
**NARROMINE SHIRE COUNCIL
ORDINARY MEETING BUSINESS PAPER – 10 APRIL 2019
REPORTS TO COUNCIL – INFRASTRUCTURE AND ENGINEERING SERVICES**

1. WORKS REPORT

Author	Director Infrastructure and Engineering Services
Responsible Officer	Director Infrastructure and Engineering Services
Link to Strategic Plans	CSP – 4.3.4 Ensure Council's property assets are monitored and well managed

Executive Summary

This report provides information regarding works undertaken for the given period in regards to both operational and capital works.

Report

The Works Report (**Attachment No. 1**) for the period 9 March 2019 to 5 April 2019 is presented to Council for their information.

Financial Implications

Council has provision for these services in its 18/19 Operational Budget.

Legal and Regulatory Compliance

Local Government Act 1993
Roads Act 1993

Risk Management Issues

Nil

Internal/External Consultation

Nil

Attachments

- Works Report

RECOMMENDATION

1. That the information be noted.

2. DRAFT TRANGIE DRAINAGE STRATEGY

Author	Manager Engineering Services
Responsible Officer	Director Infrastructure and Engineering Services
Link to Strategic Plans	CSP - 3.1.3 Review Council Facilities and activities to minimise environmental impact. CSP - 3.2.2 Ensure Regulatory compliance with environmental legislation. CSP - 4.3.4 Ensure Councils property assets are monitored and well managed.

Executive Summary

This report presents a Draft Drainage Strategy for the Trangie Township that identifies and assists with planning for capital, maintenance and operations of the Trangie Drainage System. Since this report provides a high level overview, more detailed investigations could be required to determine the best cost effective solution for each option identified.

Background

Narromine Shire Council currently have a Narromine Shire Urban Stormwater Management Plan that incorporates the urban drainage infrastructure for all townships in the area, of which was adopted by Council in March 2001. This plan excluded the Trangie Township and has not been updated since 2001.

Report

The NSW Environmental Protection Authority (EPA) issued a notice under Section 12 of the Protection of the Environment Administration Act 1991 to all NSW Councils early in 1988 requiring each Council to develop a Stormwater Management Plan. As mentioned this was undertaken in 2001.

In August 2018 Narromine Shire Council began the process of having the Urban Stormwater Management Plan updated with the development of a standalone Drainage Strategy for each township to ease the complexity of decision making. The township of Trangie was the initial strategy to commence in this process. (**Attachment No. 2**).

The strategy aims to outline existing conditions, values of catchments, management objectives and issues, performance monitoring and establishes management of objectives and reporting functions of the plan.

This strategy will give Council and staff the ability to create capital and operational plans and asset management principles for the township of Trangie and assist with the identification of potential funding opportunities. It will also assist in the prioritising of needs and community demand in a logical way to ensure the infrastructure is developed in a way that allows for the staging of future works, as funding becomes available.

2. DRAFT TRANGIE DRAINAGE STRATEGY CONT.

Financial Implications

Cost of proposed work to be funded from Reserves when budgets allow unless grant funding becomes available.

Legal and Regulatory Compliance

Protection of the Environment Administration Act 1991

Risk Management Issues

Nil

Internal/External Consultation

Consultation has been undertaken with various community groups and Council representatives to ensure that the plan meets the existing and future requirements of the stormwater management system. Further consultation may be required as projects are identified and more detailed investigations are initiated.

It is proposed that the Draft Trangie Drainage Strategy be placed on public exhibition for a period of 28 days for public submission.

Attachments

- Draft Trangie Drainage Strategy

RECOMMENDATION

1. That the Draft Trangie Drainage Strategy as attached to the report be adopted and placed on public exhibition for 28 days.

Attachment No. 1

	<p>MONTHLY WORKS REPORT</p> <p>Friday, 5 April 2019</p>	<p>Infrastructure and Engineering Services Narromine Shire Council Tel: 02 6889 9999 Fax: 02 6889 9998 mail@narromine.nsw.gov.au</p>
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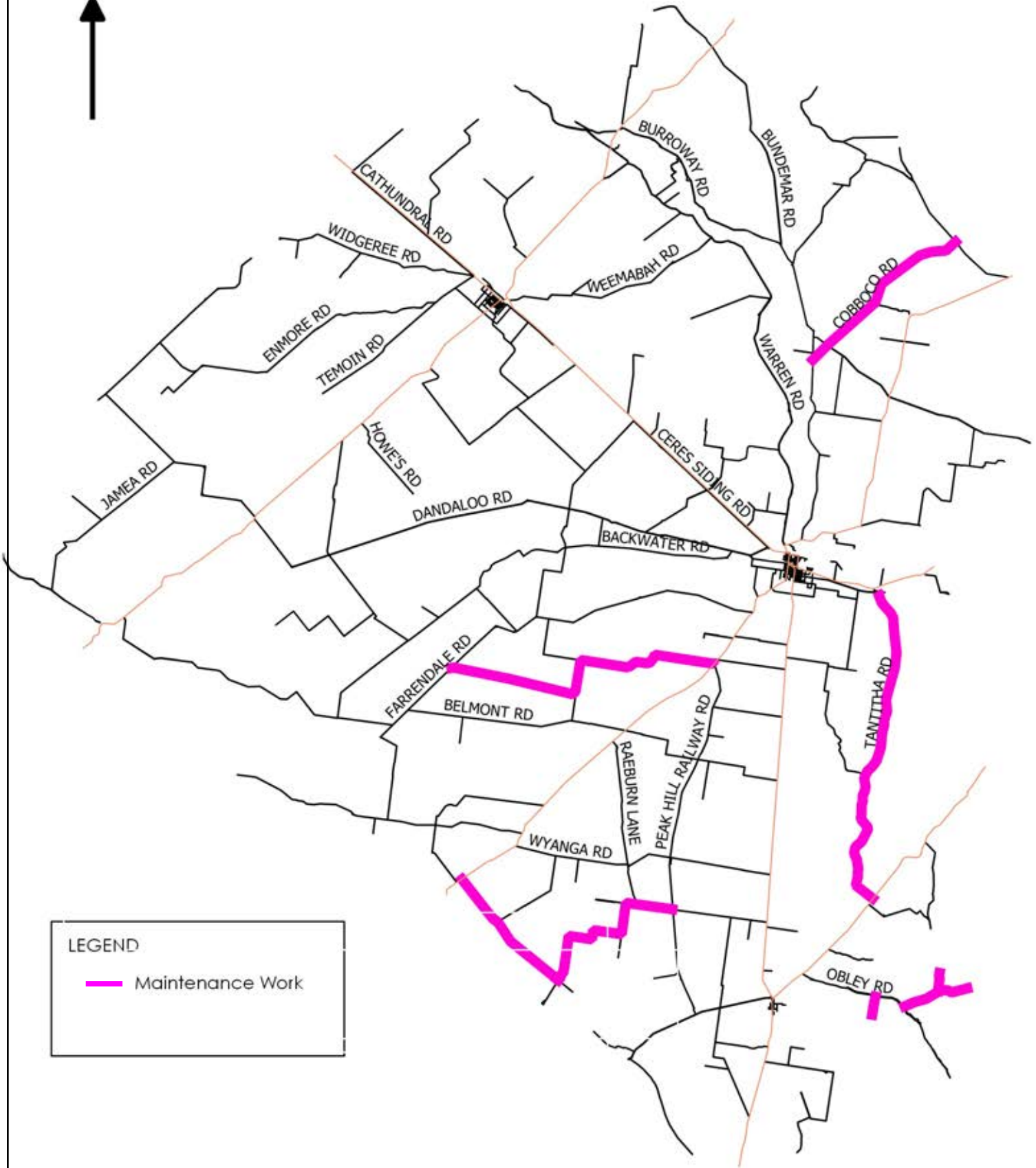
*Road and Park users are to proceed with caution at all work sites and observe work signs to ensure safety.
 Speed zones are enforceable with possible short delays.
 For all enquiries, please contact Council's Infrastructure and Engineering Services Department on 6889 9999.*

URBAN – Narromine, Trangie, Tomingley	
Various Streets (Narromine)	<p><u>Maintenance:</u></p> <ul style="list-style-type: none"> Routine Maintenance Program, patching and sweeping, etc.
Various Streets (Trangie)	<p><u>Maintenance:</u></p> <ul style="list-style-type: none"> Routine Maintenance Program, patching and sweeping, etc.
Various Streets (Tomingley)	<p><u>Maintenance:</u></p> <ul style="list-style-type: none"> Routine Maintenance Program - patching.
UNSEALED ROADS NETWORK	
Various Unsealed Roads	<p><u>Maintenance: Map No. 1</u> Maintenance Grading in progress or completed;</p> <ul style="list-style-type: none"> Dilladerry Road Job's Road Strahorns Access Road Narwonah Siding Sharkey's Lane Frecklington's Crossing Tantitha Road – drainage and formation work <p><u>Capital: Map No. 2</u> Resheeting in progress or completed;</p> <ul style="list-style-type: none"> Dilladerry Road Narwonah Road
SEALED ROADS NETWORK	
Various Sealed Roads	<p><u>Capital:</u></p> <ul style="list-style-type: none"> Eumungerie Road completed 1.2km full rehab Farrendale Road shoulder widening rehab progressing Burroway/Dubbo Burroway Road junction rehab has commenced <p><u>Maintenance:</u> Shoulder grading in progress or completed;</p> <ul style="list-style-type: none"> Cobboco Road

WATER AND SEWER	
Narromine	<p>Level 3 water restrictions continue in Narromine in accordance with the odds and evens scheme. The town supply is meeting the demand except on days of higher temperatures.</p> <p>The control system backup generator for Duffy Street has been ordered and will soon be installed. Staff are continuing with replacement of house water services in Manildra Street prior to continuation of the mains rationalisation and replacement program. Water Meters found defective at last read have been replaced by staff. Staff continue to carry out reticulation system and house services maintenance.</p> <p>Swimming Pool water quality monitoring is now complete for the season. Regular Drinking Water Quality sampling and analysis continues. Sewer pump station maintenance is continuing.</p>
Trangie	<p>Staff have continued reticulation system maintenance. Water Meters found defective at last read have been replaced by staff. Staff have commenced removal of pumping and dosing equipment at Trangie Swimming Pool ready for renovation works to commence.</p>
Tomingley	Continued regular system maintenance.
PARKS AND OPEN SPACE NETWORK CBD Gardens, Parks, Ovals, Villages	
Narromine CBD	General maintenance.
Narromine Parks and Reserves	General maintenance and mowing. Current water restrictions are limiting turf growth.
Narromine Sports Grounds	General maintenance and mowing. Current water restrictions are limiting turf growth. Additional work to be completed at Noel Powell Oval. Payten Oval closed in April for irrigation upgrade. Dundas Oval will be closed in May for irrigation upgrade.
Narromine Streets	Tree planting program on hold due to water restrictions Vegetation mowing after recent rain occupying a lot of time.
Trangie CBD	General maintenance and weed control ongoing. Vegetation mowing after recent rain occupying a lot of time.
Trangie Parks	General maintenance and mowing. Irrigation repairs undertaken to Swift Park.
Trangie Sports Grounds	Burns Oval irrigation timing still requiring adjustments to find a balance, now open to sporting groups. Fence being installed. Formal opening to be held on 12 th April.
Trangie Streets	General maintenance. Street sweeping weekly on Tuesday's. Veg mowing has commenced.
Tomingley Village	General maintenance.

SWIMMING POOLS	
Narromine Pool	Now closed. Demolition of baby pool has commenced.
Trangie Pool	Now closed. Demolition of pump room has commenced.
AERODROME	
Narromine Aerodrome	Slashing and weed control continue.
BUILDING MAINTENANCE	
All Buildings	General maintenance as required.
Narromine Medical Centre	Air conditioner and front doors replaced. Other general maintenance as required.
Council Administration Buildings	Air con being replaced in the finance building. Other general maintenance as required.
PUBLIC CONVENIENCES	
Rotary Park (Narromine) Public Toilets	Burraway toilets scheduled for refurbishment. General maintenance and repairs continue. Toilet facilities cleaned daily.
Burraway Street Public Toilets (adjacent to Pool)	
Argonauts Park (Trangie) Public Toilets (Goan Waterhole)	Toilet facilities cleaned every Tuesday, Thursday and Saturday.
Dandaloo Street Trangie (adjacent to Bakery)	General maintenance and repairs. Toilet facilities cleaned every Monday, Wednesday and Friday.
Wetlands	Toilet block secured and cleaned daily.
CEMETERIES	
Narromine Cemetery	General maintenance, mowing and weed spraying. Topping up of graves. Irrigation renewal to be completed to cover new section.
Trangie Cemetery	General maintenance, mowing and weed spraying. Topping up of graves.

