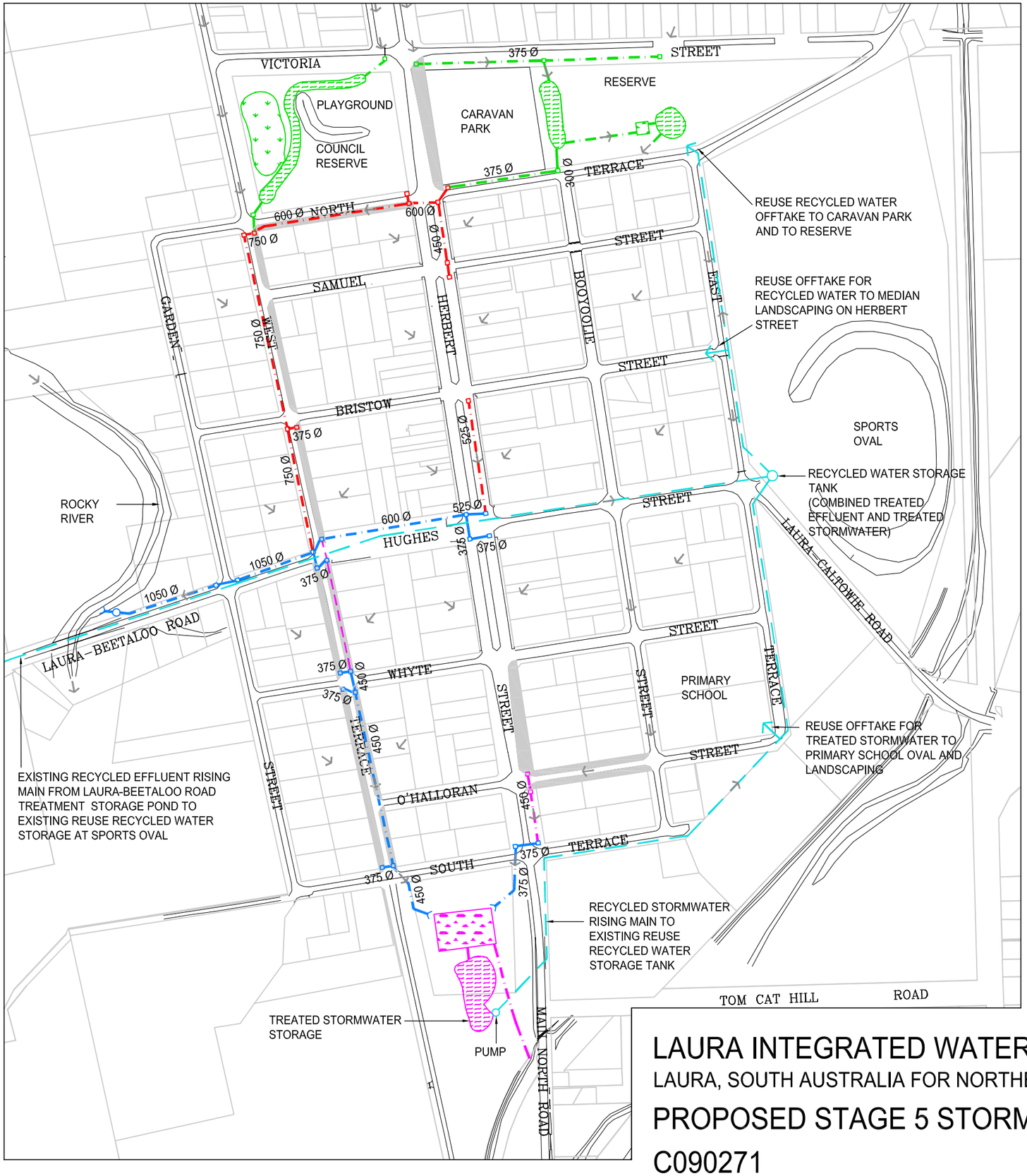
LEGEND

PROPOSED STORMWATER SYSTEM

- PROPOSED PIPE AND PIT
- BIOSWALE
- 1 IN 100 YEAR INUNDATION ZONE
- WATER STORAGE
- SPRAY SEAL AT EDGE OF ROAD
- STAGE 1 SYSTEM - BLUE
- STAGE 2 SYSTEM - RED
- STAGE 3 SYSTEM - GREEN
- STAGE 4 SYSTEM - MAGENTA
- STORMWATER SURFACE FLOW

