Clare and Gilbert Valleys Council

Stage 2 SMPs for 7 Townships

TARLEE STORMWATER MANAGEMENT PLAN

APPROVED FINAL

July 2020

CLARE & GILBERT VALLEYS COUNCIL

Government of South Australia
Stormwater Management Authority

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Australian WATER Environments

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The report contains recommendations for stormwater management. Council will seek funding and resources for these recommendations from a range of sources. The availability and timing of funding and resources will determine the order and staging of the works.

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1 Introduction

1.1 Background

The Clare and Gilbert Valleys Council (Council) engaged Australian Water Environments (AWE) to prepare a Stormwater Management Plan (SMP) for Tarlee. The SMP builds upon the outcomes of the recently completed floodplain mapping for the town prepared by AWE (2013).

The purpose of SMPs is outlined by the Stormwater Management Authority (SMA), as follows - to manage stormwater on a total catchment basis with the relevant Natural Resources Management Board (NRMB), local government authorities and state government agencies. The aim is to work together to develop, implement and fund a coordinated and multi-objective approach to stormwater management in the area. This allows for consistent management that addresses existing problems and identifies opportunities for providing a range of benefits through multi-objective planning, including stormwater reuse where feasible.

This SMP investigates ways to alleviate existing stormwater and flooding problems and provides flood protection for public and private assets. It aims to assess flood mitigation options, investigate opportunities for stormwater reuse, including Managed Aquifer Recharge (MAR), without compromising flow management or flood mitigation infrastructure. The SMP also explores opportunities for environmental enhancement in the design of stormwater infrastructure. Environmental enhancement may be in the form of improved water quality and reduced roadside erosion, and increased biodiversity. The SMP will assess stormwater management options and rank their priority in accordance with the format recognised in the SMA SMP Guidelines with verification against Council wide assessment criteria.

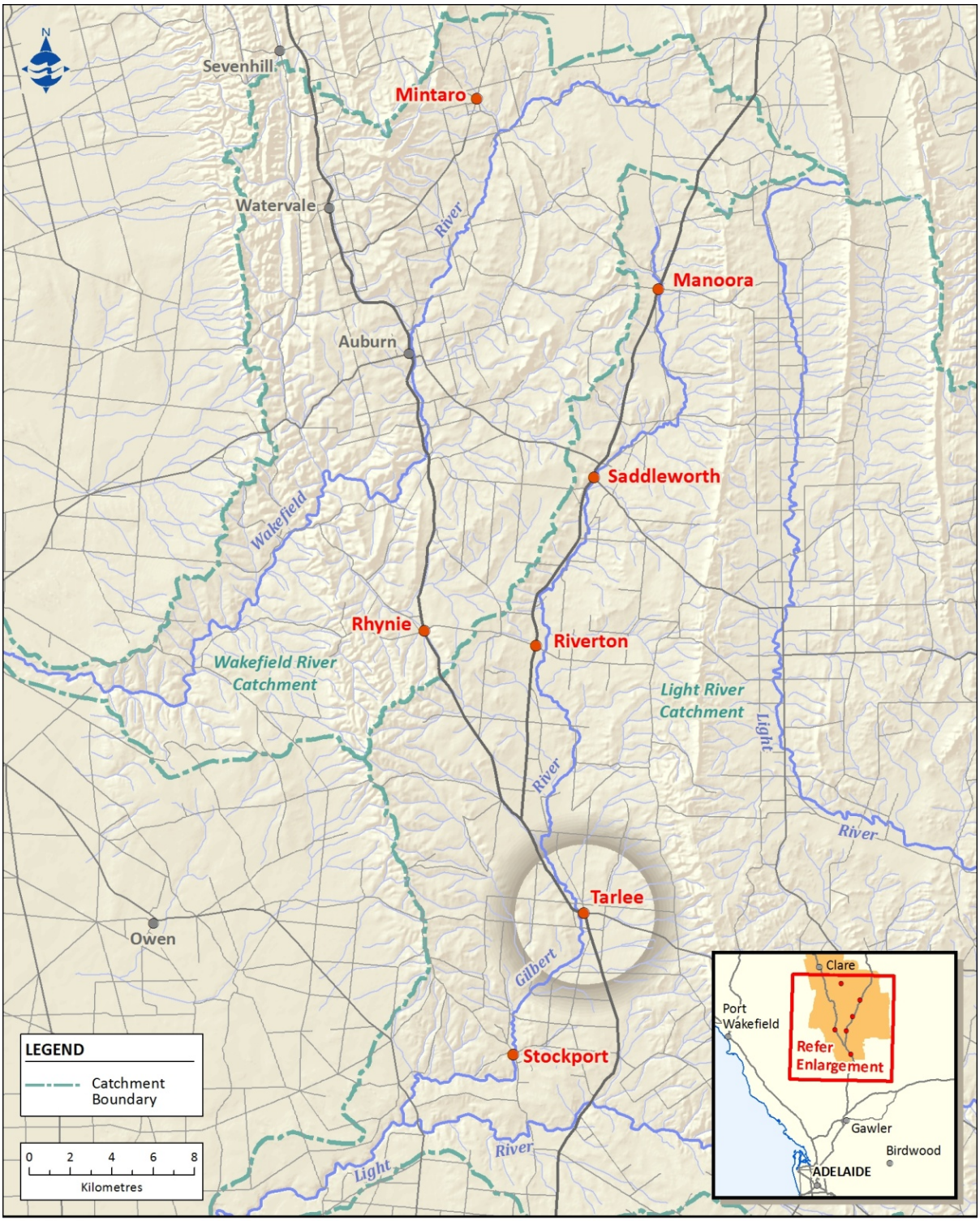
This SMP has been developed in conjunction with developing SMPs for six additional townships for the Council, including: Manoora, Saddleworth, Riverton, Stockport, Mintaro, and Rhynie. These towns are located approximately 80 km – 130 km north of Adelaide. The location of these towns in relation to each other is shown on the following page in Figure 1-1.

Tarlee, Manoora, Saddleworth, Riverton, and Stockport are located along the Gilbert River, which is a major tributary of the Light River Catchment, while Mintaro and Rhynie are within the Wakefield River catchment. Over time, the catchments have been cleared for farming and viticulture purposes, and dry land agriculture is the current dominant land use.

This report has been prepared on the basis of the best information, research and knowledge currently available to the Council. The report contains a range of recommended actions for consideration. The availability and timing of funding and resources will determine the order and staging of these actions.

Assistance in the form of funding and/or resources will be sought from the following:

- **Australian Government - grants and subsidies**
- **State Government of South Australia - grants and subsidies**
- **Private sector – developer contributions**
- **Council – administration, implementation and funding**
- **Community – volunteer support**



14009 D100 v5 Location Plan 140618
Last Updated: 18/06/2014

FIGURE 1-1: LOCATION

1.2 History and Nature of the Problem in the Region

The region has experienced flooding since its settlement, and this has become more apparent over recent years. Flooding in the townships has been caused by over bank flows from the rivers (e.g. Gilbert River and Wakefield River tributaries) and from runoff from adjacent hills and slopes. Inadequate stormwater systems/infrastructure within the towns is also contributing to flooding problems. Flooding events have been known to cause inundation and property damage, disruption to road and rail infrastructure. Council is also concerned over the quality of water in these river systems and the impacts the towns may be having on water quality.

1.3 Consultation and Development of the Plan

Council was successful in applying for funding from the SMA's Stormwater Management Fund to assist in preparing the floodplain mapping and this SMP.

The SMP was developed under the direction of a Steering Committee comprising representatives from Council, SMA/Department of Planning, Transport and Infrastructure, Northern and Yorke NRMB and the Bureau of Meteorology (BoM).

The community has also provided input in developing the SMP by confirming the nature and extent of flood and stormwater issues and were given the opportunity to provide comment on the proposed management strategies through a series of community meetings.

1.4 Legislative Context

The Local Government (Stormwater Management Agreement) Amendment Act 2016 came into operation in April 2016. This established the Stormwater Management Authority and new financing and governance arrangements for stormwater management and flood mitigation throughout South Australia.

The SMA implements the Stormwater Management Agreement and operates as the planning, prioritising and funding body in accordance with the Agreement. The SMA is charged with:

- Working with Councils to facilitate and coordinate catchment stormwater management planning;
- Allocation of State funding to projects in coordination with Council and other sources of financing; and
- Facilitating cooperative action by all relevant public authorities in the planning, construction and maintenance of stormwater management works.

The framework established by the Stormwater Management Act requires councils to prepare stormwater management plans on a catchment basis, and to implement infrastructure works in accordance with the catchment plans.

The process and content by which stormwater management plans are developed have been formalised by the State Government via the SMA in a guideline entitled *Stormwater Management Planning Guidelines*.

South Australia's legislative framework provides a number of other legislative tools and policy tools to address water management ranging from state-wide legislation to regional and local policy.

One of the key mechanisms for achieving the desired outcomes of integrated water management is to ensure that the objectives of the stormwater management plan meet and contribute to other State and National natural resource management policies and strategies. These strategies in turn assist in the implementation of the desired water management outcomes for townships.

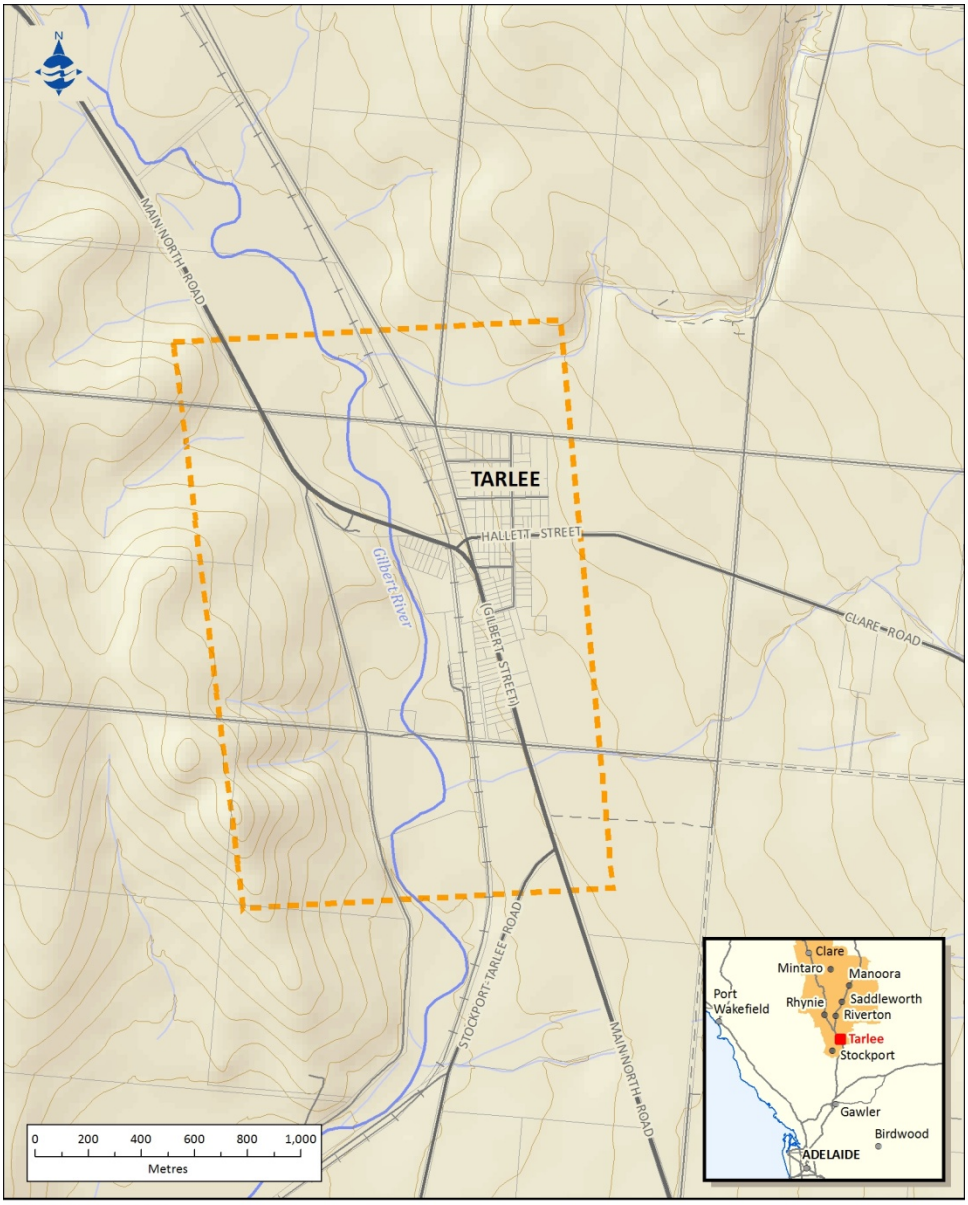
This SMP has been developed in accordance to the requirements of the Stormwater Management Planning Guidelines.