Map No. 1

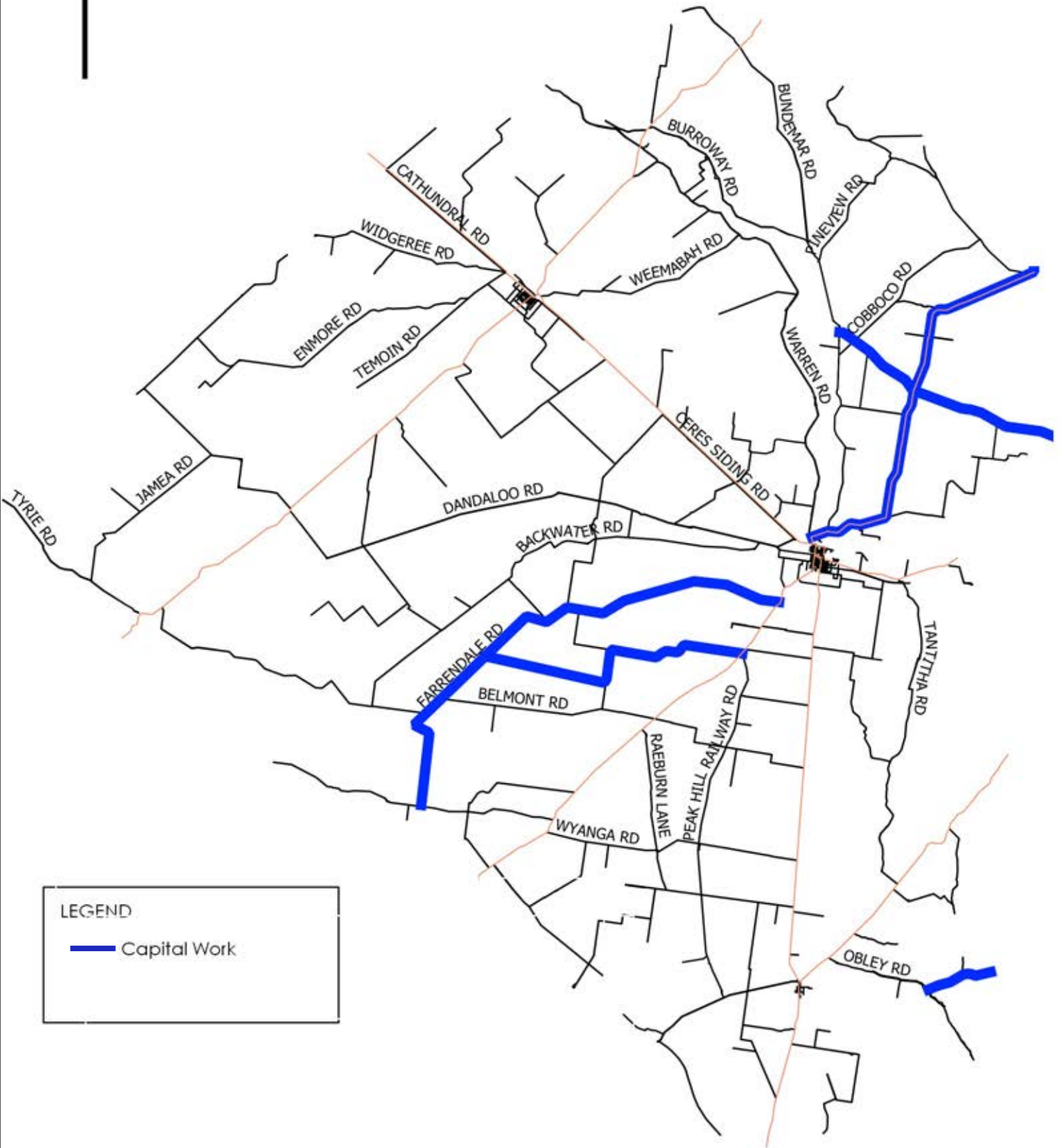


NARROMINE SHIRE COUNCIL

Maintenance Works Program 2018-2019 - March

Notes - roads that are highlighted have had work undertaken on them and are not specific sections

Map No. 2



LEGEND

— Capital Work

NARROMINE SHIRE COUNCIL

Capital Works Program 2018-2019 - March

Return to report

Notes - roads that are highlighted have had work undertaken on them and are not specific sections



TRANGIE URBAN STORMWATER MANAGEMENT PLAN

September 2018

Project No.2107

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OVERVIEW

Narromine Shire Council is committed to improving the water quality and environmental values for the township of Trangie through an integrated catchment management approach. Narromine Shire Council issued a brief for the Stormwater Management Plan for Trangie in April 2018 and Storm Consulting (Storm) was awarded the project.

In response, Storm commenced plan preparation in accordance with the Managing Urban Stormwater Council Handbook prepared by EPA in 1997 which have the following key components:

- A Detailed Action Plan which identifies and prioritise specific cost-effective solutions, assigns responsibilities for actions that is applicable to Council's needs and program
- An Implementation Strategy which defines the management framework for ongoing co-ordination between stormwater managers
- A detailed investment programs which involves the identification of funding sources to implement priority actions
- An Evaluation and Monitoring Program which determines performance indicators for the actions and identifies appropriate monitoring to measure the success of the Stormwater Management Plan.

The ecological consideration and feedbacks from local community have been discussed in Section 3.0 and 4.0 and the conclusion has been analysed in the benefit index which forms the overall ranking for the proposed options.

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APPENDICES

APPENDIX A

Photographic Record of Stormwater Issues in Trangie

APPENDIX B

Community Involvement and Education

APPENDIX C

Structural Assessment and Education Options

1.0 INTRODUCTION

The NSW Environmental Protection Authority (EPA) issued a notice under Section 12 of the Protection of the Environment Administration Act 1991 to all NSW council's early in 1988 requiring each council to develop a Stormwater Management Plan. As a result, Stormwater Management Plan was required for Narromine Shire which includes Narromine, Trangie and Tomingley. In April 2018, Narromine Shire Council issued a brief for the Stormwater Management Plan for Trangie and the project was awarded to Storm Consulting (Storm).

Storm commenced plan preparation in accordance to the Managing Urban Stormwater Council Handbook prepared by EPA in 1997. The focus of the report is to provide strategies to improve stormwater quality and minimise the impact on natural habitats by implementing local infrastructure and improve community awareness.

Storm conducted a site inspection on May 2018 to review Trangie's urban area and Goan waterholes, assess the current stormwater system and identify stormwater issues.

Public consultations were held to include the community feedbacks from Trangie Aboriginal Local Council, Trangie residents (based on previous correspondence from the local community provided by Narromine Shire Council) and Narromine Shire Council. Given the population size of Trangie, it was decided to combine the stakeholder feedbacks from the Narromine Urban Stormwater Management Plan (prepared by Hunter Water Australia – Strategy Services) into this report to maximise the stakeholder input.

1.1. Objective of Stormwater Management Plan (SMP)

The main objective of the Stormwater Management Plan is to improve the overall performance of stormwater system by:

- Implementing cost-effective stormwater treatment measures
- Improving the infrastructure such as creating road kerb & gutter and underground drainage system for the road network
- Provide treatment measures to the creek bank/bed erosion issues
- Improve the creek rehabilitation and naturalisation
- Increasing community awareness, education and interest regarding the importance of stormwater assets.

1.2. Framework and Scope of the SMP

This SMP has been prepared according to the Managing Urban Stormwater Council Hand book prepared by EPA in 1997. The aim of this plan is to improve the management of stormwater within the Trangie urban catchment by:

- Describes the catchment
- Identifies existing catchment conditions
- Establishes the values of the catchment
- States appropriate management objectives
- Identifies management issues
- Evaluates potential management practices
- Contains plan implementation strategies for Narromine Shire Council
- Presents a performance monitoring program
- Establishes stormwater management objectives for new developments
- Describes a mechanism for reporting on the implementation of the plan

1.3. Community Consultation and Collecting Existing Data

One-on-one interviews and workshop sessions with community members and government agency representatives have been conducted by Hunter Water in Oct 2000. Catchment values and stormwater management objectives had been established based on the comments provided by these stakeholders.

Additional community consultation has been conducted by Storm to engage the following stakeholders:

- Trangie Action Group
- Trangie Local Aboriginal Land Council
- The comments of the above stakeholders have been taken into consideration of the long-term and short-term objective development.

1.4. Stormwater Catchment Values

Stormwater values were developed during one-to-one stakeholder consultations. These values were incorporated into the stakeholder briefing document. The ranking of values was also accomplished during the workshops using a methodology of individual assessment and then consensus gathering. Each participant was given a total of 100 points to allocate to the stormwater values. The facilitators added all points from all stakeholders present to produce the Stormwater Catchment Values table as shown in Table 1-1.

For example, the combined stakeholders of Narromine, Trangie and Tomingley considered good water quality (regulation of supply) to be most important, with protection of community health and safety (from flooding) ranking second. The ranking of water quality as the highest is usual for stormwater values, since water quality can be linked to most other values. The lowest rank values included increased opportunity for recreation and protection of the catchment for tourism.

The ranking of the values will enable the Council to establish an 'order of priority' when considering management options for the Stormwater Management Plan. This process is ongoing, and values will change over time. Therefore, the process of development and implementing a Stormwater Management Plan needs to be feasible and dynamic.

Table 1-1: Stormwater Catchment Values

Value	Score
Water quality (regulation of supply)	165
Health and Safety (i.e., flooding)	150
Aesthetics	110
Habitat restoration (i.e. the wetlands)	98
Community awareness	95
Visual amenity	90
Property and asset protection	85
Economic value of stormwater management	75
Natural habitat	656
Reduction of maintenance/cost frequency	60
Stormwater reuse	52
Tourism	30
Recreation	25

1.5. The Development of Stormwater Management Objectives

Objectives were developed to help Council achieve their values. A considerable amount of time was spent reviewing objectives at the workshop session and are summarised in Table 1-2 which including the changes made after the workshops. These objectives are discussed in detail in Section 4.0 of this report.

Table 1-2: Stormwater Management Objectives

Objective	Score
Optimal infrastructure, management & design	817
Improved community awareness	595
Improved water quality	365
Minimised localised flooding from stormwater	295
Minimise erosion	165
Improvement of aesthetics	110
Protection of aquatic and terrestrial habitats	98
Protection of community health and safety	98

The objectives were linked to the key values by the facilitators, this assisted in demonstrating how each objective will help to address stormwater values. These were broken down into short-term objectives, which provide a means to achieving stormwater values in the short-term and to support longer-term objectives. These may also be called sub-objectives and play an important part in the initial stage of stormwater management in terms of working towards long term objectives. Overtime, the short-term objectives will be achieved and will be replaced by other objectives as the need arises.

2.0 CATCHMENT DESCRIPTION

Trangie is located in central New South Wales and is a small regional town with an estimated population of 1198 in 2016. Located around 220 metres above sea-level in the Macquarie Valley Irrigation Area, Trangie is on the main western railway line and on the Mitchell Highway, between Narromine (35 km south east) and Nyngan (90 km north-west). The locality map of Trangie can be referred in Figure 2-1



Figure 2-1: Locality Map of Trangie

Trangie is bounded to the north by the Macquarie River and to the south by the Back Water Cowal, a tributary of the Boggy Cowal. Although Trangie urban catchment area is not subject to frequent flooding, ponding, water stagnation can occur during high flow events.

2.1. Ecological Description

Goan Waterhole is located to the south of Trangie and at a certain time can be a spectacular display of mosses and water plants and home to many birds. The townscape is dominated by the Trangie silo, a testimony to the importance of wheat production in Narromine Shire. There are vast cotton fields outside the town and sheep, wool, sorghum and fat lambs are also important to the area. The area is thought to have been occupied by the Wongaibon Aborigines prior to white settlement. 'Trangie' is an indigenous word said to mean 'quick'.

The town later developed on 'Weemaabah' station, established, in the 1830s. The Cobb & Co. Coach service from Dubbo to Bourke passed through the area and stopped at the Swinging Gate Hotel. However, a township did not develop until the railway arrived in 1882, en route from Dubbo to Nevertire local wool producers benefited greatly from the improved transportation.

In 1915 a 4000-ha experimental farm was established in Trangie the farm was at the forefront of technological changes which came to the district, driving the expansion of livestock and cropping industries. The Trangie Agricultural Research Centre continues to operate today.

2.2. Waterways

According to Macquarie River (Narromine to Oxley Station) Floodplain Management Plan (2008), Trangie urban catchment area is in Macquarie River Catchment. For the 1990 design flood, 25% of the Macquarie River peak flow breaks away and flows westward to join Trangie Cowal and thereafter Beleringar/Sandy Creek thereby providing a natural relief valve for downstream flooding.