PROPOSED REUSE SYSTEM

- STAGE 5 SYSTEM - CYAN RECYCLED WATER DISTRIBUTION MAIN (INTEGRATION WITH C.W.M.S. TREATED EFFLUENT AND TREATED STORMWATER DISTRIBUTION NETWORK)



50 25 0 50 100 150 200 250 metres

SCALE 1:5000

STAGE 6 : INTEGRATION WITH C.W.M.S. REUSE SCHEME AND DISTRIBUTION NETWORK

Treated stormwater will be distributed to a number of demand sites around the town by a distribution main running along the eastern boundary of the town.
This network will be integrated with the C.W.M.S. treated effluent at a combined storage tank located next to the sports oval.

Estimated capital cost $150,000

DRAFT
FOR DISCUSSION
NOT FOR CONSTRUCTION

WALLBRIDGE & GILBERT
Consulting Engineers
60 Wyatt Street Adelaide South Australia 5000
Telephone (08) 8223 7433 Facsimile (08) 8232 0967
Email adelaide@wgeng.com

LAURA INTEGRATED WATER REUSE STRATEGY

LAURA, SOUTH AUSTRALIA FOR NORTHERN AREAS COUNCIL

PROPOSED STAGE 5 STORMWATER CONCEPT PLAN

C090271 FIGURE 6

Appendix J

Cost Estimates



Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Flood Protection Levee Upgrade (D1-A)
Estimator	QB
Reviewer	DJ
Date	19-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Excavate to remove top soil average 150mm deep	m^3	1612	$	5.00	$	8,060.00
	Imported sand filling, deposited, spread and levelled and compacted to 90%	m^3	4600	$	85.00	$	391,000.00
	Import clay for levee bank core, spread and levelled and compacted to 90%	m^3	3100	$	100.00	$	310,000.00
	Shape levee bank	m^2	10745	$	5.00	$	53,725.00
	150mm thick top soil spread, raked and levelled	m^2	10745	$	10.00	$	107,450.00
	Grass re-seeding and establishment of new vegetation	m^2	10745	$	5.00	$	53,725.00
	Subtotal					**$**	**923,960.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	138,594.00
	Design	item	1		20%	$	184,792.00
	Services modifications	item	1		0%	$	-
	Contingencies on construction	item	1		20%	$	249,469.20
	Grand Total					**$**	**1,496,815.20**

Notes

All figures are exclusive of GST (10%)

Cost estimates prepared by Southfront are based upon historical cost information and experience, and do not allow for latent or market conditions (ie. competition, escalation). Southfront recommend that a professional quantity surveyor be engaged if assurance of cost and project budget estimates allowing for these factors is required.

Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Open Channel Outlet Pipe Flap Gate (D1-B)
Estimator	QB
Reviewer	DJ
Date	18-Dec-24

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Supply and install flap valve to support 900 mm diameter pipe	item	1	$ 25,000.00	$ 25,000.00
					$ -
	Subtotal				**$ 25,000.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 3,750.00
	Design	item	1	10%	$ 2,500.00
	Services modifications	item	1	0%	$ -
	Contingencies on construction	item	1	20%	$ 6,250.00
	Grand Total				**$ 37,500.00**

Notes

All figures are exclusive of GST (10%)