2 Description of the Study Area

2.1 Study Area Boundary

Tarlee is located approximately 80 km north from Adelaide in the Mid North region of South Australia. The town is situated on the eastern bank of the Gilbert River on the Barrier Highway. The town provides a link between the Barossa and Clare Valley wine regions and is known as the southern gateway to the Gilbert Valley (Strategic Directions Report 2012/13).

The study area for the stormwater management plan is shown in Figure 2-1.



14009 D101 v1 Study Area 140219
Last Updated: 21/02/2014

FIGURE 2-1: STUDY AREA

2.2 Climate and Soils

The soils in the region are predominantly red topsoil overlaying a limestone and tend to be free-draining but have an ability to hold water, particularly in the dryer months.

The climate associated with the study area is a temperate climate with dry summers (low rainfall), and rainfall generally occurs in the winter months.

The long term average rainfall information is based on information provided by BOM for the general region and is approximately 540 mm/yr. The average precipitation and evaporation for each month in the general region is shown below in Figure 2-2.

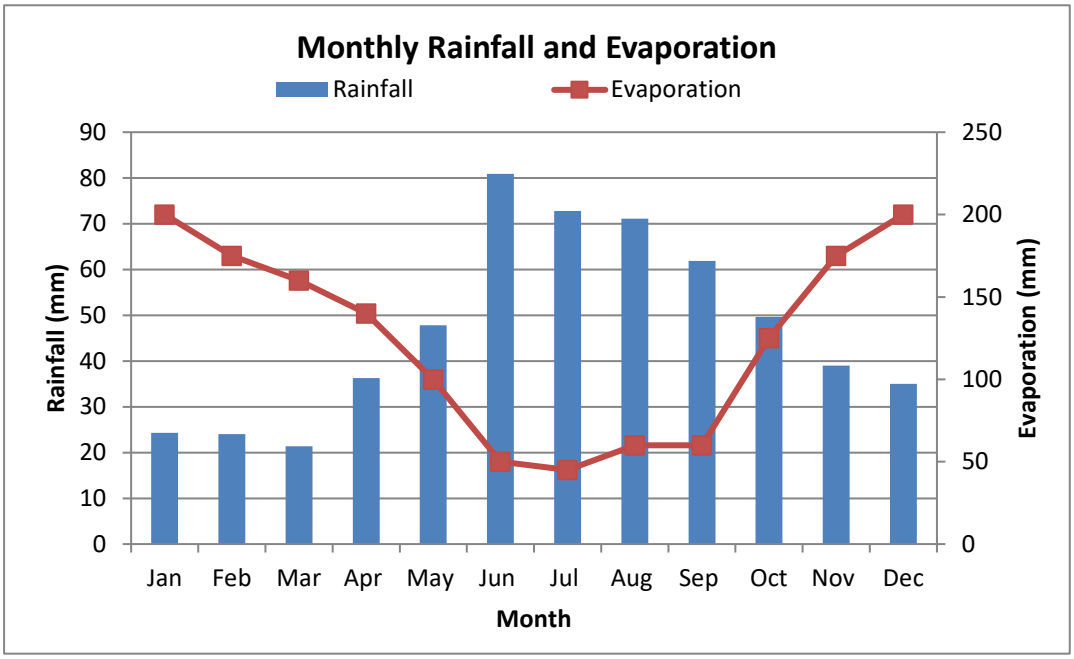


FIGURE 2-2: MONTHLY RAINFALL AND EVAPORATION

2.3 Ecology

The ecological diversity of the region has been significantly altered due to anthropogenic influences and is diminished to pockets of remnant habitats of high ecological value. Overall the ecological health of the systems is highly degraded. The systems have been dramatically modified by the impacts of European settlement and changes in land uses over time. Riverine habitats have been altered from the clearance of native riparian and floodplain vegetation; the loss of in-stream complexity due to channelisation, incision and deposition of sediment; stock grazing; and the introduction of exotic plants and animals (DWLBC, 2004). The original flow regime of the watercourses has been modified by vegetation clearance, agricultural development, farm dams and groundwater extraction. The structure and shape of watercourses have also changed over time, as well as the loss of connectivity with the floodplains.

Less than 3% of native vegetation remains in the Gilbert River catchment which provides habitats for a range of plant and animal species including orchids, native mammals, bird species and reptiles, as well as providing valuable seed reserves to re-establish vegetation (Rural Solutions, 2005).

Prior to European settlement, the in-stream vegetation of the Gilbert River comprised herbland/sedgelands consisting of common reed *(Phragmites australis)* and salt club rush *(Bolboschoenus cadwellii),* however due to land clearance, increased overland flow and sedimentation from past agricultural practices, the common reed now dominates (DWLBC, 2004). The reeds provide valuable food and shelter for fish, frogs, macroinveterbrates and birds and play an important role in preventing stream erosion by slowing the velocity of water.

The condition of riparian vegetation along the Gilbert River and tributaries is generally poor. However, there are some areas of good sedgelands especially north of Saddleworth, north of Tarlee and between Tarlee and Stockport and these are under threat from rising salinity (Rural Solutions, 2005).

The receiving environment from Tarlee runoff is the Gilbert River, which merges downstream with the Light River, which finally flows through the estuarine environment comprising samphire and mangrove vegetation as the river enters Gulf St Vincent.

2.4 Hydrology of the Catchment

Tarlee is situated on the eastern bank of the Gilbert River. The Gilbert River commences just north of Manoora and flows south through the towns of Manoora, Saddleworth, Riverton, Tarlee and Stockport where it joins the Light River just west of Hamley Bridge, before flowing out to the Gulf St Vincent between Dublin and Two Wells. There are a number of tributaries that enter the Gilbert River, including Macaw Creek, Salt Creek, Coghill Creek and other un-named Creeks (Rural Solutions, 2005).

The catchment area of the Gilbert River at Tarlee is approximately 320 km^2, and as rural land use dominates the catchment area it is considered to have a pervious landscape. There are no major storages along the Gilbert River and the channel types are considered to be 'natural'.

Within the township itself the railway line creates a levee between the township and the Gilbert River.

Topographic features of relevance to this SMP include:

- Two bridges cross the Gilbert River:
    - New bridge, high span large capacity;
    - Old stone bridge, low capacity small span between pillars, directly downstream of new bridge;
- Ford crossing downstream of township;
- Two significant local catchments to the east of the township which create inflow, one to the north (14.5km^2) and one to the south (14.2km^2); and
- Several small stormwater networks.

2.5 Township Population and Development Pressure

Council's Strategic Directions Report 2012/13 included information on population projections and stormwater management derived from its Water Security Plan (2011). According to that information the population growth in the Council region is expected to grow to 9,795 people by the year 2031 –

an average around 0.6 per cent per annum over the 25 years 2006 to 2031 or 15.5 percent in total. This is somewhat higher than projected growth at the state level over this period (11.0 percent).

The projected population growth for Tarlee along with the other 6 townships in the project is shown below in Table 2-1.

TABLE 2-1: PROJECTED POPULATION

Town	2006 population	2031 population	Projected annual growth
Tarlee	288	318	0.38%
Riverton	723	1000	1.1%
Rhynie	362	370	0.08%
Saddleworth	425	450	0.22%
Manoora	277	280	0.04%
Mintaro	223	246	0.37%
Stockport	234	259	0.02%

According to Council's Strategic Directions Report 2012/13, population growth in the region should primarily be channelled into Clare, Riverton and Saddleworth by utilising the benefit of existing community infrastructure and appropriately zoned land. The remaining towns were to retain their small scale village character, but still to allow for modest growth. Tarlee was seen to have undeveloped land to cater for any immediate expansion of the township.

2.6 Existing Stormwater Assets

The formal stormwater infrastructure in Tarlee comprises several short sections of pipes and roadside drains that collectively divert flows towards the watercourses in the township.

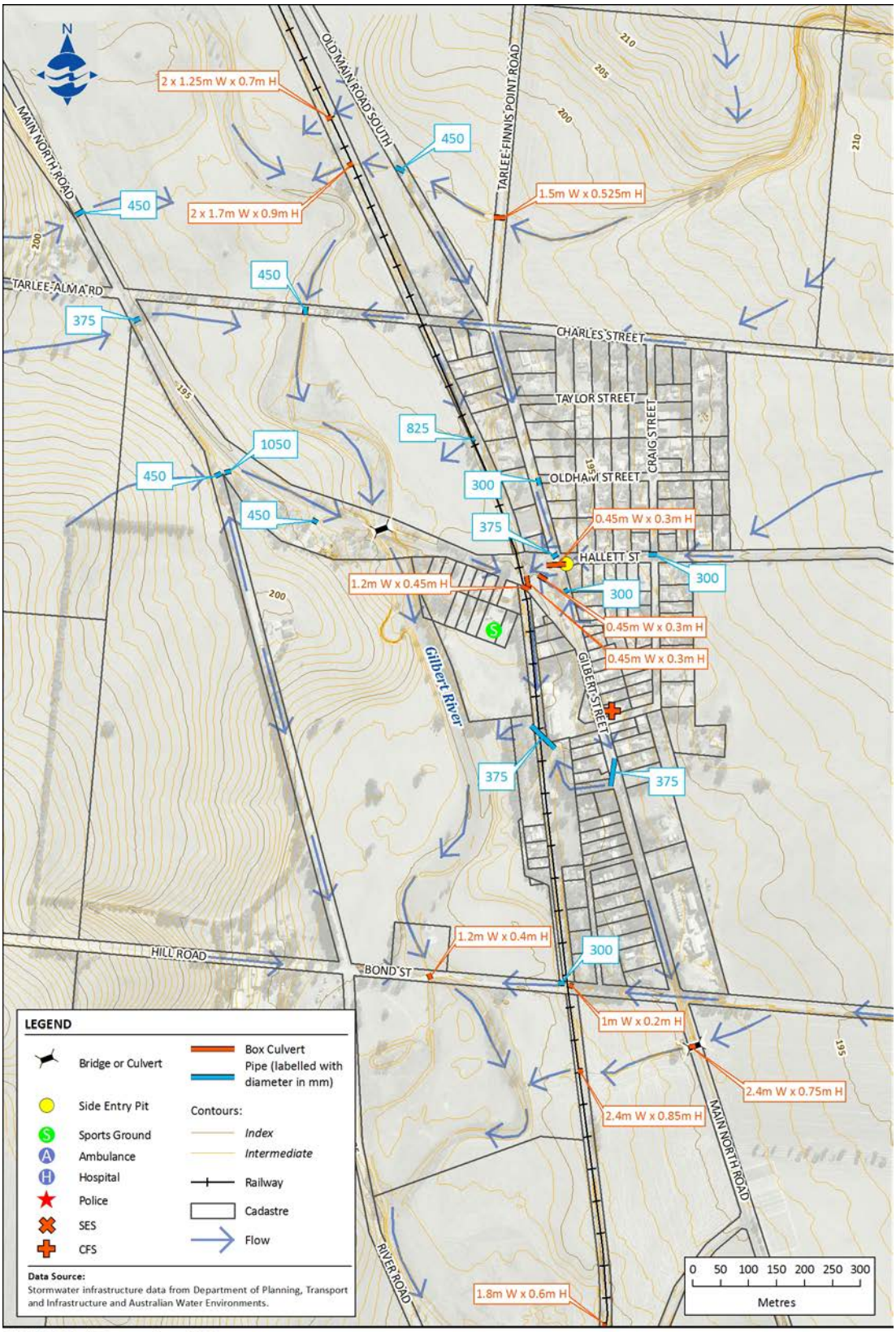
Informal infrastructure in the town includes the railway line which creates a levee between the township and the Gilbert River.

The north eastern portion of Tarlee drains east to west towards Gilbert Street, where a series of culverts near the intersection of this street and Hallett Street direct most of the flows to a informal channel running north to south along the eastern side of the railway line. A 375mm diameter pipe under the railway discharges these flows into the Gilbert River. The remainder of the flows on Gilbert Street either drain further south or are also directed towards the 375mm pipe under the railway line via a culvert under Gilbert Street.

The southern section of the township drains north to south and east to west towards the Gilbert River via a roadside channel along Bond Street and an additional culvert under the railway line at that location.

Culverts at road crossings and the railway line as well as a ford crossing are in place to direct the flows of two minor watercourses north and south of Tarlee into the Gilbert River.

Existing stormwater assets at Tarlee are shown in Figure 2-3.



14009 D108 v5 Tarlee Stormwater Assets 150123
Last Updated: 23/01/2015

FIGURE 2-3: EXISTING STORMWATER ASSETS

3 Identification of Problems and Opportunities

3.1 Social, Economic and Environmental Issues

3.1.1 Economic

In December 2010, flooding (water inundation) occurred in Tarlee as well as other towns in the region. The floods affected houses, sheds, fences, traffic disruption and accessibility, as well as causing significant damage to Council infrastructure, such as bridges and roads, which all involve significant economic costs.