The 1990 historic flood event produced a peak flow of 179,000ML/day at Narromine. The Assigned annual exceedance Probability (AEP) is 1.5% which equivalent to a 65 years of Average Recurrence Interval (ARI). Therefore, it is suggested that the Trangie urban catchment area will be affected by flood from Macquarie River during the storm events of over 50-year ARI.

Storm has analysed the stormwater surface flow using HEC-RAS 2D. The available information for the 2D flood Study are listed as follow:

- LiDAR data, Dandaloo 2012 08 2kmx2km Point Cloud Metadata (Figure 2.2)
- Rainfall Intensity Frequency Duration from Bureau of Meteorology (BOM) The coverage of this dataset is over the Trangie region.
- The 1 metre Digital Elevation Model (DEM) is produced using the TIN (Triangular Irregular Network) method of averaging ground heights to formulate a regular grid. This data set contains the ground surface model in ASCII grid format derived from C3 LiDAR (Light Detection and Ranging) from an ALS50ii (Airborne Laser Scanner). Standard Airborne Laser Sensor (ALS) products are processed to ICSM standards level C3. This data has an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal with a minimum point density of UNK laser return per square metre measured at nadir. For more information on the data's accuracy, please refer to the lineage provided in the data history.

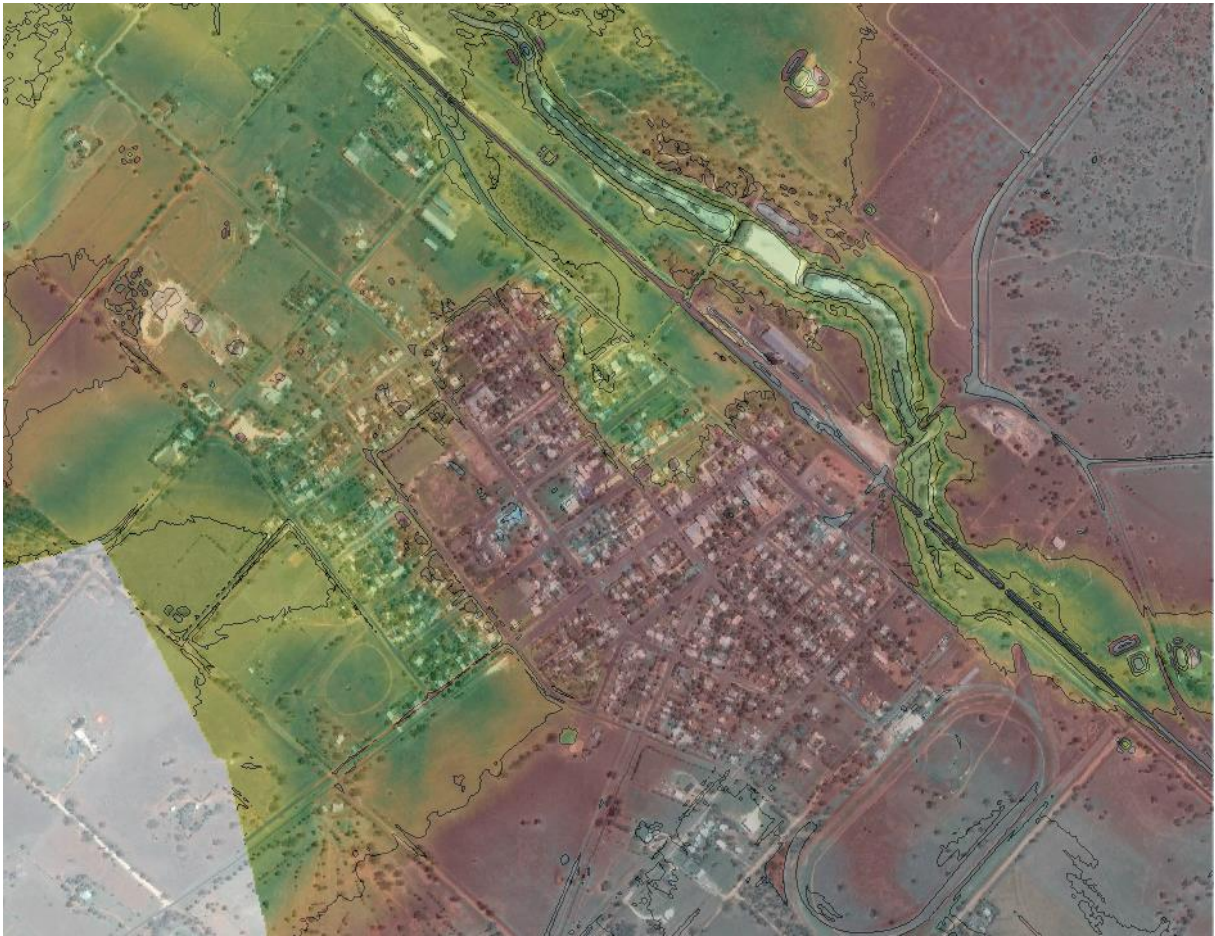


Figure 2-2: LIDAR DEM Data of Trangie Urban Catchment Area

Direct rainfall precipitation method has been used to generate rainfall over Trangie urban catchment area. Figure 2-3 shows the flood depth over Trangie urban catchment area during 10-year ARI and 50-year ARI with 2 hours rainfall duration, while Figure 2-4 shows the flood velocity during 10-year ARI and 50-year ARI with 2 hours rainfall duration.

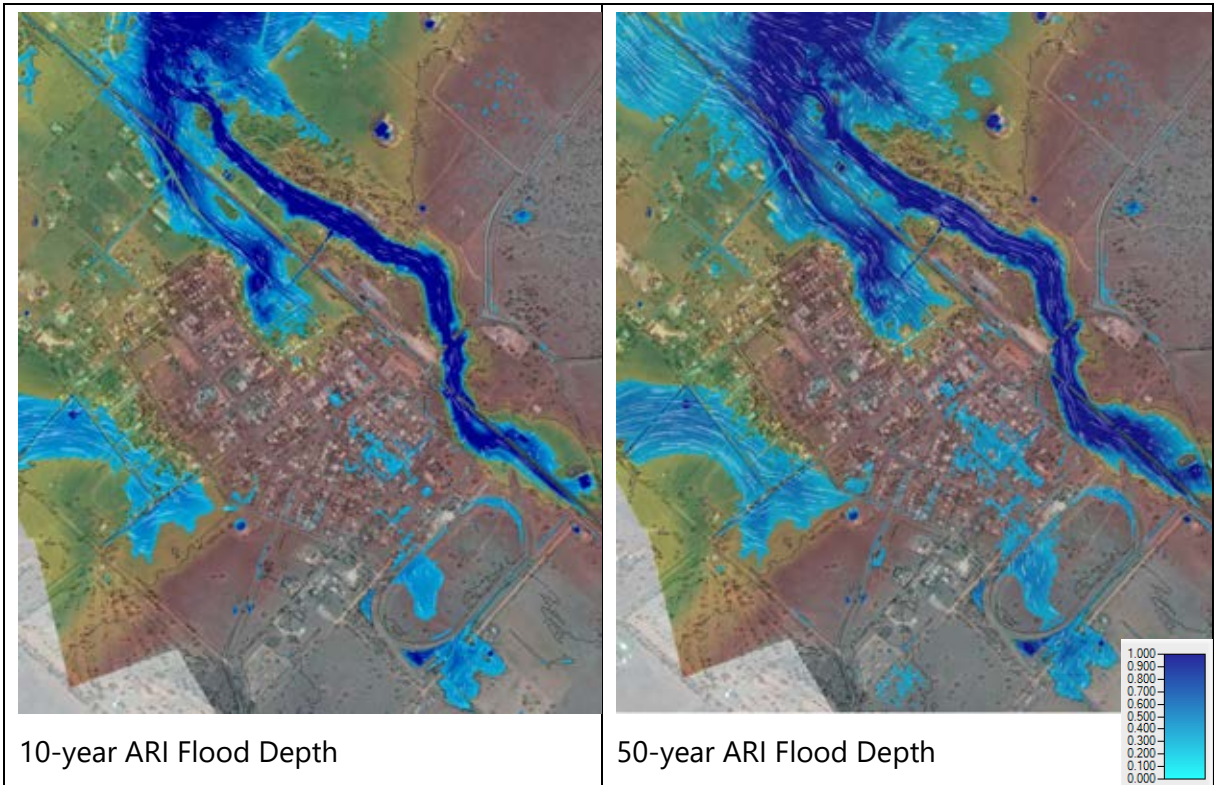


Figure 2-3: Flood Depth Maps

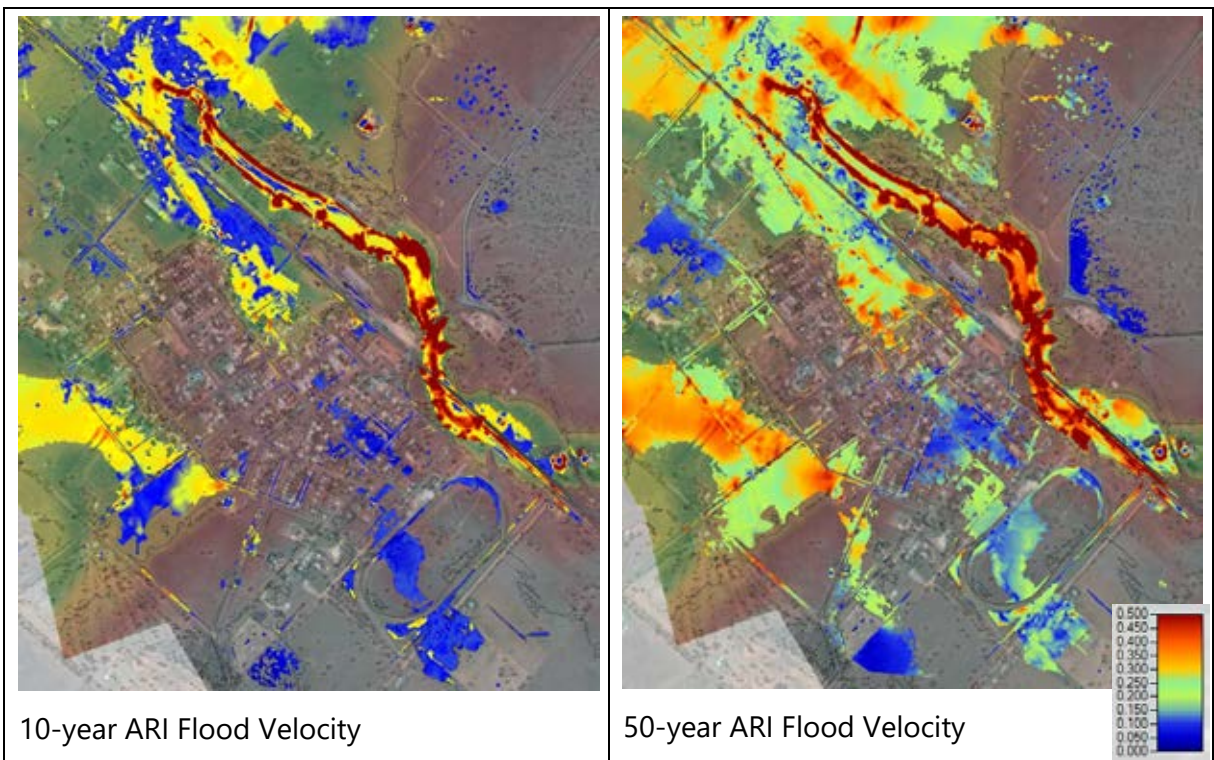


Figure 2-4: Flood Velocity Maps

According to the above figures, Trangie urban catchment can be split into two sub-catchments, northern and southern catchment divided by the topographic ridge between Harris Street and Derribong Street. The northern sub-catchment is draining to Goan Waterhole, while the southern sub-catchment is discharging to the farmland to the east of the town. Stormwater stagnant would occur during 10-year storm events and the flood extent keeps increasing to 50-year storm events.

2.3. Land use

Land use within the Trangie urban catchment area is mixed with residential area and farm land. The residential area of Trangie is low density and this transit to farm land on the outskirts of the town. The catchment contains only minor and industrial activity, which consists warehouses, fuel depot and the like.

2.4. Topography

Trangie is typically flat with local topography sloping from southeast of the town at RL 218.5m to northwest of the town at RL 216m.

2.5. Geology and Soils

In many locations, the soils within Trangie are naturally acidic with typical pH values of around 4.5, although soil types vary within the Narromine Shire due to geographic land formations. The backwater Cowal area consists of soils with mainly brown and grey cracking clays with some yellow solodics, with some Red chromosols and Non-calcic browns. The inundated areas to the south and west are mainly solodics. Solis near Macquarie River are lately alluvial made up of different layers and various textures. Many of the soils in the Narromine Shire are sodic and this affects their permeability.