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Detention Basin Volume Increase (D2-A)
Estimator	QB
Reviewer	DJ
Date	9-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Basin excavation and shaping	m^3	6600	$	95.00	$	627,000.00
	Grass re-seeding and establishment of new vegetation	m^2	9600	$	5.00	$	48,000.00
	Subtotal					**$**	**675,000.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	101,250.00
	Design	item	1		10%	$	67,500.00
	Services modifications	item	1		5%	$	33,750.00
	Contingencies on construction	item	1		20%	$	175,500.00
	Grand Total					**$**	**1,053,000.00**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Detention Basin Outlet Upgrade (D2-B)
Estimator	QB
Reviewer	DJ
Date	9-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and resinstate 1200mm x 600mm box culvert	m	42	$	1,350.00	$	56,700.00
	Supply and install large headwall (>750mm diam)	item	2	$	4,510.00	$	9,020.00
	Rock scour protection	m^2	10	$	195.00	$	1,950.00
						$	-
	Subtotal					**$**	**67,670.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	10,150.50
	Design	item	1		10%	$	6,767.00
	Services modifications	item	1		5%	$	3,383.50
	Contingencies on construction	item	1		20%	$	17,594.20
	Grand Total					**$**	**105,565.20**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Hughes Street Drainage (D3)
Estimator	QB
Reviewer	DJ
Date	18-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and reinstate 750 mm diameter RCP	m	268	$	940.00	$	251,920.00
	Supply, lay, backfill and reinstate 600 mm diameter RCP	m	12	$	790.00	$	9,480.00
	Supply, lay, backfill and reinstate 450 mm diameter RCP	m	26	$	590.00	$	15,340.00
	Supply, lay, backfill and reinstate 375 mm diameter RCP	m	57	$	490.00	$	27,930.00
	Supply and install 1200 x 1200mm junction box	item	4	$	6,440.00	$	25,760.00
	Supply and install 900 x 900mm junction box	item	4	$	3,865.00	$	15,460.00
	Supply and install double side entry pit	item	10	$	4,500.00	$	45,000.00
	Remove and dispose of existing large headwall	item	1	$	10,000.00	$	10,000.00
	Rock scour protection	m^2	8	$	195.00	$	1,560.00
	Geofab liner	m^2	8	$	75.00	$	600.00
	Supply and install flap valve to support 750 mm diameter pipe	item	1	$	19,000.00	$	19,000.00
	Subtotal					**$**	**422,050.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	63,307.50
	Design	item	1		10%	$	42,205.00
	Services modifications	item	1		5%	$	21,102.50
	Contingencies on construction	item	1		20%	$	109,733.00
	Grand Total					**$**	**658,398.00**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Mill Street Drainage Upgrade (D4-A)
Estimator	QB
Reviewer	DJ
Date	19-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and resinstate 1200mm x 600mm box culvert	m	149	$	1,350.00	$	201,150.00
	Supply, lay, backfill and reinstate 900 mm diameter RCP	m	172	$	1,270.00	$	218,440.00
	Supply, lay, backfill and reinstate 750 mm diameter RCP	m	132	$	940.00	$	124,080.00
	Supply, lay, backfill and reinstate 600 mm diameter RCP	m	77	$	790.00	$	60,830.00
	Supply, lay, backfill and reinstate 450 mm diameter RCP	m	275	$	590.00	$	162,250.00
	Supply, lay, backfill and reinstate 375 mm diameter RCP	m	27	$	490.00	$	13,230.00
	Supply and install 1500 x 1500mm junction box	item	4	$	9,660.00	$	38,640.00
	Supply and install 1200 x 1200mm junction box	item	4	$	6,440.00	$	25,760.00
	Supply and install 900 x 900mm junction box	item	3	$	3,865.00	$	11,595.00
	Supply and install double side entry pit	item	10	$	4,500.00	$	45,000.00
	Supply and install small headwall (<750mm diam)	item	1	$	3,865.00	$	3,865.00
	Supply and install large headwall (>750mm diam)	item	1	$	4,510.00	$	4,510.00
	Connect new pipe to existing system	item	4	$	1,290.00	$	5,160.00
	Rock scour protection	m^2	10	$	195.00	$	1,950.00
	Geofab liner	m^2	10	$	75.00	$	750.00
	Subtotal					**$**	**917,210.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	137,581.50
	Design	item	1		10%	$	91,721.00
	Services modifications	item	1		5%	$	45,860.50
	Contingencies on construction	item	1		20%	$	238,474.60
	Grand Total					**$**	**1,430,847.60**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Northern Catchment Earthworks and Culvert (D4-B)
Estimator	QB
Reviewer	DJ
Date	19-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and resinstate 1200mm x 600mm box culvert	m	122	$	1,350.00	$	164,700.00
	Supply and install large headwall (>750mm diam)	item	2	$	4,510.00	$	9,020.00
	Excavate to remove top soil average 150mm deep	m^3	580	$	5.00	$	2,900.00
	Imported sand filling, deposited, spread and levelled and compacted to 90%	m^3	1650	$	85.00	$	140,250.00
	Import clay for levee bank core, spread and levelled and compacted to 90%	m^3	1100	$	100.00	$	110,000.00
	Shape levee bank	m^2	3850	$	5.00	$	19,250.00
	150mm thick top soil spread, raked and levelled	m^2	3850	$	10.00	$	38,500.00
	Grass re-seeding and establishment of new vegetation	m^2	3850	$	5.00	$	19,250.00
	Earthworks within nothern catchment	m^3	1500	$	25.00	$	37,500.00
	Subtotal					**$**	**541,370.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	81,205.50
	Design	item	1		10%	$	54,137.00
	Services modifications	item	1		5%	$	27,068.50
	Contingencies on construction	item	1		20%	$	140,756.20
	Grand Total					**$**	**844,537.20**