3.1.2 Social

The social impacts of flooding and poor stormwater management are often difficult to quantify in monetary terms. These impacts are related to the physical and mental health of individuals, environmental impacts and disruption to essential community services and operations. They can include aspects such as the following:

- Loss of life, personal injury and associated losses and expenses;
- Destruction of memorabilia (e.g. family photos);
- Loss of heritage and cultural features;
- Loss of amenity, recreational value and aesthetics;
- Increased medical costs and reduced life expectancy associated with increases in levels of sickness in a community following a disaster;
- Emotional stress and mental illness associated with experiencing damage to family homes and businesses, including:
    - Replacement of damaged property, particularly if there is no flood insurance or it is insufficient;
    - Living in temporary accommodation;
    - Children attending a different school;
    - Death of pets; and
    - Loss of business goodwill.

3.1.3 Environmental Values

The condition of watercourses in the catchment and downstream has been described earlier in this report in chapter 2. In summary, the downstream (receiving) environment is the Gilbert River, which merges downstream with the Light River, which finally flows through the estuarine environment comprising samphire and mangrove vegetation as the river enters Gulf St Vincent. Erosion and sedimentation caused by stormwater and flooding in Tarlee can result in a decline in water quality and ecological health of downstream environments. Therefore, measures to control erosion and sedimentation arising from stormwater and flooding in Tarlee can help protect water quality and ecological health of these downstream environments.

There is not much water quality data available, however this SMP includes water quality principles to protect downstream environments. The water quality targets for both new and existing developments in the region are designed to reduce the impact on the receiving environments whilst preserving environmental values.

Although there is no available water quality data at present, visual assessment suggests the watercourses in the area of the SMP are in a moderate condition, despite the region as a whole being dramatically modified since European settlement.

Environmental values are those that the community place on the environmental services. The strategy underpinning the determination of the environmental values for the SMP is the National Water Quality Management Strategy (NWQMS). The NWQMS) aims to enable Council and community groups to protect the health of water bodies and waterways. Environmental values for this SMP can be guided by the objectives of this Strategy which include the following (but not limited to):

- To ensure the water quality monitoring of waterways and regulation for the discharging of pollutants into waterways adheres to the agreed water quality objectives;
- Provide a strategic direction for the management of all watercourses as well as protecting ecosystems and not compromising the economical well being of the community; and
- Prioritise funding for environmental management which will ultimately lead to improved water quality.

As part of developing this SMP, environmental values were ascribed for the region. These values reflect the community's value of the watercourses. Management actions need to safeguard these values. These values are shown in Table 3-1 on the following page.

Whilst the system downstream of the town is highly disturbed, there are areas within the SMP which may respond well to efforts to improve the system. Other stakeholders, such as the NRMB, are also working towards achieving an improved system and therefore it is recommended that such efforts be undertaken in a coordinated manner.

This SMP provides opportunities to control erosion and sedimentation arising from stormwater and flooding in Tarlee which can help protect water quality and ecological health of the downstream environments.

TABLE 3-1: SURFACE WATERCOURSES ENVIRONMENTAL VALUES

Environmental Values	Supporting Details
Aquatic Ecosystems	Supporting highly disturbed systems (**HD**) (see below)
	Highly disturbed systems (**HD**). These are degraded systems likely to have lower levels of naturalness. These systems may still retain some ecological or conservation values that require protecting. Targets for these systems are likely to be less stringent and may be aimed at remediation and recovery or retaining a functional but highly modified ecosystem that supports other environmental values also assigned to it (e.g. primary industries).
Primary Industries	**Irrigating** crops such as vines, crops, etc
	Water for **farm use** such as in fruit packing or milking sheds, etc
	Stock watering
	Human consumption of wild or stocked fish or crustaceans
Recreation & Aesthetics	**Visual appreciation** with no contact with water such as picnicking, bushwalking, sightseeing
Cultural & Spiritual	**Cultural and spiritual** values including the cultural values of traditional owners

3.2 Riverine and Local Flooding

3.2.1 Floodplain Mapping

AWE (2013) undertook floodplain mapping for the town, including riverine and local flooding. This is summarised below and also shown in 100 year ARI event inundation maps in Appendix A.

3.2.2 Riverine Flooding

A description of the riverine flooding is provided below.

20 Year ARI Event

At Tarlee, the Gilbert River is mostly contained within the channel. Downstream of the township the width of the river increases with substantial portions of the floodplain inundated.

Most of the areas inundated outside of the channel are from the two eastern tributaries. Most of this is shallow sheet flow, with some ponding behind the railway line and roads. Typically, the flow is less than 100mm deep, except for channels and roadways where it is deeper.

100 Year ARI Event

In a 100 year ARI event the flow in the Gilbert River is not confined to the main channel but flooding from the Gilbert River is largely kept to the western side of the railway line. Floodwaters pool next to Main North Road. The Town Hall and showgrounds area would be inundated.

The flood extent of the tributaries is not significantly greater than the 20 year ARI event. Most of the increase in flood extent is away from the township.

The time from the onset of rainfall in the catchment to the time of peak flooding at Tarlee is approximately 18 hours.

500 Year ARI Event

The flooding extent and water level increases in a 500 year ARI event, with the flood extent from the main channel extending to the east of the railway line in some areas. Residential properties are mostly outside of the inundation extent.

3.2.3 Local Flooding Assessment[1]

A description of the local flooding is provided below.

Tarlee is located on the side of a hill sloping from the east to the Gilbert River in the west. There are two major catchments, one to the north and one to the south of the township. There are also a number of smaller catchments which run through the township.

Most of the flow through the town is relatively shallow, i.e. less than 100mm in a 100 year ARI event, however there are a number of locations where it pools to greater depths and creates potential inundation issues for a number of properties. Refer to flood inundation maps in Appendix A.

There are also two tributaries further to the east that historically would have flowed east of the town and enter the Gilbert River downstream of Tarlee. However, channel works and road crossings have impaired the capacities of these systems. In large intense local storms flood waters have spilt out from these crossings (one at the northern extension of Charles Street, the other on the Clare Road) and flowed down roads into the Tarlee township. Many of the issues experienced in 2010 were caused by these eastern tributaries.

3.3 Properties and People at Risk of Flooding

Flood maps (based on riverine flooding for the 100 year ARI event) and aerial photography were used to identify properties/dwellings at risk of flooding. The number of people at risk of flooding in a 100 year ARI event was determined by analysing the number of dwellings at risk of flooding and the average number of people per dwelling.

[1] Runoff causing local flooding issues was assumed to be caused by rainfall falling directly on the townships and the immediate surrounding slopes. This whole area was typically contained within the Digital Elevation Model (DEM) contained within the TuFlow model for each town. In some cases, inflows from small catchment areas that lay outside the DEM could also cause local flooding issues, and in these cases the external catchment inputs were modelled in RORB and hydrographs included as boundary conditions to the TuFlow Model.

The population and number of properties in Tarlee at risk of flooding in a 100 year ARI event are shown in the table below.

TABLE 3-2: POPULATION AND PROPERTIES AT RISK IN A 100 YEAR ARI EVENT

Population at risk of flooding	No. of properties at risk of flooding in each flood hazard zone (Riverine flooding)			
	Low hazard	**Med hazard**	**High hazard**	***Total***
54	9	6	1	*16*

There are no additional properties at risk of inundation from direct rainfall (local storm) only.

3.4 Impacts of Future Development on Flooding

It is important to understand if future development is planned in the area and what impacts this may have on flooding. Any redevelopment of these will need to take into account of the flood extent and depth maps prepared for this SMP to reduce the risk of being flooded, as well as to reduce any impact they may have on flood paths and flood behaviour.

As outlined previously in chapter 2.5 of this SMP, Tarlee is not anticipated to expand in the immediate to medium term. It is to retain its small scale village character, but still to allow for modest growth.

Most of the township is zoned as 'Township', with a potion within this area zoned as 'Bulk Handling', and another area to the south zoned as 'Industry'. Surrounding land is zoned 'Primary Production'. There is no 'Deferred Urban' zone and therefore future development is likely to be limited to infill development.

3.5 Exploring Opportunities

This SMP explores opportunities for better managing the risk of flood, including structural and non-structural flood mitigation measures. Non-structural measures include aspects such as flood warning and preparedness and better integration between stormwater management and Council's Development Plans.

Harvesting of stormwater as an alternative source of water is desirable option for many towns, for purposes such as greening of public open space, irrigating sports ovals and other recreational areas. The SMP describes options for water harvesting including aquifer storage, and the likely effectiveness of any scheme.

Whilst harvesting of stormwater is to be promoted, any scheme should also have regard to water dependent ecosystems downstream.

In addition, the design of stormwater infrastructure has consideration of potential environmental enhancement and benefits to watercourses and receiving environments, such as through establishing roadside stormwater infiltration systems which provide reuse and water quality improvement benefits.

4 Stormwater Management Objectives

4.1 Approach

The development of stormwater management objectives has had consideration of the earlier floodplain mapping and technical assessments, consultation activities and the requirements of the SMA Guidelines.

The project has been overseen by a steering committee including representatives from Council, DPTI/SMA, the Northern and Yorke NRMB, and more recently from BOM. Regular meetings have been held throughout the project to discuss progress, issues arising, and to confirm the approach to technical investigations and community consultation.

Consultation with the community was undertaken in August 2013 to identify issues and opportunities for stormwater and flood management. This information helped to determine the objectives of the SMP. A summary of the issues raised by the community is shown on the following page in Figure 4-1, and in Appendix B.

4.2 Stormwater Management Objectives

With consideration of the above technical information, consultation feedback and SMA Guidelines, the following stormwater management objectives have been developed for Tarlee:

- Reduce the impact of nuisance local flooding, e.g. pooling water adjacent Main North Road;
- Provide an acceptable level of protection of assets from local and regional flooding (Gilbert River);
- Manage stormwater to benefit the community and explore opportunities for the beneficial use of stormwater runoff;
- Develop an appropriate, and sustainable, stormwater management system which has consideration of operational and maintenance requirements and costs;
- Continue to improve maintenance processes to optimise the water quality and water quantity management services performed by the stormwater network;
- Minimise adverse impacts on downstream environments resulting from stormwater management and any water harvesting activities;
- Use the planning system to achieve desirable outcomes for new developments, open spaces, recreation and local amenity;
- Manage rural catchment contributions such that the management, control and harvesting of both rural and urban runoff is efficient and effective; and
- Seek opportunities to protect water quality and ecological health of the downstream environments.

A brief description of these objectives follows.

Reinstate creek line and explore opportunities to detain water.

Railway embankment blocks flow and channels water to the south. Look into putting a drain under railway line.

Spoon drain across Charles Rd obstructs flow and causing overtopping of banks.

Formalise drain along road side of Charles St.

Check road drainage - enters property to the south.

Flooding during high flows along Taylor Street.

Local drainage issue at this intersection.

Check effectiveness of existing bank to improve protection of houses in low lying areas.

Demand for water for sporting areas. Investigate MAR potential.

Blocked culvert.

Investigate potential for street tree watering.

Bridge over creek along Kapunda Rd is too small and blocks up. Investigate method to stop water that overtops bridge going down Kapunda Rd.

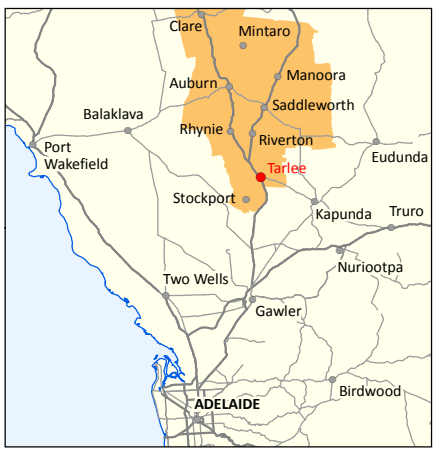
Pipe is not effective due to raising of ground level between Main North Road and the silos.

Flow path causes flooding.

Potential alteration to creek to the east may have caused changes to flow, resulting in flooding along Charles Street, Craig Street and Oldham Street. Investigate methods to manage flows.

Insufficient stormwater infrastructure.

Blocked drains and creeks.



LEGEND

Contours:
- *Index*
- *Intermediate*
- Railway
- Road Edge
- Cadastre

- Flood control/management
- General comment
- Water reuse
- Water quality/biodiversity/ erosion control

0 50 100 150 200 250 300

Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Tarlee

Issues and Opportunities Raised by the Community

Data Source:
Aerial Imagery, Road Edge and Contours from Aerometrex; Road Names and Cadastre from Clare & Gilbert Valleys Council; Railway Alignment from DTEI.

14009 D003 v6 Tarlee issues and opportunities 140821
Last Updated: 21/08/2014

Figure 4-1

4.2.1 Local Flooding

The road network and some pits and pipes currently provide the majority of drainage in Tarlee.