2.6. Climate

Climate is an important factor for appropriate stormwater management. Average annual rainfall for the Trangie is approximately 506.3mm. Table 2.1 shows the average annual rainfall and evaporation data collected from the research station at Trangie.

Table 2-1: Average Rainfall and Average Evaporation for Trangie, NSW

Month	Average Rainfall (mm)	Average Evaporation (mm)
January	55.5	9.4
February	50.4	8.4
March	48.6	6.7
April	42.0	4.6
May	39.2	2.6

Month	Average Rainfall (mm)	Average Evaporation (mm)
June	34.2	1.8
July	36.0	1.8
August	33.5	2.6
September	32.0	3.8
October	46.0	5.7
November	43.7	7.7
December	45.2	8.2
Total	506.3	63.3

Source: Bureau of Meteorology, 2000

3.0 CATCHMENT VALUES

3.1. General Ecological Constraints

3.1.1. Database Searches

Searches of several databases were made to identify threatened species and Endangered Ecological Communities (EECs) that may potentially be found on the subject site. Databases were accessed on 10th August 2018 and these includes:

- NSW Wildlife Atlas (www.bionet.nsw.gov.au/)
- Ebird (<https://ebird.org/australia/hotspots>)

3.1.2. Threatened Species

A search of BioNet- NSW Wildlife Atlas was undertaken for records within 5km of Trangie. This yielded only 3 observations in total of 2 threatened species as shown in Figure 3-1. The species recorded are both bird species and unlikely to be disturbed by any works. These species only use urban and peri-urban areas on a temporary basis.

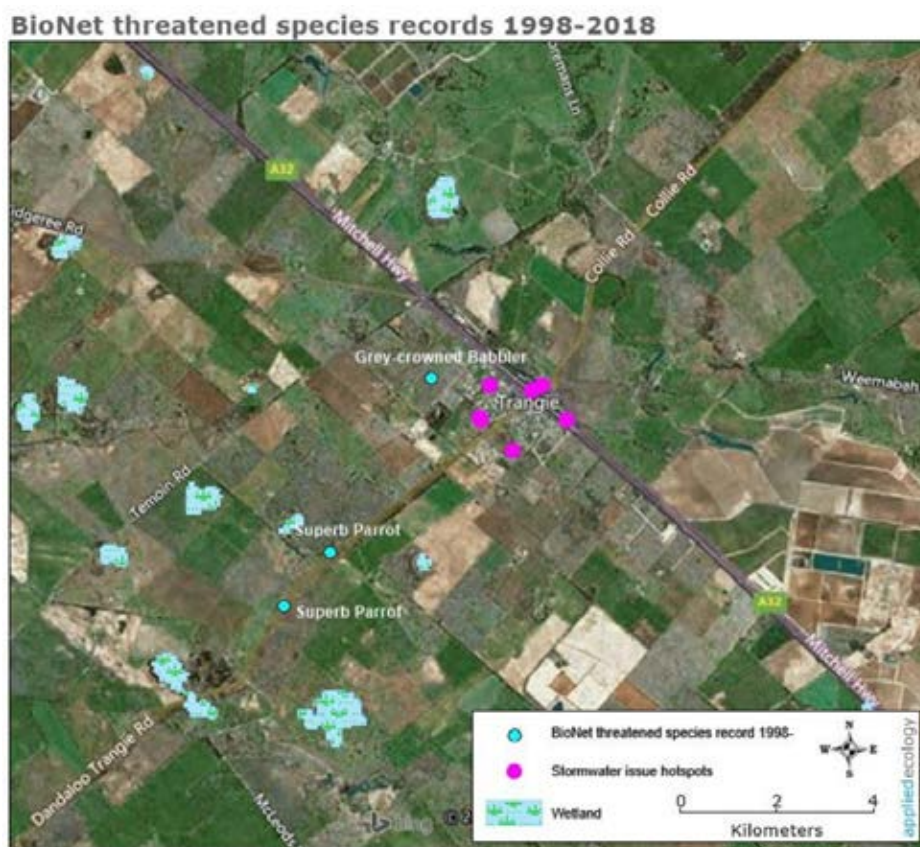


Figure 3-1: Threatened species records (BioNet 1998-2018) near Trangie

A further search was undertaken of the entire LGA. This included searches for migratory species and threatened species and included all valid records of Threatened (listed on TSC Act 1995 & Biodiversity Conservation Act 2016), Commonwealth listed, CAMBA listed, JAMBA listed or ROKAMBA listed entities in Narromine LGA recorded since 1/01/1998 until 10/8/2018. The search returned a total of 234 records of 28 species refer to Table 3-1 below.

Table 3-1: Threatened species and listed migratory species, Narromine LGA, BioNet 1998-2018

Class Name	Scientific Name	Common Name	NSW Status	Comm Status	Count
Aves	<i>Anseranas semipalmata</i>	Magpie Goose	V,P		4
Aves	<i>Stictonetta naevosa</i>	Freckled Duck	V,P		2
Aves	<i>Botaurus poiciloptilus</i>	Australasian Bittern	E1,P	E	1
Aves	<i>Circus assimilis</i>	Spotted Harrier	V,P		4
Aves	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	V,P	C	1
Aves	<i>Hieraetus morphnoides</i>	Little Eagle	V,P		8
Aves	<i>Lophoictinia isura</i>	Square-tailed Kite	V,P,3		1
Aves	<i>Falco subniger</i>	Black Falcon	V,P		3
Aves	<i>Grus rubicunda</i>	Brolga	V,P		3
Aves	<i>Hydroprogne caspia</i>	Caspian Tern	P	C,J	2
Aves	<i>Polytelis swainsonii</i>	Superb Parrot	V,P,3	V	34
Aves	<i>Ninox connivens</i>	Barking Owl	V,P,3		6
Aves	<i>Tyto novaehollandiae</i>	Masked Owl	V,P,3		2
Aves	<i>Merops ornatus</i>	Rainbow Bee-eater	P	J	15
Aves	<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V,P		54
Aves	<i>Chthonicola sagittata</i>	Speckled Warbler	V,P		3
Aves	<i>Grantiella picta</i>	Painted Honeyeater	V,P	V	4
Aves	<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V,P		50
Aves	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V,P		3
Aves	<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	V,P		6
Aves	<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V,P		1
Aves	<i>Stagonopleura guttata</i>	Diamond Firetail	V,P		1
Mammalia	<i>Phascolarctos cinereus</i>	Koala	V,P	V	1
Mammalia	<i>Petaurus norfolcensis</i>	Squirrel Glider	V,P		2
Mammalia	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V,P		1
Mammalia	<i>Chalinolobus picatus</i>	Little Pied Bat	V,P		13
Mammalia	<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	V,P	V	1
Flora	<i>Tylophora linearis</i>		V,P	E	8

3.1.3. Ebird

There are 59 species records at Trangie Park and Goan Waterhole from 10 surveys. This area includes a stormwater hotspot. The majority of these species are recorded post 2016 and are listed below with approximate counts. Details of the species can be referred to Table 3-2

Table 3-2: Species Record

Common Name	Count	Common Name	Count
Straw-necked Ibis	200	Eastern Rosella	2
Galah	50	Spiny-cheeked Honeyeater	2
Sulphur-crested Cockatoo	50	Striated Pardalote	2
Little Corella	40	Ground Cuckoo-shrike	2
Eurasian Coot	30	Magpie-lark	2
Fairy Martin	20	crow/raven sp.	2
Common Starling	16	Pink-eared Duck	1
Pacific Black Duc	14	Australasian Grebe	1
Australian Shelduck	10	Little Pied Cormorant	1
Noisy Miner	10	Australasian Darter	1
White-plumed Honeyeater	10	White-necked Heron	1
Black Swan	8	White-faced Heron	1
Australian Magpie	6	Black-shouldered Kite (Australian)	1
Apostlebird	6	Brown Goshawk	1
House Sparrow	5	Whistling Kite	1
Australian White Ibis	4	Laughing Kookaburra	1
Red-rumped Parrot	4	Australian Hobby	1
Grey-crowned Babbler	4	Blue-faced Honeyeater	1
Little Crow	4	Striped Honeyeater	1
Welcome Swallow	4	Grey Butcherbird	1
Yellow-billed Spoonbill	3	Pied Butcherbird	1
Black Kite	3	Black-faced Cuckooshrike	1
Masked Lapwing	3	Olive-backed Oriole	1
Yellow-throated Miner	3	Willie Wagtail	1
Australian Wood Duck	2	Little Raven	1
Grey Teal	2	White-winged Chough	1
Hardhead	2	Mistletoebird	1

Common Name	Count	Common Name	Count
Australian Pelican	2		
Rock Dove	2		
Crested Pigeon	2		
Sacred Kingfisher	2		
Nankeen Kestrel	2		
Australian Ringneck	2		

3.1.4. Vegetation Communities

Over-cleared Landscapes

The stormwater hotspots are all located on over cleared landscapes (Figure 3-2)

Overcleared Landscapes - Mitchell Landscapes v31

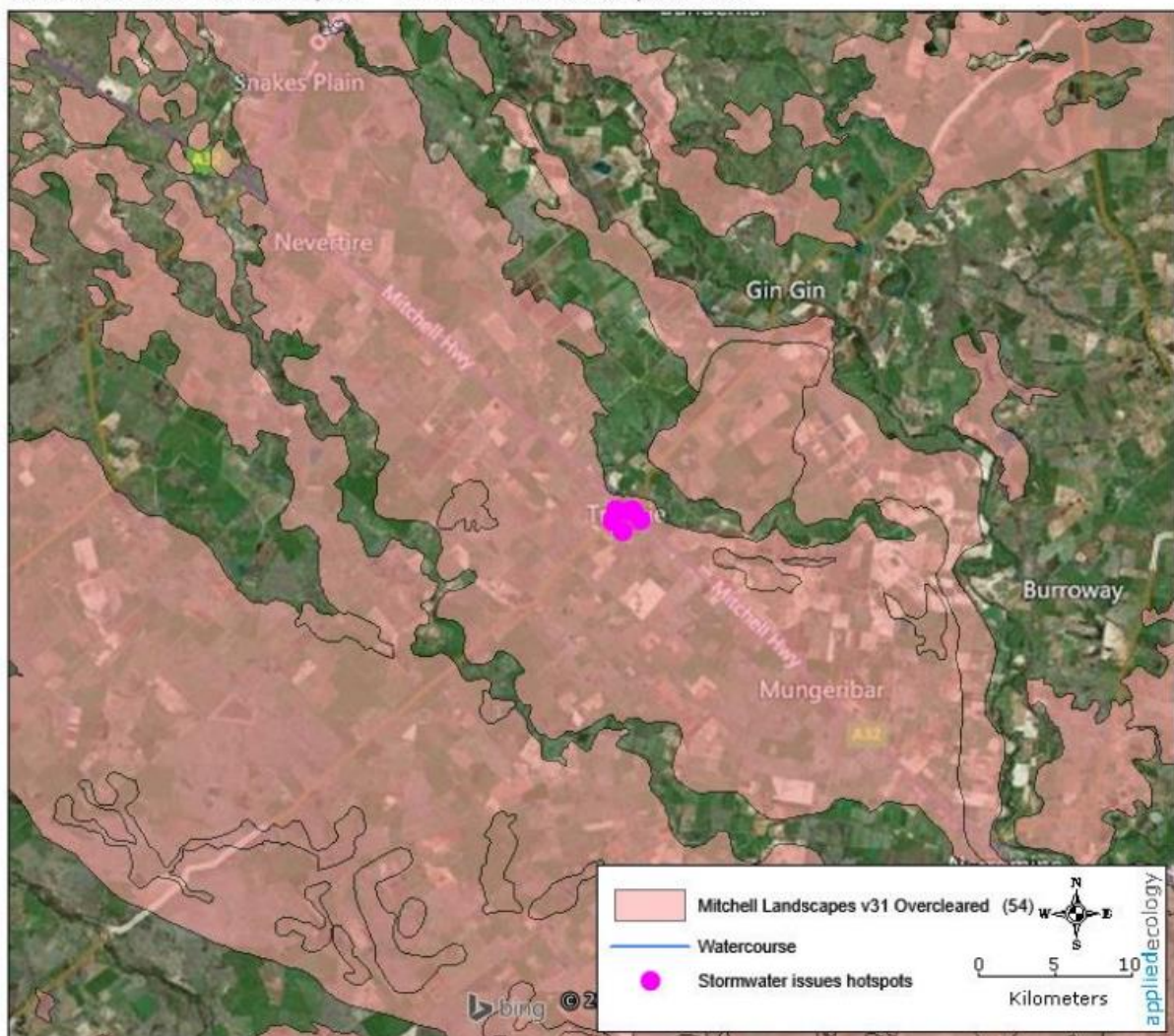


Figure 3-2: Over-cleared landscape mapping - Mitchell landscapes v31

3.1.5. Endangered Ecological Communities

Several of the stormwater hotspots identified are located near areas of remnant Endangered Ecological Communities including Weeping Myall Woodland and Inland Grey Box Woodland (Figure 3-3).