Notes

All figures are exclusive of GST (10%)

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	William Street Open Channel (D5)
Estimator	QB
Reviewer	DJ
Date	19-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and reinstate 600 mm diameter RCP	m	90	$	790.00	$	71,100.00
	Supply, lay, backfill and reinstate 450 mm diameter RCP	m	13	$	590.00	$	7,670.00
	Supply, lay, backfill and reinstate 375 mm diameter RCP	m	39	$	490.00	$	19,110.00
	Supply and install double side entry pit	item	6	$	4,500.00	$	27,000.00
	Supply and install 900 x 900mm junction box	item	2	$	3,865.00	$	7,730.00
	Remove and dispose of existing small headwall	item	3	$	5,000.00	$	15,000.00
	Open channel excavation and shaping	m^3	680	$	95.00	$	64,600.00
	Shape levee bank	m^3	420	$	5.00	$	2,100.00
	Supply and install flap valve to support 600 mm diameter pipe	item	1	$	15,000.00	$	15,000.00
	Subtotal					**$**	**229,310.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	34,396.50
	Design	item	1		10%	$	22,931.00
	Services modifications	item	1		5%	$	11,465.50
	Contingencies on construction	item	1		20%	$	59,620.60
	Grand Total					**$**	**357,723.60**

Notes

All figures are exclusive of GST (10%)

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	West Terrace Flow Path Works (D6)
Estimator	QB
Reviewer	DJ
Date	10-Dec-24

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and resinstate 450mm x 300mm box culvert	m	31	$	610.00	$	18,910.00
	Supply and install double side entry pit	item	1	$	4,500.00	$	4,500.00
	Remove and dispose of existing small pit	item	1	$	260.00	$	260.00
	Supply and install small headwall (<750mm diam)	item	1	$	3,865.00	$	3,865.00
	Remove and dispose of existing small headwall	item	1	$	5,000.00	$	5,000.00
	Raised footpath/verge construction and shaping	m^2	560	$	350.00	$	196,000.00
	Rock scour protection	m^2	6	$	195.00	$	1,170.00
	Geofab liner	m^2	6	$	75.00	$	450.00
	Subtotal					**$**	**230,155.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	34,523.25
	Design	item	1		10%	$	23,015.50
	Services modifications	item	1		5%	$	11,507.75
	Contingencies on construction	item	1		20%	$	59,840.30
	Grand Total					**$**	**359,041.80**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Verge Works in Various Streets (D7)
Estimator	QB
Reviewer	DJ
Date	18-Dec-24

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Raised footpath/verge construction and shaping	m²	670	$ 350.00	$ 234,500.00
	Subtotal				**$ 234,500.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 35,175.00
	Design	item	1	10%	$ 23,450.00
	Services modifications	item	1	0%	$ -
	Contingencies on construction	item	1	20%	$ 58,625.00
	Grand Total				**$ 351,750.00**

Notes

All figures are exclusive of GST (10%)