The following criteria were adopted:

Formal Infrastructure to Remain Effective

Formal infrastructure i.e. pits, culverts, pipes and ford should be functional and able to cope with their design flows, as well as not cause nuisance (e.g. through up welling).

Informal Infrastructure to Remain Effective

The informal infrastructure (such as the roadway, road verges and railway line) should remain effective with only standard maintenance activities.

Stormwater Flows should be Contained in the Road Reserve

Stormwater flows should not inundate and cause damage to areas outside of the road easement. If significant flows leave the road reserve there is potential for damage to private property.

All Built Roads are Required to be Trafficable

Council's built roads are required to be trafficable against the following ARI events:

- 5 year ARI event for local arterial and collector roads; and
- 2 year ARI event for the remaining roads.

The road was assumed to be trafficable when small conventional vehicles can safely traverse the sections of deepest flowing water. The deepest water is expected to occur in the roadside swales. A small vehicle is expected to be able to safely traverse flows that are less than or equal to 0.3m deep.

The velocity of the flowing water is also important in determining whether the flow can be safely traversed. The combination of depth and velocity (i.e DxV) reflects the hazard of the flows. To provide safe access for small conventional vehicles the hazard must be low (SCARM, 2000). Low hazard has previously been defined for floodplain mapping projects in South Australia as flows with a depth less than 0.3m and a velocity less than 0.3m/s i.e. a maximum DxV of 0.09 m^2/s. This value of the DxV relationship is also supported by the data in SCARM (2000) which specifies low hazard flows to have a DxV value of less than or equal to $0.09m^2/s$.

New Developments to not Increase Peak Flow Rates

The SMP is to seek ways to support Council's Development Plan which specifies that water discharged from a development site should:

> (a) be of a physical, chemical and biological condition equivalent to or better than its pre-developed state; and
>
> (b) not exceed the rate of discharge from the site as it existed in pre-development conditions.

4.2.2 Regional Flooding

Tarlee experiences flooding from eastern tributaries during the 20 year ARI event and also from the Gilbert River during the 100 year ARI event. SMP objectives include providing protection to properties within the identified township boundary from a 100 year ARI event. The SMP can assist with achieving this by providing guidance on:

- Appropriate finished floor levels to prevent over bank flooding from Gilbert River and the two eastern tributaries entering buildings in the town;
- Exploring ways to reduce any restriction to flows caused by the bridge over Kapunda Road and railway embankment;
- Formulising drainage paths to limit flooding of properties in the township; and
- Options for mitigating flooding from Gilbert River.

The SMP is to seek ways to support Council's Development Plan relating to flood hazards. It specifies the following principles of development control:

- *Principle 4 - Development should not occur on land where the risk of flooding is likely to be harmful to safety or damage property.*
- *Principle 5 - Development should not be undertaken in areas liable to inundation by tidal, drainage or flood waters unless the development can achieve all of the following:*
  - *a) it is developed with a public stormwater system capable of catering for a 100 year average return interval flood event; and*
  - *b) buildings are designed and constructed to prevent the entry of floodwaters in a 100 year average return interval flood event.*

In terms of flooding and mitigating peak flows, Council's Development Plan also includes information on stormwater and includes the following principles of development control:

- *Principle 31 - Development should include stormwater management systems to protect it from damage during a minimum of a 100 year average return interval flood event.*
- *Principle 33 - Development should have adequate provision to control any stormwater over-flow run-off from the site and should be sited and designed to improve the quality of stormwater and minimise pollutant transfer to receiving waters.*
- *Principle 34 - Development should include stormwater management systems to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure downstream systems are not overloaded.*
- *Principle 38 - Where not detained or disposed on site, stormwater should be drained to a public stormwater disposal system.*

The SMP is to seek ways to support the above principles of development control.

4.2.3 Water Quality and Ecological Protection

Stormwater runoff should not impair the health of receiving environments, such as the Gilbert River and downstream environments such as the saltmarsh coastal environment of Gulf St Vincent. The

SMP can assist this by estimating the quality of runoff and developing mitigation strategies aimed at protecting water quality.

Desirable end-state values for watercourses and riparian ecosystems have been identified earlier in this SMP in section 3.1.3. This also included objectives aimed at protecting the health of waterbodies and waterways. This issue is expanded below.

The SMP aims to reduce the pollutant load of stormwater and will be guided by the State Government's targets for stormwater quality (pollutant reduction), as outlined below:

- 80% reduction in Total Suspended Solids
- 60% reduction in Total phosphorus
- 45% reduction in Total nitrogen
- 90% reduction in litter/gross pollutants

(Water Sensitive Urban Design, 2013).

In addition, the SMP will help support the following Council objectives:

Council's Development Plan provides objectives to protect natural resources, such as:

> *Objective 2 - Protection of the quality and quantity of South Australia's surface waters, including inland and underground waters.*

The Development Plan also includes principles of development controls that aim to manage the quality of stormwater runoff, such as:

> *Water Sensitive Design*
>
> *Principle 11 - Development should have adequate provision to control any stormwater over-flow runoff from the site and should be sited and designed to improve the quality of stormwater and minimise pollutant transfer to receiving waters.*
>
> *Water Catchment Areas and Water Quality*
>
> *Principle 24 - The quality of water leaving the site of a development should be of a physical, chemical and biological condition equivalent to or better than pre-development conditions, and the rate of water discharged from the site should not exceed the rate of discharge from the site in pre-development conditions.*
>
> *Stormwater*
>
> *Principle 35 - Development should include stormwater management systems to minimise the discharge of sediment, suspended solids, organic matter, nutrients, bacteria, litter and other contaminants to the stormwater system.*
>
> *Principle 36 - Stormwater management systems should preserve natural drainage systems, including the associated environmental flows.*

The SMP aims to support the Northern and Yorke NRM's resource condition targets for a range of NRM issues - the most relevant issues and their targets are outlined below:

- Integrity of native vegetation communities:
    - By 2030, maintain the condition of the region's 1,200,000 ha of remnant native vegetation, and improve the condition of 15% from 2008 levels.

- Integrity of inland aquatic ecosystems (rivers and other wetlands):
  - By 2030, inland and estuarine water-dependent ecosystems are maintained or improved in condition from 2008 levels.
  - By 2030, core refuge areas are protected by a 20% reduction in the extent of priority degrading watercourse management issues.
- Integrity of estuarine, coastal and marine habitats:
  - By 2030, there is no reduction in the extent and a steady improvement in the condition of coastal, estuarine and marine ecosystems, compared to 2008.
  - By 2030, the extent and diversity of coastal landscapes is maintained and their condition improved, compared with 2008.
- Nutrients in aquatic environments, Turbidity/suspended particulate matter in aquatic environments, Surface water salinity in freshwater aquatic environments:
  - By 2030, water quality is maintained, within climatic limitations and natural conditions, below levels set for aquatic ecosystems in the Environment Protection (Water Quality) Policy.
- Significant native species and ecological communities:
  - By 2030, there has been no loss of species or ecological communities and their viability and conservation status has improved from 2008 levels.

The Northern and Yorke NRM's Regional Plan (Volume D) also contains information and requirements relating to managing works around watercourses, known as Water Affecting Activities (WAA's). A permit is required to undertake any of the WAAs listed in Section 5 of the NRM Plan either in the non-prescribed areas, or in relation to prescribed water resources where no water allocation plan exists. The purpose of this permit is to ensure activities support the NRM's aims of protecting water resources. However, Council may decide to develop Best Operating Practices that have been approved by the Board which will replace the need for a WAA permit, such as for the construction of a culvert or managing vegetation along a watercourse.

4.2.4 Stormwater Reuse

The reuse of stormwater was identified by the community as a potential opportunity to be explored through this SMP, such as watering the bowling green and street trees.

The SMP is intended to describe options for MAR and stormwater harvesting without causing harm to downstream water dependent ecosystems. The SMP will describe the likely effectiveness of the reuse scheme so that Council can plan for its future development should funds become available.

Supporting Documents

Opportunities for stormwater harvesting and reuse at Tarlee will help to support the Government strategies described below.

The South Australian Government's Stormwater Strategy (2011) has targets for the Greater Adelaide region however it also provides the basis for stormwater management in regional areas of the State. It supports the State Government's water security plan "*Water for Good" (2009)* target of harvesting 15 GL a year in regional areas by the year 2050.

Regional Development Australia Yorke and Mid North in partnership with the Clare & Gilbert Valleys Council, the Northern and Yorke NRM Board, the Clare Wine Grape Growers Association, SA Water and the Department for Water prepared the Water Security Plan (2011) with the aim of water proofing the region. This is to be done by diversifying the availability of water resources via assessing the future water requirements of the region; identifying future potential water sources, including those created through stormwater capture and wastewater treatment and reuse; and identifying the appropriate strategies to secure water fit for purpose over the next 20 years to 2030.

Council should continue to ensure development is sited and designed to capture and re-use stormwater, where practical, as outlined in its Development Plan.

4.2.5 Desirable Planning Outcomes

New Development

As outlined earlier in this SMP, there is no 'Deferred Urban' zone and therefore future development is likely to be limited to infill development.

Some allotments in the township are currently affected by flooding, such as those adjacent to the main watercourse channels, and some that are affected by sheet flow coming down the surrounding slopes towards the town, particularly from the eastern slopes. The land zoned as 'Industry' also experiences flooding.

Any future development needs to have consideration of the land's flood risk. Flood maps produced in this SMP provide information on flood extents and heights. This information is useful in Council setting minimum finished floor levels to adequately provide protection from floods.

Future development also needs to have consideration of how it may affect flood paths. To ensure adequate drainage is achieved, it may be necessary to provide detention onsite for a single allotment, or a detention basin placed within a larger subdivision, so not to exacerbate the town's drainage system.

Open Space, Recreation and Amenity

Areas of open space, recreation and amenity are important to the community and options to safeguard and enhance these values are explored in this SMP, such as investigating watercourse rehabilitation works, water quality improvements, and stormwater reuse options.

5 Stormwater Management Plan Strategies

5.1 Approach

The development of stormwater management strategies has been based on the stormwater management plan objectives, modelling and technical investigations, and feedback received from the Steering Committee, Elected Members and the local community. A summary of the community feedback on draft strategies is provided in Appendix B.

The recommended strategies in this report are assigned a unique label and number, such as:

Flood management: F1, F2, etc

Water Quality: WQ1, WQ2, etc

Reuse: R1, R2, etc

Preparedness and planning: P1, P2, etc

Combined strategies (not predominantly one of the above): C1, C2, etc.

Strategies for managing flooding and stormwater runoff, and opportunities for improving water quality, the local amenity and potential reuse are outlined as follows.

In addition to the proposed measures outlined below, the road network's function of conveying high flows will continue.

It is noted that the availability and timing of funding and resources will determine the order and staging of the recommended works.

5.2 Non-Structural Flood Management Measures

In addition to structural measures aimed at controlling flooding, there is a range of non-structural measures that can assist in achieving this outcome and minimise the impacts of flooding in the future. Non-structural measures are typically highly cost effective and can be implemented over much shorter timeframes. Both structural and non-structural approaches should be incorporated within an overarching management plan for Tarlee.

Examples of non-structural measures are described below.

5.2.1 Flood Preparedness

Flood preparedness is a cost effective non-structural means of reducing damages as a result of a flood. Flood preparedness is basically about helping people to be aware of the flood risk and how best to respond to it. Flood preparedness programs in this context are considered in four phases: flood awareness, flood warning, response and recovery. They form the key elements of a total flood warning system (Commonwealth of Australia, 2009).

Flood Awareness

A flood awareness program for people in Tarlee is an important aspect of reducing the risk of flood damage. A community awareness program, similar to the Clare township's 'Floodsafe' program which assists the community in being better prepared and able to respond to flood risks and events

is recommended. This program is based on the SA State Emergency Service's (SES) highly successful community education and awareness raising 'Floodsafe' program. A program such as this may include awareness activities such as informing the community through discussions with individual households, the Council's newsletters, public presentations, articles in local media, information included on Council's website, and information about a flood emergency kit.

A coordinated education program is one means of ensuring this information is effectively disseminated. The development of such programs is essential for ensuring that landholders can take full advantage of flood warnings.

Flood Warning

Research has demonstrated that flood warning can substantially reduce the damage costs associated with flooding. Generally, the greater the warning time, and the more prepared the community are then the greater the savings may be. A well informed community can reduce the costs associated with a flood by around 20% with only 2 hours warning whilst with 12 hours warning costs can be reduced by around 60% (BTE, 2001). At Tarlee, there is approximately 18 hours from the onset of rainfall in the catchment to the time of peak flooding from the Gilbert River. This provides time for the community to prepare for an impending flood event.

Flooding from the local catchments is likely to occur over much shorter timeframes (less than two hours). Nevertheless, warnings based on forecast and recorded rainfalls can be provided to help alert towns people of a potential impending flooding issue from the local catchment to the east of the town.