Vegetation Communities (PCT) OEH VIS 4468

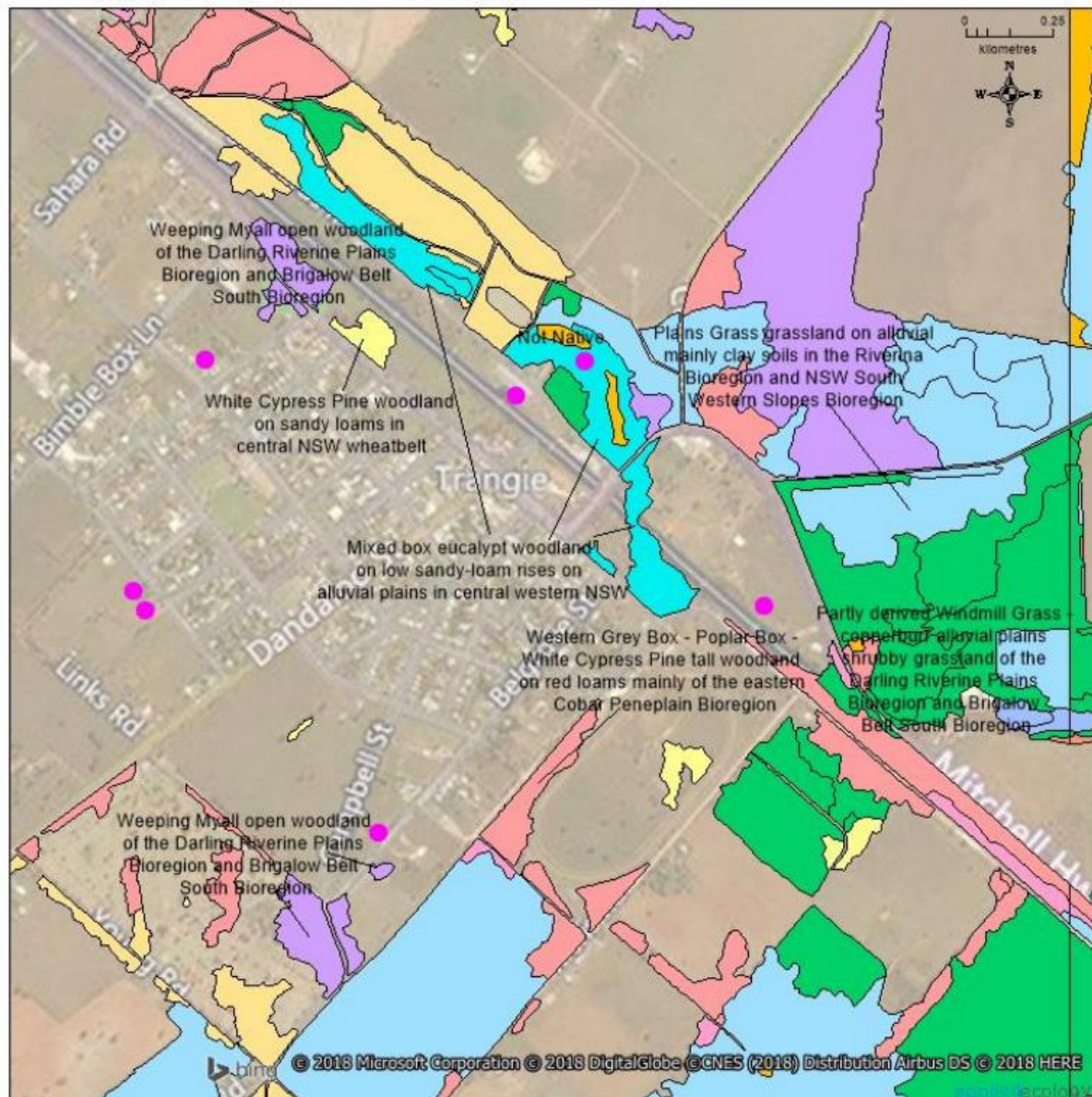


Figure 3-3: Plant Community types from Vis 4468 mapping (OEH 2017)

Based on the results of literature and database searches there are no major constraints associated with threatened species or endangered ecological communities. Goan Waterhole provides a local fauna hotspot, with a concentration of records of avian fauna from this location.

Works at sites that drain to this location may have an impact on these birds. Works at several other sites have some potential to impact on an endangered ecological community. All the vegetation communities in the area are associated with over-cleared landscapes and should be considered with the precautionary principle in mind.

Stormwater hotspots were inspected on 21st July 2018 to gain a more detailed understanding of site specific constraints. The results of these surveys are provided in the following sections of this report.

3.2. Community Consultation

It should be noted that the scoring results from the previous report has been included in this ranking of values as well. Therefore, the score allocation values were obtained from the stakeholders of Narromine, Trangie, Tomingley and Trangie Local Aboriginal Land Council.

Table 3-3: Stakeholder Scoring Sheet

Stakeholder Number	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Property and asset protection	120	10	20	15	20	15	10	20	20	20	5	10	10	10	10	10
Water Quality	205	20	5	10	10	15	15	30	5	10	25	5	10	10	10	10
Health and Safety	190	5	0	5	10	10	5	5	20	10	15	10	10	10	10	10
Community awareness	135	10	20	5	8	10	5	10	20	5	0	5	5	5	5	4
Habit restoration (esp. the wetlands)	117	5	5	10	10	5	10	5	20	10	10	20	10	10	10	8
Aesthetics	148	10	10	10	0	20	5	0	0	5	10	20	5	5	5	5
Visual amenity	110	0	5	0	0	5	0	0	0	5	5	10	5	5	2	4
Tourism	46	5	0	5	10	5	20	0	5	5	5	0	5	5	5	5
Reduction of maintenance cost/frequency	80	0	0	5	0	5	0	0	0	5	5	5	10	5	1	5
Recreation	46	5	5	5	5	5	0	20	5	5	5	5	5	10	5	10
Natural habitat	95	5	5	15	10	0	20	0	0	5	5	10	5	5	5	5
Economic value of stormwater management	95	10	10	10	10	0	10	10	5	10	10	0	10	10	8	10
Stormwater reuse	123	15	15	5	7	5	0	0	0	5	0	0	10	10	10	10

The total scores for each stormwater values are listed in Table 3-4 as follow:

Table 3-4: Total Stormwater Catchment Values

Value	Total
Water Quality	205
Health and Safety	190
Aesthetics	148
Community awareness	135
Stormwater reuse	123
Property and asset protection	120
Habit restoration (esp. the wetlands)	117
Visual amenity	110
Natural habitat	95
Economic value of stormwater management	95
Reduction of maintenance cost/frequency	80
Recreation	46
Tourism	46

In summary, the stakeholders consider water quality to be the most important factor followed by health and safety while the lowest ranked values included recreation and tourism. It was also noted by Council to upgrade the local stormwater drainage system. The correspondent values can be referred to property and asset protection, visual amenity and reduction of maintenance cost/frequency.

4.0 STORMWATER MANAGEMENT OBJECTIVES

4.1. Introduction

According to the meeting with Council on 30/06/18, the primary objective for stormwater management in Trangie is to improve the efficiency of the drainage system. During the site inspection, Storm has examined the stormwater hotspots raised by the local community and listed from the previous Narromine Urban Stormwater Management Plan prepared by Hunter Water Australia back in 2010. A list of long-term and short-term objectives is shown below in Table 4-1.

Table 4-1: Connection between long-term/short-term to stormwater values

Long Term (Overriding Objectives)	Short Term (Sub-objectives)	Link to Values
Improve Water Quality		
To improve and maintain water quality within ANZECC guidelines	<ul style="list-style-type: none"> • To reduce the amount of litter entering waterways, especially from the CBD. • To reduce the risk of contaminated run-off entering waterways from the CBD. • To reduce the levels of nutrients entering Trangie. • To reduce the amount of siltation in the waterhole. 	<ul style="list-style-type: none"> • Water quality • Visual amenity
Minimise Erosion		
To minimise the impact of erosion on property and the environment	<ul style="list-style-type: none"> • To enforce the correct procedure for erosion control on new development sites. • To reduce the number of unsealed road verges susceptible to erosion. • To reduce the incidence of river and stream bank erosion. 	<ul style="list-style-type: none"> • Water quality • Natural habitats • Reduction in maintenance cost/frequency

	<ul style="list-style-type: none"> To reduce erosion caused by stormwater outlets into the creeks. 	
Improve Aesthetics of the Catchment		
To improve the aesthetics of the stormwater system	<ul style="list-style-type: none"> Reduce odour and algae problems due to stagnant stormwater 	<ul style="list-style-type: none"> Aesthetics Health and safety
Protection of Aquatic and Terrestrial Habitats		
To ensure that the stormwater system does not impact on aquatic and terrestrial habitats	<ul style="list-style-type: none"> Reduce sedimentation around stormwater outlets. Improve water quality, especially regarding silt and litter around stormwater outlets. Reduce weed introduction in creeks through stormwater channels 	<ul style="list-style-type: none"> Water quality Natural habitat Habitat restoration Recreation
Ensure Community Health and Safety		
To ensure that public health and safety is not compromised by the stormwater system	<ul style="list-style-type: none"> Minimise opportunities for mosquito breeding in stagnant water. Monitor and reduce the impact of septic 	<ul style="list-style-type: none"> Health and safety
Increase Community Awareness		
To improve community awareness, education and involvement in stormwater management	<ul style="list-style-type: none"> Implement public education programs to increase public awareness and ownership 	<ul style="list-style-type: none"> Stormwater reuse Community awareness
Optimal Infrastructure Planning and Management		
Ensure stormwater and other infrastructure is designed, planned and managed to reduce impacts on property, public health and the environment	<ul style="list-style-type: none"> Improve maintenance of stormwater infrastructure. Ensure that the SMP is compatible with other Management Plans. 	<ul style="list-style-type: none"> Reduction in maintenance cost/frequency Economic value of stormwater management
Localised Flooding		

To ensure that stormwater does not inundate properties and roads.	<ul style="list-style-type: none"> To minimise localised flooding by improving stormwater management and maintenance. 	<ul style="list-style-type: none"> Property and asset protection.
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4.2. Management Objectives

Management objectives have been developed to protect the 'high priority' catchment values of the stormwater system and its catchment. These include both 'long-term' commitments to principle (a 'vision' for the catchment) and 'short-term', quantifiable objectives help form the basis of actions to be incorporated in the stormwater strategies. The project objectives can be scored by linking to the corresponding values as shown in Table 4-2. And The stormwater objectives ranking is shown in Table 4-3.

Table 4-2: Score for the Stormwater Objectives

Objectives	Linked values and their scores	Total Score
Improved water quality	<ul style="list-style-type: none"> Water quality (205) Aesthetics (148) Stormwater reuse (123) Recreation (46) 	522
Minimise erosion	<ul style="list-style-type: none"> Water quality (205) Habitat restoration (esp. the wetland) (117) 	322
Improvement of aesthetics	<ul style="list-style-type: none"> Aesthetics (148) 	148
Protection of aquatic and terrestrial habitats	<ul style="list-style-type: none"> Habitat restoration (esp. the wetland) (117) 	117
Protection of community health and safety	<ul style="list-style-type: none"> Health and safety (190) 	190
Improved community awareness	<ul style="list-style-type: none"> Water quality (205) Community awareness (135) Habitat restoration (esp. the wetland) (117) Visual amenity (110) Tourism (46) Natural habitat (95) Stormwater reuse (123) 	831
Optimal infrastructure, management & design	<ul style="list-style-type: none"> Water quality (205) Health and safety (190) Aesthetics (148) Visual amenity (110) Tourism (46) 	1117

Objectives	Linked values and their scores	Total Score
	<ul style="list-style-type: none"> • Reduction of maintenance cost/frequency (80) • Economic value of stormwater management (95) • Property and asset protection (120) • Stormwater reuse (123) 	
Minimised localised flooding from stormwater	<ul style="list-style-type: none"> • Health and safety (190) • Reduction of maintenance cost/frequency (80) • Property and asset protection (120) 	390

Table 4-3: Ranking for Stormwater Objectives

Objectives	Score	Rank
Optimal infrastructure, management & design	1117	1
Improve community awareness	831	2
Improve water quality	522	3
Minimise localised flooding from stormwater	390	4
Minimise erosion	322	5
Protect community health and safety	190	6
Improve aesthetics	148	7
Protect aquatic and terrestrial habitats	117	8

5.0 STORMWATER MANAGEMENT ISSUES

Table 5-1 shows a list of issues and possible causes which incorporated the results from Trangie local community, Narromine Shire Council and Trangie Local Aboriginal Land Council. The onsite observation during the site meeting with Narromine Shire Council on 07/06/17 was also taken into consideration. The score of the identified issues are listed in Table 5-2 which link these issues to their objectives, the rankings of the stormwater issues are shown in Table 5-3.