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Laura Parkland Bioretention Basin (WQ1)
Estimator	QB
Reviewer	DJ
Date	7-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	HDPE liner	m^2	500	$ 95.00	$ 47,500.00
	Perforated PVC pipe	m	130	$ 90.00	$ 11,700.00
	Filter media	m^3	250	$ 115.00	$ 28,750.00
	Screenings and transition layer	m^3	50	$ 90.00	$ 4,500.00
	Submerged zone	m^3	250	$ 115.00	$ 28,750.00
	Plantings and temporary irrigation	m^2	500	$ 25.00	$ 12,500.00
	Subtotal				**$ 133,700.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 20,055.00
	Design	item	1	10%	$ 13,370.00
	Services modifications	item	1	5%	$ 6,685.00
	Contingencies on construction	item	1	20%	$ 34,762.00
	Grand Total				**$ 208,572.00**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	Raingardens (WQ3)
Estimator	QB
Reviewer	DJ
Date	7-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Excavation (cut to disposal of Waste Fill)	m^3	20	$ 120.00	$ 2,400.00
	HDPE liner	m^2	30	$ 95.00	$ 2,850.00
	Perforated PVC pipe	m	20	$ 90.00	$ 1,800.00
	600mm square field inlet	item	1	$ 3,750.00	$ 3,750.00
	Filter media	m^3	7.5	$ 115.00	$ 862.50
	Screenings and transition layer	m^3	1.5	$ 90.00	$ 135.00
	Submerged zone	m^3	7.5	$ 115.00	$ 862.50
	Rock scour protection	m^2	3	$ 195.00	$ 585.00
	150mm high barrier kerb (or similar concrete edging)	m	20	$ 120.00	$ 2,400.00
	Plantings and temporary irrigation	m^2	15	$ 25.00	$ 375.00
	Subtotal				**$ 16,020.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 2,403.00
	Design	item	1	10%	$ 1,602.00
	Services modifications	item	1	5%	$ 801.00
	Contingencies on construction	item	1	20%	$ 4,165.20
	Total				**$ 24,991.20**
	Number of Raingardens				**12**
	Grand Total				**$ 299,894.40**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	D3 Gross Pollutant Trap (WQ5)
Estimator	QB
Reviewer	DJ
Date	7-Jan-25

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply and install Ecosol GPT 4600 (max pipe diameter 900mm)	item	1	$	115,500.00	$	115,500.00
	Subtotal					**$**	**115,500.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	17,325.00
	Design	item	1		10%	$	11,550.00
	Services modifications	item	1		5%	$	5,775.00
	Contingencies on construction	item	1		20%	$	30,030.00
	Grand Total					**$**	**180,180.00**

Notes

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Indicative Construction Cost Estimate

Project	Laura SMP
Job Number	22035
Title	D5 Gross Pollutant Trap (WQ5)
Estimator	QB
Reviewer	DJ
Date	7-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Supply and install Ecosol GPT 4450 (max pipe diameter 600mm)	item	1	$ 59,400.00	$ 59,400.00
	Subtotal				**$ 59,400.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 8,910.00
	Design	item	1	10%	$ 5,940.00
	Services modifications	item	1	5%	$ 2,970.00
	Contingencies on construction	item	1	20%	$ 15,444.00
	Grand Total				**$ 92,664.00**

Notes

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Appendix K

MCA Scores



Flood Mitigation Strategies MCA

Project ID	Project Description	Criteria					Score
		Capital Cost	Reduced Street Drainage Nuisance	Reduced Major Flooding Risk	Precursor to WSUD Strategy	Community Buy-In	
		20%	20%	30%	10%	20%	
D1	Rocky River Flood Protection	2	1	5	1	4	3.0
D2	Laura Parkland Stormwater Upgrade	2	3	1	5	5	2.8
D3	Hughes Street Drainage	3	5	1	5	5	3.4
D4	Northern Catchment Diversion Works	1	3	2	5	3	2.5
D5	William Street Open Channel	4	3	1	3	3	2.6
D6	West Terrace Flow Path Works	4	5	1	1	3	2.8
D7	Verge Works throughout Laura	4	5	1	1	2	2.6

Water Sensitive Urban Design Strategies MCA

Project ID	Project Description	Criteria					Score
		Capital Cost	Annual Maintenance Cost	Pollutant (TSS) Reduction	Stormwater Capture and Reuse	Community Buy-In	
		20%	20%	20%	20%	20%	
WQ1	Laura Parkland Bioretention Basin	4	5	5	3	3	4.0
WQ2	South Terrace Bioretention Basin	2	2	5	3	4	3.2
WQ3	Streetscape Raingardens	3	4	3	3	5	3.6
WQ4	Stormwater Harvesting and Reuse Scheme	4	4	1	5	4	3.6
WQ5	Gross Pollutant Traps	3	5	2	1	5	3.2