A flood warning service would be useful for the Gilbert River, such as the system currently provided by BOM for other areas e.g. the Gawler River. This may require more flow information, additional river and rain gauging stations in the Gilbert River catchment to significantly improve the ability to warn the people of Tarlee of impending high flows or intense rainfall.

Flood Response

The flood response phase (and to a lesser extent the recovery phase) is highly influenced by the experience or knowledge of people of the likely behaviour and nature of a flood event. There are a range of actions people can do with their property before and during a flood that can substantially reduce the damage costs. Many of these measures are very simple and easily implemented. To be effective landholders potentially affected by flooding need to be aware of their options and response strategies.

The response of emergency services during a flood is obviously also a key factor in reducing flood damages and threats to public safety. Integrated disaster response plans are an important means for helping to ensure emergency services can effectively respond. Whilst not wishing to suggest that current response services are deficient (because they are not), the regular review of these plans and the conduct of "dry run" flood response exercises can be effective ways of ensuring emergency response staff and volunteers are aware of the issues, hazards, and opportunities that might be presented to them during a real flood event. Such initiatives should be effectively supported.

Flood Recovery

The recovery phase post flood is critical to reducing social disruption and long lasting health issues associated with trauma (and in extreme cases disease) as well as ensuring communities can get back to "normal" as soon as possible and thereby contain the overall damage costs.

A flood preparedness program is included in the list of recommendations as option P1 in Table 6-1. This includes a total flood warning system and a community awareness/education program (to be implemented every 5 years).

5.2.2 Development/Planning controls

The Development Plan is a statutory document that controls and manages all forms of development within the Clare and Gilbert Valleys area. It sets out a range of development zones, maps and rules (Objectives and Principles) to help ensure that development occurs in a well-managed way and takes account of relevant environmental, infrastructure, urban design, heritage and community requirements (Strategic Directions Report 2012/13).

Planning controls within Council's Development Plan provide a framework to plan and build in a manner that incorporates stormwater management. Council already has information in its Development Plan to help guide development in terms of stormwater runoff volumes, water quality and reuse aspirations. To improve the effectiveness of the Development Plan Council may consider including specific water quality targets identified in the State Government's targets and the NRM Board's resource condition targets as described earlier in this SMP.

It is recommended that Council includes flood maps in its Development Plan to demonstrate land at risk of flooding and to guide appropriate development.

In relation to stormwater reuse, the Development Plan may be improved by including the reuse targets outlined in the State Government's Stormwater Strategy and "Water for Good" plan and also support the region's "Water Security Plan" (2011).

It is also recommended that Council enforces its current flood hazard requirements in its Development Plan, such as not allowing development on land where the risk of flooding is likely to be harmful to safety or damage property. In addition, to avoid buildings being constructed too low and thus potentially at risk of flooding, it is recommended that finished floor levels of new developments are 300mm above 100 year ARI event level or if the develop lies outside a floodplain area then 300 mm above surrounding land levels.

There are a variety of planning and legislative controls available to minimise the various risks to the receiving environments, with the fundamental requirement that stakeholders have a duty of care to not adversely impact on the environment. For example, the Development Plan has a section on Water Sensitive Design which, amongst other provisions, requires:

Water discharged from a development site should:

> *(a) be of a physical, chemical and biological condition equivalent to or better than its pre-developed state*
>
> *(b) not exceed the rate of discharge from the site as it existed in pre-development conditions.*

Improvements to stormwater management and water quality are outlined below. These also have the potential to achieve better planning outcomes associated with open space, recreation and amenity.

Development / planning controls are included in the recommendations as option P2 in Table 6-1.

5.2.3 Improvements to Township Amenity and Promotion of Open Space

The development of the Stormwater Water Management Plan identified a number of opportunities to further improve the amenity of the township.

A series of verge side watering systems have been proposed to water street trees and there are potentially longer term opportunities to use stormwater runoff to irrigate the bowling green area surrounds. These works would need to be done in collaboration with local business and residents.

A number of residents also use the old stone road bridge over the Gilbert River as part of a walking trail through the town. It is proposed that this bridge be removed to improve flood conveyance through the town. A replacement low level pedestrian bridge is proposed to ensure the walking trail can continue to serve the local community without compromising flood protection.

The works around the bridge are located at the northern end of town and near the town showground/oval area. The amenity and biodiversity values associated with this section of the Gilbert River could be further improved through a weed control and revelation program focussing on local native species. These activities in this location would be ideally placed from a community benefit and exposure perspective.

In the first instance Council should liaise with the Northern and Yorke NRMB to determine if the rehabilitation of this section of watercourse can be included in the Board's forward work program and if so, Council could support this initiative with the support of local landowners. This could then form a pilot site with the ultimate goal being the rehabilitation of the river through the full length of town should there be sufficient landholder and community support for this.

5.3 Management of Flood and Local Runoff

Management strategies have been developed that focus on improving flows through the main flow paths, such as Gilbert River, Shannon Creek and other watercourses from the east of the town, as well as upgrading drainage infrastructure to reduce flooding. The suggested measures described below are based on a level of protection for inundation in the 100 year ARI event.

In addition to the proposed measures outlined below, the road network's function of conveying high flows will continue.

The recommended measures are described below and shown in Figure 5-1. This figure also shows the effectiveness of these recommendations on flood inundation. The difference in flood inundation pre and post measures is shown in Figure 5-2. Further information on the properties protected in different ARI events is provided in section 5.4 of this report.

5.3.1 New and Upgraded Infrastructure to the North and East of Tarlee

The following measures are proposed for the area to the north and east of Tarlee:

- Create a swale from Finnis Point Road all the way to discharge point at the Gilbert River (swale dimensions: 10m wide (top), 6.5m wide (bottom), 1.2m high, 1:1.5 side slopes) (this may involve works on private land).
- Replace culvert road crossings with spoon drains on Finnis Point Road (depth 0.5m, width (along the road, perpendicular to the flow) 25m) (this may involve works on private land)

and on Old Main Road (depth 0.5m, width (along the road, perpendicular to the flow) 26m), and provide an additional culvert under railway line (1.7m wide x 0.9m high culvert).

- Create roadside swale along northern verge of Clarke Road and Charles Street (4.3m wide (top), 1.2m wide (bottom), 0.5m high, 1:3 side slopes), all the way to outflow point into the Gilbert River to cut off any spills from the Clarke Road crossing. Regrade road near ford crossing to ensure water enters swale and does not flow down the road.
- Provide a swale (1m wide (top) and 2% fall (sides) along southern verge of Charles Street and spoon drains at property entrance crossings (1m wide each) (this may involve works on private land).
- Install a spoon drain (depth 0.25m, width (along the road, perpendicular to the flow) 11m) at intersection of Charles Street and Finnis Point Road to convey flows along southern verge of Charles Street into a proposed roadside swale along the northern verge of Charles Street all the way to the Gilbert River.
- Install a spoon drain (depth 0.1m, width (along the road, perpendicular to the flow) 6m) and headwalls at road crossing at Finnis Point Road and an additional box culvert under the railway line crossing on Charles Street.
- Provide levee (0.5m high) on Tarlee-Kapunda Road near the bridge crossing to the east of the township to prevent flows running down this road. (This may involve works on private land). The required length of the levee needs to be determined from engineering survey data yet to be captured in this area.

These recommended works are expected to protect 9 properties. The catchment area associated with this measure is greater than 40ha.

These works are included in the list of recommendations as F1 in Table 6.1.

5.3.2 Removal of the Old Stone Bridge

The old stone bridge prevents the efficient flow of water during major storm events, causing water to back up and flood adjacent properties. In order to allow water to flow without obstruction during storm events, it is recommended to remove the bridge. It is noted that this bridge does not have any listed heritage value.

Pedestrian access across the bridge would be retained through the installation of a low level bridge / walkway than does not interfere with the river hydraulics.

Opportunities for Council to develop a revegetation program at this location with the NRM Board and landholders should also be considered as part of these works.

This is expected to protect 8 properties. The catchment area associated with this measure is greater than 40ha.

This is identified in the list of recommendations as F2 in Table 6.1.

5.3.3 New and Upgraded Infrastructure to the South of Tarlee

The southwest drainage path along the southern verge of Bond Street and Horrocks Highway is to be formalised by providing a new swale (8.5 m wide (top) x 3.5 m wide (bottom) x 0.85 m high and 1:3 side slopes) (this may involve works on private land); and a corresponding ford crossing at the

intersection with the road (Bond Street/Sanders Road). Formalising the flow path in this manner will help protect properties from flooding as the flow will be contained within the swale and no longer spread across the landscape.

A small levee (0.2 metres high 45 metres long) is recommended on the southern verge of Bond Street (west of Gilbert Street) to provide a barrier to protect properties from flows. An additional culvert (2.4 m wide x 0.75 m high) is recommended at the crossing of Horrocks Highway.

An additional culvert crossing (2.4 m wide x 0.85 m high) is also recommended under the railway line crossing to reduce pooling of flood waters behind the railway line.

These recommended works are expected to protect 3 properties. The catchment area associated with this measure is greater than 40ha.

This is identified in the list of recommendations as F3 in Table 6.1.

5.3.4 Regrading of Horrocks Highway and Add Culvert

It is recommended that 100m of the eastern verge on Horrocks Highway (Gilbert St) is regraded, north of the intersection of Bond Street. A culvert (0.45m diameter RCP) should also be provided at the intersection at Bond Street along with a corresponding headwall.

These recommendations aim to reduce flooding of Horrocks Highway. The catchment area associated with this measure is less than 40ha.

These works are identified in the list of recommendations as F4 in Table 6.1.

5.3.5 Other Options

During the Council and community consultation meetings there were a number of people indicating that farm dams upstream of the towns should be assessed for their potential to reduce peak flow rates.

Aerial photography was used to identify potential dams and to estimate their approximate size. In most cases it was found that existing dams were either too small or not located in an area of the catchment that would allow them to be effective with respect to flood mitigation. Therefore, the use of farm dams in mitigating floods is not recommended in this SMP.

Opportunities were also considered for the construction of new flood control dams upstream of the townships. This assessment process revealed that the volumes of storage required were large and the rounded topography made it impractical to size a dam that would be effective for major floods. Therefore, this is not an option recommended in this SMP.

Landholders also identified that land management practices have improved and are continuing to improve further with respect to minimum tillage / direct drilling / contour bank techniques that are all effective in retaining more water on farm. These techniques along with farm dams all contribute to reducing peak flows but the effectiveness of these systems diminishes with the larger, less frequent floods. The volumes of water associated with the 20 year ARI event are simply too great for these measures to be effective. Their effectiveness is usually limited to floods up to the 5 or occasionally 10 year ARI event. Therefore, this is not recommended as an effective flood mitigation option for this SMP.

5.4 Effectiveness of Flood Mitigation Works

5.4.1 Difference in Flood Inundation Pre and Post Mitigation Measures

The 100 year ARI event was modelled with the recommended management measures in place. The difference in flood inundation as a result of the mitigation measures is shown in Figure 5-2. This figure shows areas that were once inundated are either now shallower or dry. As a result of changing the flow paths there would now be some areas becoming wet in the 100 year ARI event which would normally remain dry. The measures have been designed to ensure that these new areas do not create a nuisance or damage to third parties.

The number of properties at risk of flooding in the 100 year ARI event is 16 and the recommended measures are expected to protect all these properties. These properties are all impacted by riverine flooding from either the tributaries to the east of the Tarlee township or the Gilbert River itself. A breakdown of the number of properties protected in a range of ARI events (with the recommendations in place), is provided in Table 5-1.

TABLE 5-1: BREAKDOWN OF PROPERTIES PROTECTED IN DIFFERENT ARI EVENTS

ARI event	20 year ARI	50 year ARI	100 year ARI
Number of properties protected	11	16	16

5.4.2 Trafficability of Road Network

Objectives of this SMP include Council's built roads to be trafficable under the following scenarios:

- 5 year ARI event for local arterial and collector roads; and
- 2 year ARI event for the remaining roads.

The 5 year ARI event (based on local flooding/direct rainfall) was modelled to assess the trafficability of roads following the implementation of recommended works. This showed that the recommended measures would improve the trafficability of the road network. There was only one location where there would be the potential for water to over top the road, for a short period of time. This was on Main North Road just south of the intersection of the Tarlee-Alma Road. The length of road overtopped would be approximately 10 m, with a depth of less than 50 mm. This road would therefore remain trafficable.

The road trafficability is shown in Figure 5-3.

5.4.3 Impact of Mitigation Measures on Downstream Stream Stability

It is important to understand the impact of the proposed mitigation measures on downstream environments, such as higher flow velocities that may cause erosion issues.

There is no significant change in velocity immediately downstream of the town as a result of the works proposed in this Stormwater Management Plan compared to the existing situation.