Table 5-1: Stormwater Issues and Causes from Trangie Urban Catchment Area

Issues	Causes
Water Quality	
Nutrients	<ul style="list-style-type: none"> Fertilizer runoff from gardens and farms Runoff from public toilets – stormwater infiltration Possible large nutrient store at old stockyards
Salinity	<ul style="list-style-type: none"> Nature of soil Soil strip related
Erosion	
Creek bank erosion	<ul style="list-style-type: none"> Erosion associated with the river system
Aquatic & Terrestrial Habitats	
Weeds	<ul style="list-style-type: none"> Weeds block drains Agriculture plant pests introduced through the stormwater system
Impact on habitats	<ul style="list-style-type: none"> Changed habitat conditions Accumulated rubbish after floods
Health & Safety	
Mosquito breeding	<ul style="list-style-type: none"> Stagnant water Mosquitoes in creek – kids use creek to bathe in
Community Awareness	
Lack of community awareness	Lack of awareness
Planning Issues	
Access	<ul style="list-style-type: none"> Difficult access to drains for maintenance

Issues	Causes
Flooding	
Localised flooding due to stormwater impacts	<ul style="list-style-type: none"> • Low lying flat ground, lack of slope • Insufficient drainage capacity • Blocked underground drainage which feeds into open grassed drains, which stops the flow of stormwater. • Old infrastructure • Insufficient capacity of culverts • Insufficient pipe size

Table 5-2: The score of the Stormwater Issues

Linked Issues	Objectives and their scores	Total Score
Nutrients and Salinity	<ul style="list-style-type: none"> • Improve water quality (522) • Improve aesthetics (148) • Protect aquatic and terrestrial habitats (117) • Protect community health and safety (190) 	977
Creek bank erosion	<ul style="list-style-type: none"> • Improve water quality (522) • Minimise erosion (322) • Protect aquatic and terrestrial habitats (117) 	961
Weeds and Impact on habitats	<ul style="list-style-type: none"> • Improve aesthetics (148) • Protect aquatic and terrestrial habitats (117) 	265
Impact on natural species	<ul style="list-style-type: none"> • Protect aquatic and terrestrial habitats (117) 	117
Mosquito breeding	<ul style="list-style-type: none"> • Protect community health and safety (190) 	190
Insufficient feedbacks from community consultation	<ul style="list-style-type: none"> • Improve community awareness (831) 	831
Localised flooding due to flat terrain and difficult design constrains	<ul style="list-style-type: none"> • Optimal infrastructure, management & design (1117) • Minimise localised flooding from stormwater (390) • Improve aesthetic (148) 	1655
Ponding due to flat terrain	<ul style="list-style-type: none"> • Optimal infrastructure, management & design (1117) • Minimise localised flooding from stormwater (390) • Improve aesthetic (148) 	1655

Table 5-3: Stormwater Issue Scores (impact) for the Urban Areas of Trangie

Issue	Score	Impact	Frequency
Localised flooding due to lack of infrastructure	1655	5	2
Stagnant water due to flat terrain	1655	5	4
Nutrients and Salinity	977	3	3
Creek bank erosion	961	3	2
Insufficient feedbacks from community consultation	831	3	5
Weeds and Impact on habitats	265	2	5
Mosquito breeding	190	2	3
Impact on natural species	117	1	5

The impact and frequency of each issue has also been listed in Table 5-3. These factors will form benefit index in the option selection stage which will be specified in Section 7.

6.0 STORMWATER MANAGEMENT OPTIONS

Stormwater management options were developed by the facilitator in co-operation with Narromine Shire Council and other stakeholders. Options were linked to Stormwater issues and Objectives. The issue with higher scores represent higher concerns from the local community. Some preliminary options are listed in Table 6-1. Details are listed in Table 6-1. Detailed stormwater treatment strategies will be specified to each site in Section 7.

Table 6-1: Stormwater Issues and Objectives and their link to Stormwater Management Options for Trangie Urban Catchment

Issue	Cause	Objectives	*Score of Issues	Options
Localised flooding due to lack of infrastructure	<ul style="list-style-type: none"> Lack of kerb & gutter and underground drainage system Flat terrain, lack of slope 	<ul style="list-style-type: none"> Optimal infrastructure, management & design (1117) Minimise localised flooding from stormwater (390) Improve aesthetic (148) 	1655	Encourage stormwater retention policies for future development Apply kerb & gutter and underground drainage system to Trangie urban area
Stagnant water due to flat terrain	<ul style="list-style-type: none"> Flat terrain, lack of slope Lack of infrastructure and street drainage system such as kerb & gutter or table drain 	<ul style="list-style-type: none"> Optimal infrastructure, management & design (1117) Minimise localised flooding from stormwater (390) Improve aesthetic (148) 	1655	Encourage stormwater retention policies for future development Apply underground infiltration system
Nutrients and Salinity	<ul style="list-style-type: none"> Fertilizer runoff from gardens and farms Lack of treatment of stormwater runoff 	<ul style="list-style-type: none"> Improve water quality (522) Improve aesthetics (148) Protect aquatic and terrestrial habitats (117) Protect community health and safety (190) 	977	Apply stormwater quality treatment such as wetland or bioretention to Goan waterhole
Creek bank erosion	<ul style="list-style-type: none"> Lack of scour protection to the stormwater pipe outlet Lack of scour protection to the creek bed/bank 	<ul style="list-style-type: none"> Improve water quality (522) Minimise erosion (322) Protect aquatic and terrestrial habitats (117) 	961	Apply riverbank/bed protection measures

Issue	Cause	Objectives	*Score of Issues	Options
Insufficient feedbacks from community consultation	<ul style="list-style-type: none"> Lack of community awareness on stormwater issues 	<ul style="list-style-type: none"> Improve community awareness (831) 	831	Implement community education program in terms of stormwater issues and impacts
Weeds and Impact on habitats	<ul style="list-style-type: none"> Water ponding along street strip due to uneven finished surface 	<ul style="list-style-type: none"> Improve aesthetics (148) Protect aquatic and terrestrial habitats (117) 	265	Remove weeds and apply native vegetation
Mosquito breeding	<ul style="list-style-type: none"> Stagnant water 	<ul style="list-style-type: none"> Protect community health and safety (190) 	190	Apply kerb & gutter and underground drainage system to Trangie urban area Apply underground infiltration system
Impact on natural species			117	

* Score of issues – the higher the score, the higher the priority that these issues are fixed, according to residents' feedback

7.0 STORMWATER MANAGEMENT OPTIONS CATEGORIES

Stormwater management options proposed for Trangie area are classified in the following categories: Natural Processes, Source Control and Structural Options. The options are listed and ranked in Table 7-1: Structural Options. Detailed implementations of the options are shown in the Section 1.0.

7.1. Natural Processes

Many of the stormwater issues in Trangie such as weeds overgrowth and creek erosions are caused by local development. Weeds overgrowth issues have been raised by local communities and observed during the site inspection in several locations in Trangie residential area. Weeds out-compete native vegetation communities, blocked stormwater flow, and may reduce habitat for native animals. Creek bank and bed erosion issues were observed in the creek channel between Saleyards Road and Goan Waterhole. These issues can be mitigated by applying natural processes such as applying native vegetation and creek bank stabilisation.

7.2. Source Control

Source control is often the most cost-effective way to manage stormwater since it is far easier to prevent pollutant from entering the system instead of removing the pollutant from the system. Source control options identified in Trangie include a range of educational program, operational and planning actions

Community education is a process of enhancing people's knowledge, understanding and skills. Applying suitable educational program regarding stormwater quality source control can help to reduce the amount of pollutant from entering into the stormwater system.

Stormwater re-use and detention system can reduce the stormwater runoff that has been caused by the increased impervious area from the development. By encouraging the developers and new land owners to install of the measures such as rainwater tanks and OSDs, the peak flow and overall nutrients from stormwater runoff can be reduced.

7.3. Structural Options

Several hotspots have been identified in Trangie area with Stormwater issues such as stagnant water and weeds overgrowth. These issues were caused by flat local terrain and uneven road verge gradings which cannot be easily solved by applying non-structural options.

Table 7-1: Structural Options

Location	Description	Issues	Options
1	Intersection of Harris Street & Enmore Street	Stagnant water	Apply underground absorption trench at footpath of the intersection (Harris Street & Enmore Street)
2	Intersection of Bimble Box Ln & Mitchell Hwy	Algae, spike-rush and stagnant water	Create a swale and wetland system at Mitchell Hwy near the intersection of Bimble Box Ln & Mitchell Hwy
3	Southern side of Mungery Street between Mullah Street and Swift Street	Stagnant water	Re-grade the swale channel and let it naturally drain to the dam
4	Intersection of Dandaldo Street & Mungery Street	Stagnant water	Apply underground absorption trench
5	Belgrove Street, between Campbell Street and Nicholas Street	Stagnant water	Apply kerb & gutter system and install an absorption trench at the road low point
Reach 1*	Creek/Concrete channel between Narromine Street and Saleyards Road	Stormwater outlet blockage issue	Apply regular maintenance to remove the sediment and pipe outlet blockage
Reach 2*	Creek channel between Saleyards Road and Goan Waterhole	Creek bank/bed erosion issue	Apply creek bed/bank erosion protection measures
Outlet 1*	Stormwater Culverts to Saleyards Road	Stormwater outlet scouring issue	Apply scour protection measures at stormwater outlets
Outlet 2*	Stormwater Culverts to Waterhole	Stormwater outlet scouring issue	Apply scour protection measures at stormwater outlets

*Photos of Reach 1,2 and Stormwater Outlet 1,2 are shown in Figure 7-2 to 7-5



Figure 7-1: Locations of the Stormwater Channel, Creek Reaches and Outlets



Figure 7-2: Existing Stormwater Outlet 1



Figure 7-3: Existing Stormwater Outlet 2



Figure 7-4: Existing Stormwater Reach 1



Figure 7-5: Existing Stormwater Reach 2

7.4. Evaluate Options

The options proposed in Table 7-1 will be evaluated based on their benefits and costs. The methodology developed from the NSW Environment Protection Authority (1997) has been implemented to assess the options. The benefit index includes assessing aspects such as environment impact, social impact, effectiveness of addressing issues and ease of implementation.

7.4.1. Environmental Impact:

The ecology value of Trangie has been assessed and the ecological constraints have been provided. Environmental impact of each option has been assessed against the ecological constraints. The environmental impact weighting has been scaled from 5 to 1, with 5 being the most positive impact on the environment while 1 being the least positive impact on the environment.

Table 7-2: Environmental Impact Score

Impact	Weighting
Significantly beneficial to the overall environment	5
Significantly beneficial to the local environment or beneficial to the overall environment	4
Beneficial to the local environment or moderately beneficial to the overall environment	3
Moderately beneficial to the local environment	2
Minimum beneficial to the environment	1

7.4.2. Community Consultation

Table 7-3 shows the benefit index from the score of the community consultation that has been analysed in Section 6.0. The Ranking of the proposed options based on Cost-Benefit Ratio is shown in Table 7-4. The ranking of detail options is shown in Table 7-5, this table forms a base of the implementation strategy in Section 1.0.