5.5 Maintenance of Drainage Infrastructure and Watercourse Management

5.5.1 Drainage Infrastructure

The effectiveness of stormwater drainage infrastructure is influenced by whether or not they are maintained and free of blockages. It is recommended that Council maintain the drainage paths and infrastructure in a manner to ensure they perform as designed, i.e. to enable efficient flow of water.

Council will continue to improve maintenance processes to optimise the water quality and water quantity management services performed by the stormwater network.

5.5.2 Watercourse management

The primary watercourse associated with Tarlee is the Gilbert River which flows along the western side of the town.

Much of the river through the town is on private land, however the management of the river can have a significant effect on the flood behaviour. An ongoing issue for Council and landholders in other towns has been in relation to the construction of fences across watercourses.

An action for Council, in conjunction with the NRM Board, would be to assess the suitability of stream fencing that may be in place, and identify the need for any upgrade/modification to existing fences as appropriate. It is anticipated that this work would be done in partnership with landholders and the NRM Board.

These actions are included in the list of recommendations as option F5 in Table 6-1.

Further information and recommendations on the maintenance of watercourses and stormwater infrastructure located in private and public land is provided in section 7.3 of this report.

Provide an additional culvert under railway line.
Catchment area greater than 40ha.

Provide spoon drain at Old Main Rd.
Catchment area greater than 40ha.

Provide spoon drain at the Finnis Point Rd crossing.
Catchment area greater than 40ha.

Provide headwall and spoon drain at intersection of Charles St and Finnis Point Rd to convey flows along southern verge of Charles St into a proposed upgraded roadside swale along the northern verge of Clarke Rd and Charles St all the way into the Gilbert River.
Provide a spoon drain and headwalls at road crossing at Finnis Point Rd.
Catchment area greater than 40ha.

Formalise drainage path west of Finnis Point Rd all the way to discharge point at the Gilbert River. Proposed grassed swale.
Catchment area greater than 40ha.

Proposed grassed swale along northern side of Charles St. Regrade road near ford crossing to ensure water enters swale and does not flow down the road.
Catchment area greater than 40ha.

Provide a box culvert under railway line crossing on Charles Street.
Catchment area greater than 40ha.

Formalise stormwater drainage path along southern side of Charles St by providing swale/drain and provide 1m wide spoon drain at property entrance crossings.
Catchment area greater than 40ha.

Remove existing stone bridge downstream of Main North Rd and provide a low level footbridge.
Catchment area greater than 40ha.

Regrade section of eastern verge of Horrocks Hwy. Provide additional pipe and headwall at intersection of Horrocks Hwy and Sanders Rd and remove accumulated sediment from existing culvert.
Catchment area less than 40ha.

Provide levee where creek crosses Clare – Kapunda Rd to prevent bypassing of the road bridge.
Catchment area greater than 40ha.

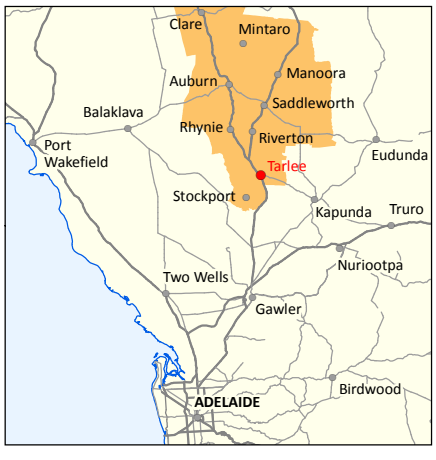
Formalise drainage path – Proposed grassed swale along Bond St and Horrocks Hwy.
Catchment area greater than 40ha.

Provide levee at Bond St.
Catchment area greater than 40ha.

Provide ford crossing at Bond St/ Sanders Rd.
Catchment area greater than 40ha.

Provide additional culvert at railway line crossing.
Catchment area greater than 40ha.

Provide additional culvert at Horrocks Hwy crossing.
Catchment area greater than 40ha.



LEGEND

Proposed Remediation Options:
- *Upgraded Culvert*
- *Roadside Swale*
- *Regraded Road*
- *Channel Modification*
- *Levee*
- Railway
- Road Edge

Cadastre

Flood Depth (m):
- *0 - 0.10*
- *0.11 - 0.25*
- *0.26 - 0.50*
- *0.51 - 1.00*
- *1.01 - 1.50*
- *1.51 - 2.50*
- *2.51 - 5.00*
- *Greater than 5.00*

Data Source:
Road Edge and Aerial Imagery from Aerometrex; Road names and Cadastre from Clare & Gilbert Valleys Council; Railway alignment from DTEI; Flood Data modelled by Australian Water Environments.

0 50 100 150 200 250 300
Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

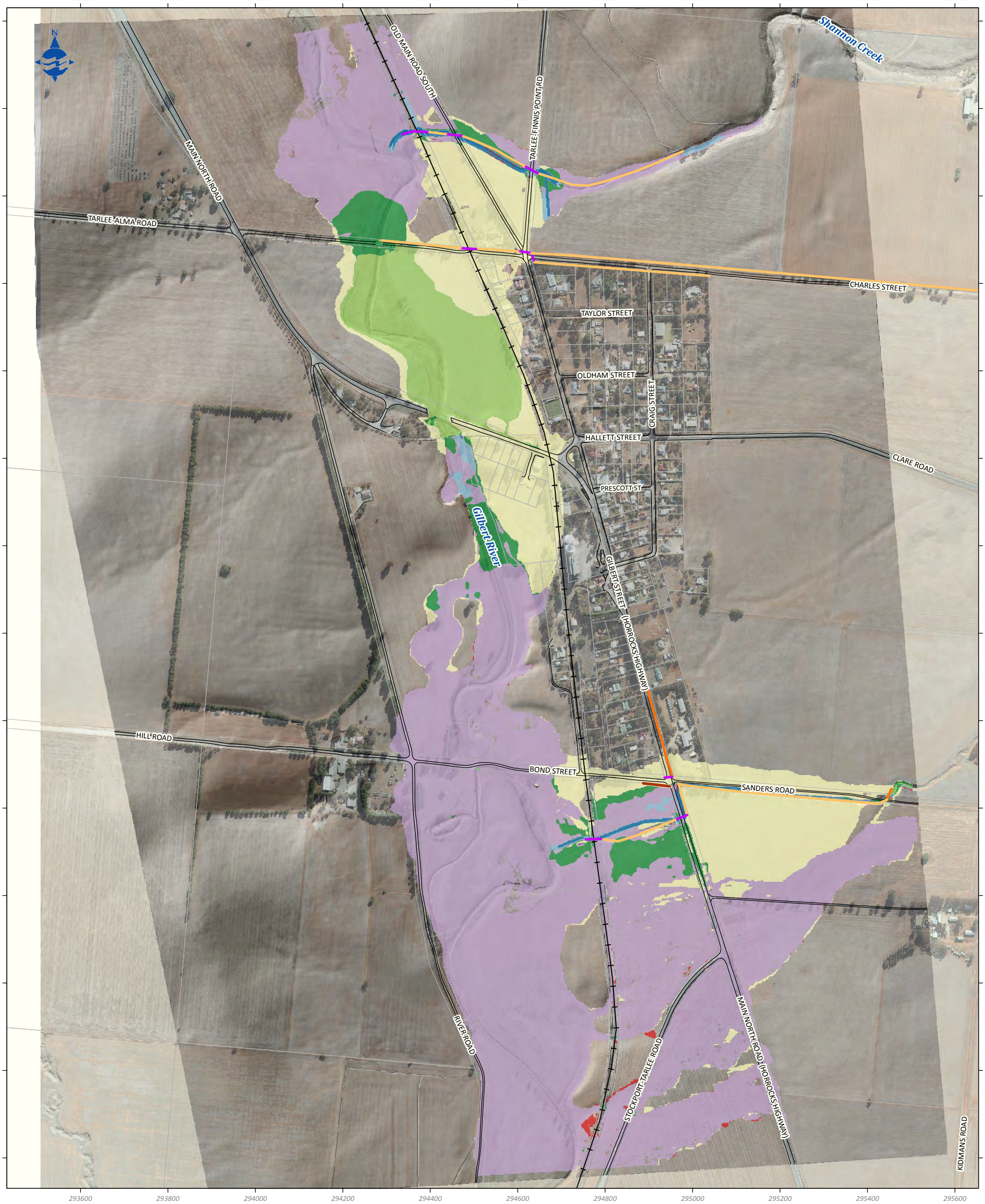
Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Tarlee

Recommended Measures and Effectiveness on Flood Inundation

14009 D115 v4 Tarlee Flood Management Strategies 160223
Last Updated: 23/02/2016

Figure 5-1



LEGEND

Proposed Remediation Options:

- *Upgraded Culvert*
- *Roadside Swale*
- *Regraded Road*
- *Channel Modification*
- *Levee*
- Railway
- Road Edge Cadastre

- Wet Previously Dry
- Dry Previously Wet

Wet Previously Wet:

- Significant increase in flood depth (over 0.5m)
- Moderate Increase in flood depth (up to 0.5m)
- No significant change in flood depth
- Moderate decrease in flood depth (up to 0.5m)
- Significant decrease in flood depth (over 0.5m)

Note:
Flood difference was determined by subtracting mitigation data from the current scenario therefore negative values represent a greater depth in mitigation data.

Data Source:
Road Edge and Aerial Imagery from Aerometrex; Road names and Cadastre from Clare & Gilbert Valleys Council; Railway alignment from DTEI; Flood Data modelled by Australian Water Environments.

0 50 100 150 200 250 300
Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

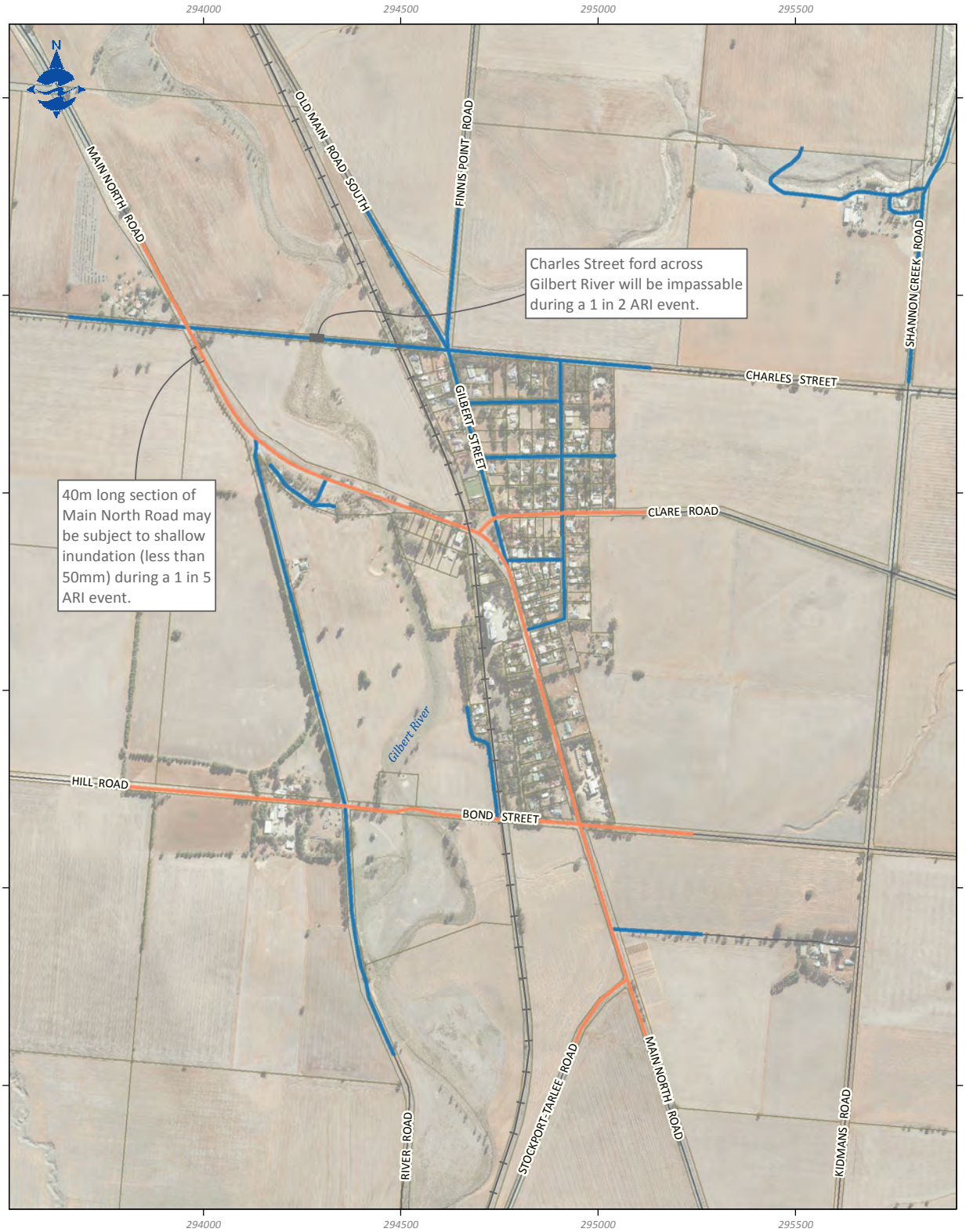
Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

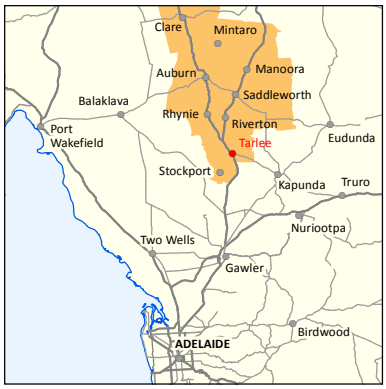
Tarlee

100 Year ARI Event Inundation Difference

14009 D122 v3 Tarlee 1 in 100 Flood Inundation Difference 140611
Last Updated: 24/07/2014

Figure 5-2





LEGEND

Road Trafficability Standard
Post Mitigation Works:

- *5 year ARI event*
- *2 year ARI event*
- Road (outside dtm extent)
- Railway
- Cadastre

Data Source:
Railway alignment from Department of Planning, Transport and Infrastructure; Cadastre and Roads from Clare & Gilbert Valleys Council; Aerial Imagery from Aerometrex.