Table 7-3: Community Consultation Score

Issue Score	Community Consultation
<400	Low (1)
400-800	med-low (2)
800-1200	Med (3)
1200-1600	med-high (4)
>1600	High (5)

Table 7-4: Ranking for the Proposed Options based on Benefit Cost Ratio

Options	Cost (20 years Capital + Maintenance)	Benefit Factor			Benefit Index	Benefit Cost Ratio	Ranking
		Effectiveness*	Impact on native vegetation and indigenous species	Community Consultation			
1	\$10,000	med (3)	neutral (3)	high (5)	11	1.100	1
2	\$36,000 (\$16,000 Capital + \$500/a)	med (3)	neutral (3)	high (5)	11	0.306	7
3	\$30,000 (\$10,000 Capital + \$500/a)	med (3)	neutral (3)	high (5)	11	0.367	5
4	\$42,000 (\$22,000 Capital + \$1000/a)	med-high (4)	neutral (3)	med (3)	10	0.238	8
5	\$50,000 (\$40,000 Capital + \$500/a)	med (3)	neutral (3)	high (5)	3	0.060	18
6	\$50,000 (\$5,000/a)	med-high (4)	neutral (3)	med (3)	4	0.080	17
7	\$6,000	med-low (2)	neutral (3)	med (3)	2	0.333	6
8	\$100,000 (\$80,000 Capital + \$1,000/a)	med-high (4)	neutral (3)	med (3)	4	0.040	20
9	\$120,000 (\$100,000 Capital + \$1,000/a)	High (5)	beneficial (5)	med (3)	5	0.042	19

Options	Cost (20 years Capital + Maintenance)	Benefit Factor				Benefit Cost Ratio	Ranking
		Effectiveness*	Impact on native vegetation and indigenous species	Community Consultation	Benefit Index		
10	\$39,000 (\$19,000 Capital + \$1,000/a)	med-high (4)	beneficial (5)	med (3)	4	0.103	15
11	\$30,000 (\$20,000 Capital + \$500/a)	med-high (4)	beneficial (5)	med (3)	4	0.133	13
12	\$14,000 (\$10,000 Capital + \$200/a)	med (3)	beneficial (5)	med (3)	3	0.214	9
13	\$8,000 (\$4,000 Capital + \$200/a)	med (3)	beneficial (5)	med (3)	3	0.375	4
14	\$5,000	med-low (2)	neutral-beneficial (4)	med (3)	2	0.400	3
15	\$15,000 (\$5,000 Capital + \$500/a)	med (3)	neutral-beneficial (4)	low (1)	3	0.200	11
16	\$19,000 (\$9,000 Capital + \$500/a)	med-high (4)	neutral-beneficial (4)	low (1)	4	0.211	10
17	\$25,000	med (3)	neutral (3)	low (1)	3	0.120	14
18	\$45,000	med-high (4)	neutral (3)	low (1)	4	0.089	16
19	\$16,000	med (3)	neutral (3)	low (1)	3	0.188	12

Options	Cost (20 years Capital + Maintenance)	Benefit Factor			Benefit Cost Ratio	Ranking	
		Effectiveness*	Impact on native vegetation and indigenous species	Community Consultation			Benefit Index
20	\$9,000 (\$5,000 Capital + \$200/a)	med-high (4)	neutral (3)	low (1)	4	0.444	2

*Effectiveness to each treatment measure has been analysed based on the hydraulic impact and efficiency.

Table 7-5: Details of the Ranking for the Proposed Options

Issue/Causes	Options		Option Number	Ranking
Localised flooding due to: <ul style="list-style-type: none"> Lack of kerb & gutter and underground drainage system Flat terrain, lack of slope 	Encourage stormwater retention policies for future development		1	1
Stagnant water due to: <ul style="list-style-type: none"> Flat terrain, lack of slope Lack of infrastructure and street drainage system such as kerb & gutter or table drain 	Apply underground infiltration system	Site 1	7	7
		Site 4	5	6
	Re-grad the swale channel to let the stagnant water drain to the dam	Site 3	8	8
	Apply kerb & gutter system and install an absorption trench at the road low point	Site 5	18	18
	Clean the outlet stormwater culverts to let the stagnant water freely pass through the culverts	Reach 1	17	17
Nutrients and Salinity due to: <ul style="list-style-type: none"> Fertilizer runoff from gardens and farms Lack of treatment of stormwater runoff 	Residents' education program in relation to fertiliser use		7	6
	Create a swale and wetland system at Mitchell Hwy near the intersection of Bimble Box Ln & Mitchell Hwy	Site 2	20	20
	Create a swale along the southern side of Mungery Street and converting the existing pond into a wetland	Site 3	19	19

Issue/Causes	Options	Option Number	Option Number	Ranking
	Create a vegetated swale along Reach 2 and converting Goan Waterhole into a wetland	Reach 2	15	15
	Apply riverbank/bed protection measures	Reach 2	13	13
	Apply stormwater outlet scouring protection measures	Outlet 1	9	9
		Outlet 2	4	5
Insufficient feedbacks from community consultation due to <ul style="list-style-type: none"> Lack of community awareness on stormwater issues 	Implement community education program in terms of stormwater issues and impacts		14	3
Weeds and Impact on habitats due to: <ul style="list-style-type: none"> Water ponding along street strip Uneven finished surface 	Remove weeds and apply native vegetation	Site 2	11	11
		Site 3	10	10
Mosquito breeding due to: <ul style="list-style-type: none"> Stagnant water 	Apply kerb & gutter and underground drainage system to Trangie urban area	Site 1	14	14
		Site 3	16	16
		Site 4	12	12
	Clean the blocked culverts under the driveway and redefine the driveway	Site 5	2	2

8.0 IMPLEMENTATION STRATEGIES

Implementation strategies developed from the proposed stormwater management options in Section 7.0 take into account Stormwater Values and objectives described in Section 3.0 and 4.0. After the evaluation process in Section 7.0, these options have been translated into an Implementation Strategy where actions are in accordance to budget, responsibility and timeframe. The implementation strategy is outlined as shown in Table 8-1 below.

Table 8-1: Implementation Strategy

Action	Benefit Cost Ranking	Timeframe/Responsibility	Group Assisting Implementation
Option 1 <ul style="list-style-type: none"> Encourage stormwater retention policies for future development 	1	2020/Council	Council to engage consultants to provide Stormwater Management Policies in Development Control Plan for Narromine Shire Council
Option 20 <ul style="list-style-type: none"> Clean the blocked culverts under the driveway and redefine the driveway for Site 5 	2	2020/Council	N/A
Option 14 <ul style="list-style-type: none"> Residents' education program in relation to fertiliser use 	3	2020/Council	Council to engage consultants provide workshop and relevant training materials
Option 13 Apply stormwater outlet scouring protection measures to Stormwater Outlet 2	4	2021/Council	Council to engage consultants to provide detailed design for the scouring protection measures
Option 3 <ul style="list-style-type: none"> Apply underground infiltration system for site 4 	5	2022/Council	Council to engage consultants to provide detailed design for the underground infiltration system
Option 7	6	2020/Council	N/A

Action	Benefit Cost Ranking	Timeframe/Responsibility	Group Assisting Implementation
<ul style="list-style-type: none"> Apply education program for residents in relation to fertiliser use 			
Option 2 <ul style="list-style-type: none"> Apply underground infiltration system for site 1 	7	2022/Council	Council to engage consultants to provide detailed design for the underground infiltration system
Option 4 <ul style="list-style-type: none"> Re-grad the swale channel to let the stagnant water drain to the dam 	8	2022/Council	Council to engage consultants to provide detailed design for the swale and wetland
Option 12 <ul style="list-style-type: none"> Apply stormwater outlet scouring protection measures to Stormwater Outlet 1 	9	2021/Council	Council to engage consultants to provide detailed design for the scouring protection measures
Option 16 <ul style="list-style-type: none"> Remove weeds and apply native vegetation for site 3 	10	2021/Council	Council to engage ecologist to provide vegetation management plan
Option 15 <ul style="list-style-type: none"> Remove weeds and apply native vegetation for site 2 	11	2021/Council	Council to engage ecologist to provide vegetation management plan
Option 19 <ul style="list-style-type: none"> Apply kerb & gutter and underground drainage system to Trangie urban area 	12	2023/Council	Council to engage consultants to provide detailed design for the kerb and gutter system

Action	Benefit Cost Ranking	Timeframe/Responsibility	Group Assisting Implementation
Option 11 <ul style="list-style-type: none"> Apply riverbank/bed protection measures 	13	2022/Council	Council to engage consultants to provide detailed design for riverbank/bed protection measures
Option 17 <ul style="list-style-type: none"> Apply kerb & gutter and underground drainage system to Trangie urban area 	14	2023/Council	Council to engage consultants to provide detailed design for the kerb and gutter system
Option 10 <ul style="list-style-type: none"> Create a vegetated swale along Reach 2 and converting Goan Waterhole into a wetland 	15	2022/Council	Council to engage consultants to provide detailed design for the swale and wetland
Option 18 <ul style="list-style-type: none"> Apply kerb & gutter and underground drainage system to Trangie urban area (16	2023/Council	Council to engage consultants to provide detailed design for the kerb and gutter system
Option 6 <ul style="list-style-type: none"> Clean the outlet stormwater culverts to let the stagnant water freely pass through the culverts from Reach 1 	17	2021/Council	N/A
Option 5 <ul style="list-style-type: none"> Apply kerb & gutter system and install an absorption trench at the road low point (Site 5) 	18	2023/Council	Council to engage consultants to provide detailed design for the kerb and gutter system

Action	Benefit Cost Ranking	Timeframe/Responsibility	Group Assisting Implementation
Option 9 <ul style="list-style-type: none"> • Create a swale along the southern side of Mungery Street and converting the existing pond into a wetland (Site 3) 	19	2022/Council	Council to engage consultants to provide detailed wetland design
Option 8 <ul style="list-style-type: none"> • Create a swale and wetland system at Mitchell Hwy near the intersection of Bimble Box Ln & Mitchell Hwy (Site 2) 	20	2023/Council	Council to engage consultants to provide detailed swale and wetland design

9.0 MONITORING

EPA's Managing Urban Stormwater: Council Handbook outlines the requirements for a monitoring program for the stormwater management. The monitoring program can be classified into two broad types:

- Water quality and biological monitoring
- Observation monitoring

Stormwater monitoring can be undertaken for the following purposes:

- Assessing the prevailing conditions within a stormwater system or receiving waters
- Obtaining water quality data for use in designing new stormwater management practices
- Deterring the performance of existing stormwater management practices.

The conventional approach to monitoring relies solely on technical monitoring programs, however there is considerable benefit in primarily non-technical monitoring undertaken by the community. If the community is involved in monitoring the success of a plan, a sense of community pride can be achieved if the monitoring indicates that the plan is successful. On the other hand, it can be expected that they will be more likely to modify their behaviour if the objectives of plan are not being met.

Making the results of technical monitoring programs readily available to the community, including both the detailed results of the program and a more widely circulated nontechnical summary, can assist this. Catchment Management Committees can be a useful forum for both undertaking and reporting on monitoring programs. For Council to comply the required monitoring progress, a detailed monitoring program has been stated in Table 9-1.

Table 9-1: Monitoring and Testing Program

Parameters for Testing	Proposed Locations	Responsibility for Financing	Responsibility for Testing
<ul style="list-style-type: none"> • Turbidity • Temperature • pH • Total Suspend Solids (TSS) • Total Nitrogen (TN) • Total Phosphorous (TP) • Chlorophy11 A • Electrical Conductivity 	Outlet 1	Council	Council
<ul style="list-style-type: none"> • Turbidity • Temperature • pH • Total Suspend Solids (TSS) • Total Nitrogen (TN) • Total Phosphorous (TP) • Chlorophy11 A • Electrical Conductivity 	Outlet 2	Council	Council
<ul style="list-style-type: none"> • Turbidity • Temperature • pH • Total Suspend Solids (TSS) • Total Nitrogen (TN) • Total Phosphorous (TP) • Chlorophy11 A • Electrical Conductivity 	Intersection of Bimble Box Ln & Mitchell Hwy (Site 2)	Council	Council

Parameters for Testing	Proposed Locations	Responsibility for Financing	Responsibility for Testing
<ul style="list-style-type: none"> • Turbidity • Temperature • pH • Total Suspended Solids (TSS) • Total Nitrogen (TN) • Total Phosphorous (TP) • Electrical Conductivity 	Southern side of Mungery Street between Mullah Street and Swift Street (Site 3)	Council	Council

9.1. Program for Revision

The stormwater management plan will need to be reviewed in three years. The revision process will involve the implementation of the stormwater management plan and monitoring/reporting process. The revision can be undertaken in two different ways and timeframes these includes: revise the implementation strategy and review the SMP document.

9.2. Revise Council Implementation Strategy

The implementation strategy is the basis for Council's stormwater management program and address each stormwater issue within the catchment in a cost-effective and community-beneficial manner. It is dynamic and should evolve as stormwater works have been completed. Table 8.1 provides a schedule of review for the Narromine Stormwater Management Plan implementation.

Table 9-2: Review for Implementation Strategy

Year	1				2				3				4				5			
Quarter	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
TASKS																				
Interim observational stormwater quality monitoring progress results (Table 8.1)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Catchment audits/surveys			■				■				■				■				■	
Review/revise Implementation Strategy				■				■				■				■				■
Incorporation of Implementation Strategy into Council works program	■				■				■				■				■			
SMP revision																			■	

9.3. Review the SMP Document

Since the stormwater objectives and issues are dynamic, the Stormwater Management Plan will be reviewed once every five years and will involve:

- Results from any monitoring program e.g. Water quality monitoring
- The effectiveness and efficiency of options implementation
- Document what objectives and issues have been addressed
- The effectiveness of satisfying the community's values
- Newly arising issues and objectives
- Improve the local understanding of issues within the catchment
- Identify if additional options need to be developed or if presented options need to be modified

9.4. Mechanisms of Reporting

The process of the implementation of the SMP and monitoring results of stormwater quality will be included in the council's State of the Environment Report where possible and will then be used as a valuable input into future improvements of stormwater management. The effectiveness of pollution control devices needs to be highlighted to pinpoint any weakness of these and aid in improving its effectiveness as stormwater management is a long term process and requires a process of continuous improvement.