0 100 200 300 400 500
Metres (Scale 1:15,000 A4 Sheet)

Government of South Australia
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For Seven Townships In The
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Tarlee

Trafficability of Roads

14009 D257 v1 Tarlee Trafficability of Roads 150923
Last Updated: 25/09/2015

Figure 5-3

5.6 Water Quality Assessment

Opportunities for verge infiltration pit systems along the main road to improve water quality at Tarlee have been explored and are included in the range of recommendations for this plan.

The investigation is described below.

Analysis of the catchment area and landuses was undertaken to determine the likely pollutants at Tarlee. These attributes were modelled using the computer software program MUSIC (Model for Urban Stormwater Improvement Conceptualisation). This program enables the user to quantify stormwater volumes and quality as well as to develop conceptual designs for treatment systems.

Due to factors such as limited available area at Tarlee for treatment systems and low stormwater yields, it was determined that verge pits/infiltration systems would be the most appropriate water quality treatment system for Tarlee. It is therefore decided to evaluate the effectiveness of four of these roadside watering systems along the main road in Tarlee. They would help to drain stormwater into the pit, to be utilised by a landscaped verge area or allowed to naturally infiltrate. This process would help filter pollutants that would otherwise not be treated.

5.6.1 Verge Infiltration Systems (C1)

The primary role of the verge infiltration systems is to provide a treatment of localised flows from adjacent residential dwellings or runoff from the localised road drainage system and to improve amenity of the streetscape. Capturing the water also reduces runoff rates, and this will help minimise adverse impacts to watercourses and receiving waters.

The recommended dimensions of verge infiltration systems are in the order of 2-2.5m wide (width of a standard car parking lane) x 6-8m in length. The sizing of these systems is limited by the width of the car park and the availability of space to provide suitable vegetation in this vicinity. These are generally spaced out along a verge car parking area.

The effectiveness of implementing this treatment system in improving water quality compared to the existing water quality at Tarlee is shown below in Table 5-2.

TABLE 5-2: EFFECTIVENESS OF WATER QUALITY TREATMENT

	Average Pollutant Loads (kg/yr)		
	Total Suspended Solid (TSS)	**Total Phosphorus (TP)**	**Total Nitrogen (TN)**
Water quality with no treatment	9,100	20	143
Water quality with treatment	8,890	19	132

A comparison of the improved water quality against the State Government targets (Water Sensitive Urban Design, 2013) is shown on the following page in Table 5-3.

TABLE 5-3: COMPARISON AGAINST POLLUTANT LOAD REDUCTION TARGETS FOR EACH SYSTEM

	Surface Area (m^2)	% Reduction		
		TSS	TP	TN
State Government target		80	60	45
Verge infiltration pit systems (4 systems) (north to south)	12	98	49	72
	12	98	51	73
	12	98	49	75
	12	98	48	75

There is only a small section of the Tarlee main street which verge watering systems are suitable, which is the eastern side of Main North Road. The results of the MUSIC modelling suggest that TP is not meeting the recommended state target of 60% reduction for each of the verge watering systems. Whilst this is not meeting the recommended target, the sizing of the verge watering systems has a surface area of $12m^2$ (assuming 2 x 6m). These dimensions are in line with the above recommended verge water systems dimensions. To achieve a TP reduction of 60%, a further analysis in MUSIC has suggested that the watering system would need to be increased to a size of $80m^2$. This increase in size would make it unfeasible given limitation of space, the potential need to realign the road and loss of street car parks to allow the systems to be implemented in a road side verge.

The implementation of verge watering systems will improve the overall total phosphorus loads from 20 kg/yr reduced to 19kg/yr, providing an annual average 1 kg reduction in the loads.

A flow weighted mean concentration (mg/L) was calculated for the outflow from the proposed treatment system to understand the quality of water as a result of treatment. The results of this analysis were compared against water quality criterion for TSS, TP and TN identified in the Environment Protection (Water Quality) Policy 2003 for fresh water. These results are summarised in Table 5-4.

TABLE 5-4: COMPARISON OF WATER QUALITY AGAINST ENVIRONMENT PROTECTION POLICY CRITERION

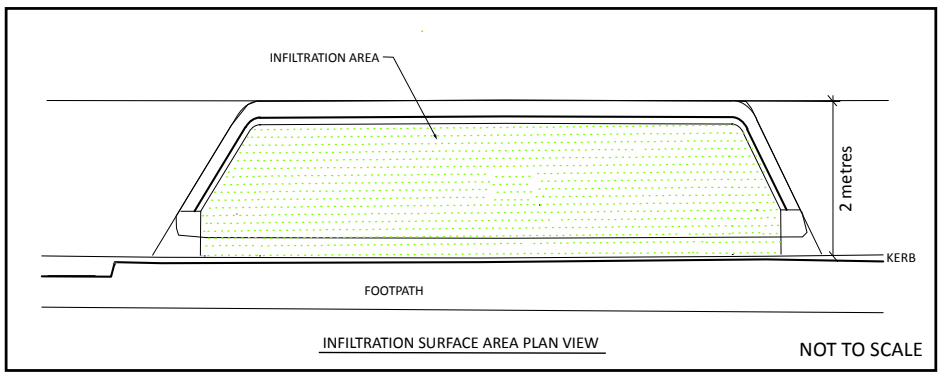
Treatment System	Pollutant	Fresh Water Criterion (mg/L)	Flow Weighted Mean Concentration (mg/L)
Verge Infiltration Systems (<0.1 catchment size)	TSS	20	3 - 7
	TP	0.5	0.2
	TN	5	0.6 - 0.8

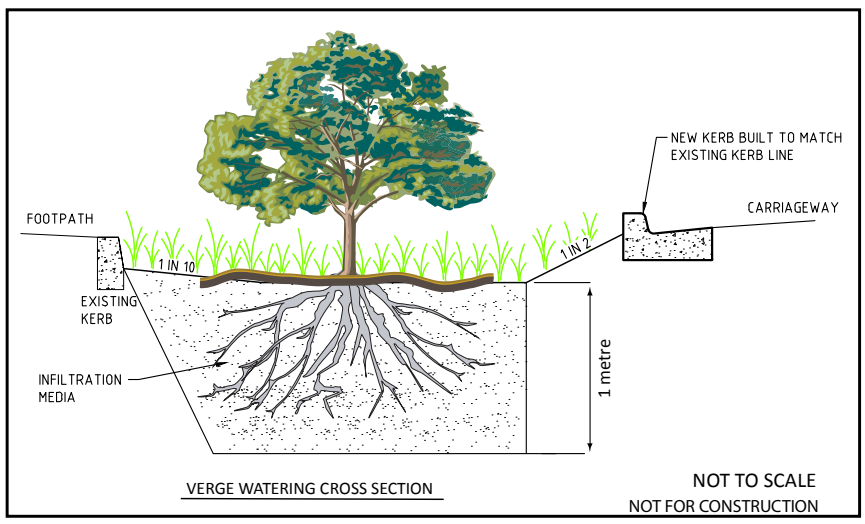
The expected improvement in water quality and meeting the above Policy (2003) supports Council's Development Plan principles relating to managing and improving the quality of stormwater runoff. It also helps support the NRMB's resource condition targets relating to maintaining and improving water quality in aquatic environments.

The recommended verge infiltration systems along the main road are shown on the following page in Figure 5-4.

This is included in the list of recommendations in Table 6.1 as C1.

TYPICAL PLAN AND CROSS SECTION VIEW OF VERGE WATERING SYSTEM





294200 294400 294600 294800 295000 295200

6205800 6205600 6205400 6205200 6205000

N

TAYLOR STREET

OLDHAM STREET

GRAIG STREET

HALLETT STREET

PRESCOTT ST

GILBERT STREET

Gilbert River

Potential site to capture stormwater in MAR scheme.

Potential verge watering (4 systems). (see Cross Section and Plan View)

LEGEND

- Railway
- Road Edge
- Cadastre
- Verge Watering Tree

0 50 100 150 200 250 300

Metres (Scale 1:5,000 A3 Sheet)

Data Source:
Aerial imagery, Road Edge and Contours from Aerometrex; Roadnames, Cadastre from Clare & Gilbert Valleys Council; Railway alignment from DTEI.

Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Tarlee

Stormwater Treatment, Harvest and Reuse

5.7 Stormwater Harvesting and Reuse

5.7.1 Overview

The verge infiltration pits recommended for improving water quality also provide an opportunity for reusing the captured runoff for watering roadside vegetation.

There is also the potential for a rain garden to be established to the south of the bowling club adjacent the main road (Gilbert Street). This could potentially then become the site for a small scale MAR recharge scheme.

These two types of reuse are included in the recommendations for this plan.

Opportunities for harvesting and reusing stormwater were explored in response to the community's aspiration to reuse stormwater, as well as it being a requirement of the SMA as part of preparing stormwater management plans. The verge infiltration pits described in the previous chapter for treatment purposes also provides an opportunity for reusing the captured runoff for watering roadside vegetation.

Opportunities for harvesting and reusing stormwater for watering other areas, such as the bowling green were also explored. This involved undertaking a high level water balance assessment to assess the potential for stormwater reuse. The stormwater volumes generated as part of the MUSIC modelling process were used for this assessment. Large scale reuse at Tarlee was found to be a difficult proposition due to the limited land availability for water treatment and the relatively modest stormwater yields. Therefore, the most practical reuse options were limited to watering roadside vegetation via a proposed verge/infiltration pit system.

The investigations are summarised below.

5.7.2 Roadside Vegetation Watering (C1)

Reusing stormwater for watering a landscaped verge, such as street trees or shrubs, on the main street would help 'green' the town, improve the local amenity and potentially lower ambient street temperatures.

The water balance assessment process confirmed that the verge infiltration pits provided an opportunity to reuse stormwater to irrigate roadside vegetation, as shown in Figure 5-4. The average amount of stormwater being generated from the catchment which drains into the proposed verge/infiltration pits is outlined below in Table 5-5.

TABLE 5-5: STORMWATER RUNOFF YIELDS FOR REUSE

System	Infiltration Pit Surface Area (m2)	Average Catchment Stormwater Yields (kL/yr)
Verge infiltration pits (4 systems)	12	320
	12	320
	12	270
	12	240

The investigation determined that some watering of the main street verge (street trees, landscaping) is a viable option.

This is included in the list of recommendations in Table 6.1 as C1.

5.7.3 Other Stormwater Reuse Options

Whilst a wetland is not proposed for Tarlee at this time, a high level water balance assessment was undertaken to determine the available stormwater for potential reuse opportunities in the future, such as for the bowling club and Soldier's Memorial Gardens.

The average annual total flow of stormwater being generated from the catchment which could be harvested in the future is summarised below in Table 5-6.

TABLE 5-6: AVERAGE ANNUAL TOTAL STORMWATER RUNOFF YIELD

Catchment Area (ha)	Average Catchment Stormwater Yields (kL/yr)
43	47,000

The second phase of the high level water balance assessment was undertaken to determine the indicative harvestable volume of stormwater based on the flows being conveyed into wetlands. As part of acquiring a permit to construct a water storage (such as wetland), the total amount of actual water which can be harvested must not exceed the 25% of the median annual flow calculated for the total catchment (Northern and Yorke NRM Board 2004). The median annual and harvestable volume respectively based on the requirements for obtaining a permit is outlined below in the following table:

TABLE 5-7: STORMWATER RUNOFF YIELDS FOR REUSE

Catchment Area (ha)	Median Annual Volume (kL)	Harvestable Annual Volume (kL)
43	43,000	10,750

The table above (Table 5-7) provides a summary of indicative runoff volumes which are generated from the Tarlee township. This harvestable volume of water could be reused for purposes of irrigation and/or supplying existing irrigation systems for Council gardens, parks and reserves within in Tarlee provided it would be captured and treated.