APPENDIX A

Photographic Record of Stormwater Issues in Trangie

TRANGIE



Site 1



Site 2



Site 3



Site 4



Site 5



Reach 1



Reach 2



Stormwater Outlet 1



Stormwater Outlet 2

APPENDIX B

Community Involvement and Education

THE FOLLOWING INFORMATION WAS TAKEN FROM THE NARROMINE URBAN STORMWATER MANAGEMENT PLAN

Community Involvement

Community education programs are implementation strategies to prevent, control and treat stormwater by observing substantial environmental improvements, realising economic advantages and enjoying various associated quality-of-life benefits. Community benefits may include aesthetics or improving community relations.

While many day-to-day activities impact on stormwater runoff, there are control strategies that work.

Polluted urban runoff can be prevented in a cost-effective response that comes from preventative, enforceable efforts that integrate all levels of government, design professionals from multiple disciplines, private organisations, and the local community. The following strategies have been proven effective in many stormwater cases:

Preserving and utilising natural features and processes have many benefits. Undeveloped landscapes absorb large quantities of rainfall and vegetation helps to filter out pollutants from stormwater. Buffer zones, conservation design development, sensitive area protection, or encouragement to infill development all try to enhance natural processes and are among the most effective stormwater programs.

Strong incentives, routine monitoring and consistent enforcement to establish accountability are the key element in improving water quality. Programs with high accountability can reduce pollutant loading by 50% or greater.

Establishing a dedicated source of funding ensures long term viability of programs and public support. Detailed funding sources, such as stormwater utilities or dedicated grants, help ensure that stormwater programs are stable over time and help gain public support.

Strong leadership is often a catalyst for success. An individual is needed to champion the project and make it happen.

Effective administration is critical. This allows implementation of broad-based, multi-faced programs.

In summary, together the following summary key points build a strong framework for effective, efficient, and successful stormwater management over the long term.

- Plan and set clear goals.
- Encourage and facilitate broad participation.
- Work to prevent pollution first, rely on structural treatment only when necessary.
- Establish and maintain accountability.
- Create a dedicated funding source.
- Tailor strategies to the region and setting.
- Build broad-based programs.
- Evaluate and allow for evolution of programs.
- Recognise the importance of associated community benefits.

Implement a Public Education Program

Public education is an important part in stormwater management. This action provides ownership to the community by informing the community about values of healthy, well-maintained stormwater system. Public interest will be encouraged through education and ensured community involvement in the stormwater process. For example, leaves, grass clippings and organic matter from yards increase oxygen demands and may contribute nutrients to algae blooms that may result in fish kills. A significant source of nutrient input to water bodies is from grass clippings and leaves washed into drainage systems during storms.

The following are issues that should be addressed;

Appropriate car washing:

Washing cars on lawns and not on roadsides or driveways

Prevent excess waste water from entering stormwater drains

Appropriate litter disposal:

Educate community about effects and consequences of inappropriate litter disposal
outline correct litter disposal behaviour

Appropriate waste oil and other chemical disposal:

Ensure the community is aware of correct disposal for waste such as oil and other chemicals such as herbicides

Provide oil disposal facilities at service stations:

Promote Hunter Water's free domestic chemical collection services

Appropriate disposal of domestic animal droppings:

Encourage dog walkers to implement correct disposal of dog droppings encourage appropriate disposal methods for households (compost bins, garbage bins, sewer)

Appropriate garden and lawn maintenance:

Correct levels of fertiliser use in gardens

Encourage use of low maintenance, native plant species

Discourage hosting lawn clippings from entering the stormwater gutters

Safety awareness:

Prevent contact with high velocity stormwater flows

Encourage Public Involvement in the Stormwater Management Process:

Community involvement will provide a sense of ownership to the community and will aid the management of the urban stormwater system. The value of the stormwater system will be increased with the community's desire to maintain a healthy stormwater system. Public involvement should be encouraged during all stages of the stormwater process, including planning, implementation and review stages.

Various programs such as Streamwatch and Landcare groups, school syllabus and community groups can be used to promote awareness and involvement of the community in managing and monitoring section of the stormwater system.

APPENDIX C

Structural Assessment and Education Options

Possible Stormwater Management Devices

There are a range of devices in the market which assist in the management of stormwater problems. The NSW EPA and other stormwater management authorities in the or states, have published documents which describe these devices and various constraints and limitations associated with each.

Structural Measures

Rainwater Tanks

Rainwater tanks will be used for irrigation of the landscaped areas and toilet flushing within each allotment. The reuse of water collected by the tanks will prevent some stormwater pollutants from reaching downstream waterways.

Gross Pollutant Traps

Gross pollutant trap (GPT) devices are typically provided at the outlets of stormwater pipes draining road runoff. These devices operate as primary treatment to remove litter, particulate matter, oils, grease and coarse sediments prior to discharge to a secondary treatment device.

GPTs have been modelled as CDS units for the purpose of defining treatment capabilities in MUSIC modelling. Alternative types of GPTs will be the subject of additional investigation during the detailed design stage.

WSUD Device Profile – Gross Pollutant Trap

A GPT is a device used to remove litter, organic matter and coarse sediments from stormwater. These devices can be installed within a stormwater system or at the end of it. A CDS unit is shown here as an example. This device uses the water velocity to create a centrifugal force within a mesh basket. Pollutants are trapped in the basket while water can pass through and return to the stormwater system.



Bioretention Basins and Raingardens

Bioretention systems are essentially large raingardens which comprise of an engineered filter media profile planted with drought tolerant species suitable for pollutant removal. These systems form part of the treatment train for the upstream sub-catchments and are utilised to facilitate the removal of fine sediments and sediments in stormwater runoff from the development, prior to discharge downstream.

The bioretention basins are to be constructed as standalone features located in available open space areas or easements.

Gross pollutants and coarse sediments will generally be collected in the entry areas of the raingardens, which can be designed as a forebay to contain litter in the entry area for ease of maintenance. These features will be detailed at the next design stage.

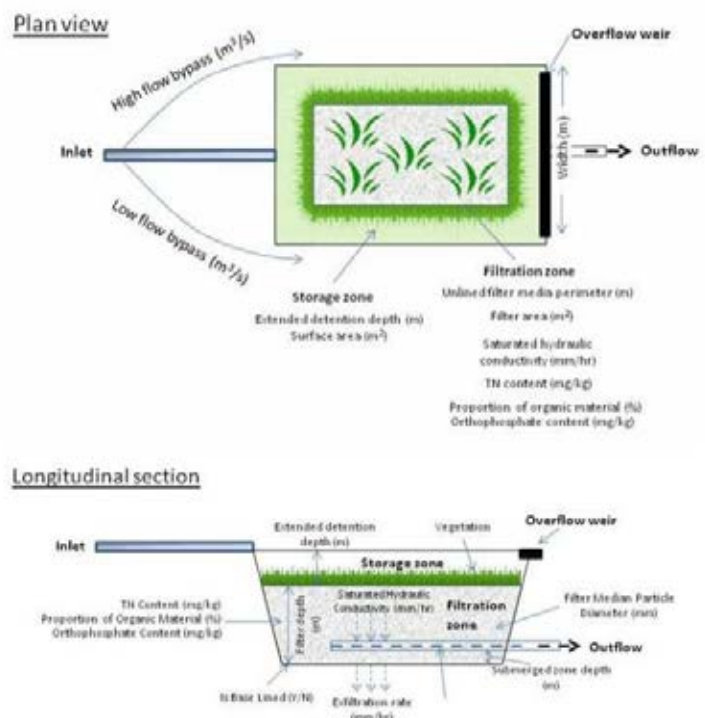
The proposed basins will generally consist of an extended detention zone designed to detain and treat frequent flows from the upstream catchments. The sizes of the basins have been configured to service the long-term developed catchments that will discharge to them. The surface of the basins will be mass planted with native, drought-tolerant species and the filtration beds will be typically 500mm deep.

WSUD Device Profile – Bioretention Systems

A bioretention basin is a special type of garden bed designed to treat stormwater and improve runoff quality. A bioretention system works by:

- collecting polluted stormwater from impervious urban areas
- storing stormwater at a shallow depth, allowing coarse sediments to settle out
- allowing stormwater to pass through specially selected soil media which traps smaller sediments and, using the biological action of plants and bacteria to remove nutrients
- returning treated stormwater to the stormwater system through a slotted pipe in the base of the garden bed profile.

Typical Detail – Bioretention



Bioretention Basin




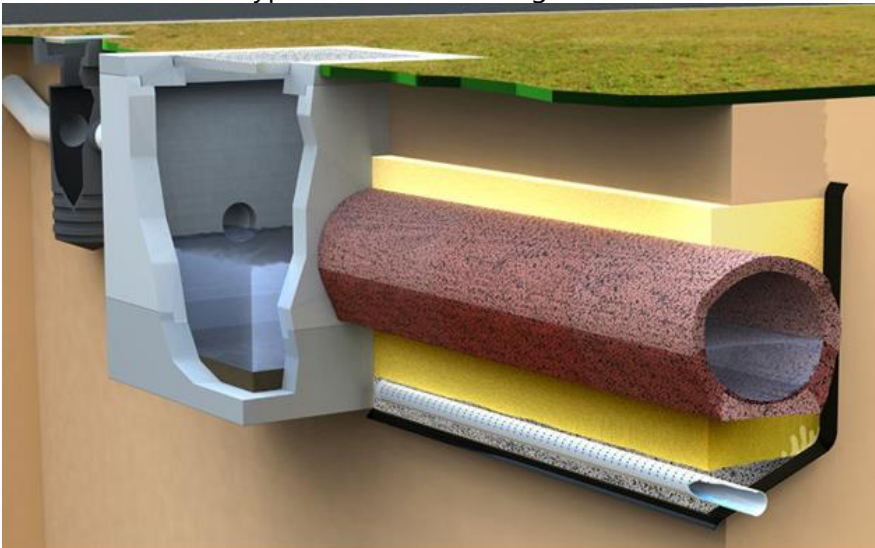
Constructed Wetlands

A constructed wetland is a large open shallow water body with extensive emergent macrophytes (large aquatic plants whose parts protrude above the waterline). Epiphytes (algae growing on the surface of aquatic macrophytes) are often associated with macrophytes in wetlands. Three key pollutant retention processes occur in constructed wetlands:

- Enhanced sedimentation
- Fine particle filtration
- Nutrient uptake by sediments, biofilms (eg epiphytes) and macrophytes

Sandfilters

Where above ground systems are not feasible, underground treatment systems comprising of porous pipes and sandfilter media are proposed to treat stormwater. A sandfilter is proposed to treat runoff that drains to the northern valley and is located beneath a grassed basin. Refer to Appendix C for proposed location of the sandfilter. Hydrocon pipes have been adopted for the purpose of defining pollutant removal relationships in MUSIC. Other products may also be suitable, and this would be the subject of further investigation at detailed design stage.

WSUD Device Profile – Sand Filter	
<p>Specially designed porous concrete pipes through which water is filtered to remove pollutants are used. They are particularly effective at removing suspended solids and phosphorus. The water that exfiltrates from the pipes is directed through a sand filter to remove nitrogen. A perforated pipe at the base of the sand filter collects the treated water and returns it to the pit downstream of the system from where it returns to the outlet pipe.</p>	<p>Porous Concrete Pipes</p> 
	<p>Typical Sandfilter configuration</p> 

Integration with Urban Design

The proposed stormwater quality devices will integrate with and enhance the existing landscape. Gentle vegetated batters will provide a safe and suitable appearance. Planting will consist of low maintenance native grasses.

Operation and Maintenance

Operation and maintenance of the proposed treatment systems are straightforward and are similar to maintenance of standard gardens and drainage infrastructure. Typical maintenance requirements are:

- Maintain bioretention vegetation, remove weeds and litter as required
- Empty GPT sump and basket every 3-6 months and after significant rainfall events
- Flush bioretention basin underdrainage as required (allow every 5 years)
- Replace bioretention media every 20-30 years (likely top 150mm)

Operation and Maintenance plans for the stormwater elements are proposed to be developed during detailed design. A Water Balance assessment will inform development of the Operation and Maintenance plan for the water bodies for aesthetic reasons as well as to effectively manage algae in the extended dry periods.