There is limited available land to store water for reuse purposes. For harvesting of runoff in Tarlee to occur in the future would require further investigations into the actual demands for stormwater reuse and finding and/or acquiring land for the purposes of storage and treatment.

5.7.4 Managed Aquifer Recharge (R1)

Managed Aquifer Recharge (MAR) is the process of adding stormwater and/or treated wastewater to aquifers in a controlled environment. The purpose of MAR is to allow for the extraction and storage of reuse water for irrigation and providing alternative water resources particularly in extended dry periods.

Investigating the feasibility of an MAR scheme usually takes into consideration the following factors:

- Properties of the aquifers in the area;
- The salinity of the groundwater;
- The supply of the stormwater;

- The demand and intended purpose of the stormwater;
- Treating water to suitable water quality requirements for injection;
- Availability of land; and
- The associated costs.

A desktop study identified only one bore in Tarlee which is used for domestic purposes. This bore utilises the Saddleworth Formation and typically generates bore yields of around 0.5L/s which is considered very low. The water quality for the Saddleworth Formation aquifer is 3385 mg/L which is considered to be brackish.

The volume of local runoff that could be expected on a regular basis is small (46 ML/yr), of which possibly 11ML/yr could be harvested. Typically, MAR schemes need to be between 100 to 200 ML/a to be cost effective. Whilst there can be many other factors that support the development of a MAR scheme the limited supply availability was considered to be a major limitation on feasibility. Furthermore, stormwater needs to be treated before it is used in a MAR scheme, usually requiring an area of available land. The only open area of land large enough for this purpose was assessed to be the community oval/showgrounds area. Use of this land would compromise these existing uses and hence is not recommended at this time.

The community also had mixed opinions about the suitability of the existing bore quality and yields.

It was determined that developing a large scale MAR scheme for harvesting and reuse was not a commercially feasible option at this time due mainly to the low stormwater supply yields, lack of available land required for the scheme to operate, not a high demand for reuse, and relatively high costs involved in the scheme. There was also uncertainty amongst the community about the suitability and yields of existing bores. However, a small scale scheme may prove feasible with further investigations. The most likely scenario would be for a small scale system to be developed as part of a biofiltration system or rain garden.

There is the potential for a rain garden to be established to the south of the bowling club adjacent the main road (Gilbert Street). This could potentially then become the site for small scale MAR recharge purposes. Further investigation of the existing bore that was once used near the bowling club would be necessary to determine the condition and suitability of the aquifer for reuse purposes. A further complication to be overcome would be the fact that there is an existing domestic bore which could mean the treatment and testing regime for even a small scale MAR system might be prohibitive. The location of the potential recharge site is shown in Figure 5-4.

The catchment area associated with this measure is greater than 40ha.

This is included in the list of recommendations in Table 6.1 as R1.

6 Recommendations

6.1 Structural and Non-structural Measures

Recommendations include structural measures aimed at improving stormwater and flood management, opportunities for stormwater harvesting and reuse, as well as several non-structural measures.

Recommendations with their associated costs and benefits are outlined in Table 6-1.

This table also identifies if the catchment area of the proposed works is greater than 40ha.

TABLE 6-1: RECOMMENDATIONS

Recommended works	Preliminary construction cost estimate	Benefits	
		Number of dwellings protected	Other
Stormwater and flooding measures: **F1:** New and upgraded infrastructure to the north and east of Tarlee *(catchment area is greater than 40ha)* • Provide swale from Finnis Point Road to discharge point at Gilbert River • Provide spoon drains at crossings on Finnis Point Road and Old Main Road, and upgrade culverts under railway line. • Provide swale along northern verge of Clarke Road and Charles Street, to outflow point into the Gilbert River. Regrade road near ford crossing. • Provide a swale along southern verge of Charles Street and spoon drains at property entrance crossings. • Provide headwall and spoon drain at intersection of Charles Street and Finnis Point Road. • Provide a spoon drain and headwalls at road crossing at Finnis Point Road and an additional box culvert under the railway line crossing on Charles Street. • Provide levee on Tarlee-Kapunda Road near the bridge crossing to the east of the town.	$590,000 *Cost breakdown:* *$30,000* *$330,000* *$50,000* *$50,000* *$50,000* *$70,000* *$10,000*	9	Formalising drainage paths and better managing flows will help to achieve better planning outcomes associated with open space, recreation and amenity. Improved road trafficability.
F2: Removal of the old stone Bridge *(catchment area is greater than 40ha)*	$210,000	8	Improved road trafficability.
F3: New and upgraded infrastructure to the south of Tarlee *(catchment area is greater than 40ha)*	$280,000	3	Improved road trafficability.
F4: Regrading Horrocks Highway and add culvert *(catchment area is less than 40ha)*	$20,000	-	Reduce flooding of Horrocks Highway (improved road trafficability)
F5: Regular maintenance of stormwater drainage infrastructure	$5000		An effective drainage system.
C1: Treatment, Harvesting and Reuse: • Street verge watering (4 systems)	$24,000		Reduced pollutant loads. Improved local amenity through planting and watering of roadside vegetation. Potential to enhance biodiversity values. Provides some flood detention.
R1: Treatment, Harvesting and Reuse: • Rain garden and small scale MAR feasibility scheme assessment *(catchment area is greater than 40ha)*	$10,000	-	Potential water supply for Bowling Club and community landscaping.
P1: Flood preparedness • Establish a total flood warning system for Gilbert River • Community education program - e.g. Floodsafe (Community/education officer role and associated materials)	$30,000 $10,000		Provides a warning for flood events which provides time for preparation and therefore reduces the risk and impact of flooding. Build the capacity of the community to prepare for floods and reduce risk of flooding. Gain community support for stormwater management measures. Improve the community's sense of worth and feeling of security.

Recommended works	Preliminary construction cost estimate	Benefits	
		Number of dwellings protected	Other
P2: Development / planning controls: • Enforcement and inclusion of flood maps in Council's Development Plan • Ensure siting of developments 300mm above surrounding land level. • Water quality targets and the NRM Board's resource condition targets to be included in Council's Development Plan • Stormwater reuse targets to be included in Council's Development Plan			Reduced risk and cost of flooding to properties and people. Improvements to stormwater management resulting in improved water quality, lower risk of flooding, and reuse to 'green' the town, will also help to achieve better planning outcomes associated with improving the values of open space, recreation and amenity for the community. There will also benefits to watercourses and receiving waters as a result of detaining flows and reducing runoff rates by the biofiltration systems.

6.2 Environmental, Social and Economic Opportunities/Benefits

Environmental enhancement opportunities resulting from the recommended actions in this SMP are predominantly based on the improvements to water quality and better management of stormwater flows. There will also benefits to watercourses and receiving waters as a result of detaining flows and reducing runoff rates by the biofiltration systems. These systems have the potential to support native vegetation and wildlife which would also improve the amenity of the town. These actions will help to protect the receiving environment of the Gilbert River, Light River as well as the estuarine and marine environment associated with Gulf St Vincent.

Reusing of stormwater through watering roadside vegetation helps maintain the hydrological balance by using natural processes of storage, infiltration and evaporation. The 'greening' of the main street minimises the impact of urban development on the environment, can enhance the diversity of natural habitats/landscapes, and help recharge the groundwater.

Inclusion of water reuse and treatment objectives in Council's Development Plan will also help to ensure the protection of these downstream environments.

The improved infrastructure aimed at flood control recommended in this SMP will provide opportunities for social benefits, including improved road trafficability, public safety, protection of property and continuity of community services. The increased standard of drainage and regular infrastructure maintenance will help to prevent nuisance flooding, particularly at the main township intersections and behind the railway line. This will alleviate community frustration and help maintain business trade in the town.

Other social benefits arise from the reuse of stormwater for irrigating street trees. The 'greening' of the township can enhance the local amenity and engender a sense of community pride and belonging, as well as reducing the costs of using mains water. Street trees can provide opportunities to link community nodes through open space and help to ameliorate urban heat island effects.

Non-structural measures, such as flood preparedness programs, flood warning systems and education will improve the community's capacity to prepare for and manage stormwater issues, as well as create a stronger sense of security within the community. Planning controls (e.g. Council's Development Plan) provide a framework to plan and build in a manner that incorporates stormwater management.

The improvements to stormwater management resulting in improved water quality, lower risk of flooding, and reuse to 'green' the town, will also help to achieve better planning outcomes associated with improving the values of open space, recreation and amenity for the community.

There are also economic benefits as there won't be the same damage costs as there would be without the stormwater infrastructure. The measures help to prevent flooding which will result in less disruption to business trade and transport routes, and also avoid economic losses arising from stormwater issues. The reuse of stormwater will reduce the reliance on mains water which will have cost savings for the community. In addition, the improvements to stormwater management may have a positive impact on business confidence and attract future economic investment in the area.

The implementation of the verge infiltration pits can reduce the costs of any water quality improvement by maintaining existing waterways.

7 Implementation Issues and Funding Opportunities

7.1 Priorities and Timeframes for Implementation

The SMA Guidelines recommend that the highest priorities are for works and measures that reduce flood hazard and protect life and property. In accordance to the multi-objective approach to stormwater management, greater weighting should be placed on strategies that also provide opportunities for stormwater reuse, and improvement to water quality, open space/local amenity, biodiversity and recreation.

A subjective assessment of the recommended strategies has been undertaken to determine their ranking and priorities. This assessment is shown Appendix C.

A detailed 10 year program for implementing the recommended strategies has been developed for Council, refer to the Implementation Plan in Appendix D. It provides information on the priorities, timeframes, costs, benefits and potential funding partners.

Notwithstanding this preferred list of actions and timing, the availability and timing of funding and resources will determine the order and staging of the works. A summary of the priorities is provided below in Table 7-1.

TABLE 7-1: SUMMARY OF PRIORITIES

Priority	Timeframe (years)	Recommendations		Capital Cost ($)	Recurrent Cost ($ pa)
1	0 - 1	F5	Regular maintenance of stormwater drainage infrastructure and watercourses	$5,000	$3,000
1	0 - 1	P2	Development / planning controls	-	-
1	1 - 5	P1	Flood preparedness - • Flood warning system for Gilbert River • Community education program	$30,000 $10,000	$5,000 $1,000
1	1 - 5	F1	New and upgraded infrastructure to the north and east of Tarlee	$590,000	$1,000
1	1 - 5	F2	Removal of the old stone Bridge	$210,000	-
2	1 - 5	F3	New and upgraded infrastructure to the south of Tarlee	$280,000	$1,000
3	1 - 5	R1	Rain garden and small scale MAR scheme feasibility assessment	$10,000	-
3	5 - 10	F4	Regrading of Horrocks Highway and add culvert	$20,000	$500
4	5 - 10	C1	Water Treatment - 4 verge infiltration systems	$24,000	$1,000

7.2 Responsibilities for Implementation and Potential Funding Contributions

Council will incorporate stormwater management strategies in its Infrastructure and Asset Management Plan, however it will need to seek funding contributions from other sources. The availability and timing of funding and resources will determine the order and staging of the works.

A stormwater management plan approved by the SMA and gazetted is in a good position to attract funding contribution from the SMA to implement the recommendations. The SMA 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 in a catchment of less than 40 ha, provided that those works form part of an approved Stormwater Management Plan. To assist in identifying funding opportunities with the SMA, the catchment sizes for the structural measures are provided in Table 6-1.

Council may also be able to secure some funding from the NRM Board, particularly in relation to watercourse rehabilitation and water quality improvement works. The Commonwealth government also offers grants at various times for the purpose of flood disaster planning and relief.

The Yorke and Mid North Regional Development Board may also be another source of funding for implementing some of the recommended actions in this SMP. For example, the Regional Development Fund (RDF) is an annual grant fund administered by South Australia (Regions SA). This funding is to drive economic growth and productivity by investing in regional infrastructure, creating jobs and new opportunities for regional South Australia.

Responsibilities for implementation of recommendations and potential funding opportunities are presented in Table 7.2, with further details in the Implementation Plan (refer Appendix D).

TABLE 7-2: RESPONSIBILITY FOR IMPLEMENTION AND POTENTIAL FUNDING / PARTNERSHIP OPPORTUNTIES

Recommendations		Responsibilities for Implementation and Potential Funding
F5	Regular maintenance of stormwater drainage infrastructure and watercourses	Council, and in partnership with landholders and the NRM Board as appropriate
P2	Development / planning controls	Council
P1	Flood preparedness program	Council, with potential partnership and/or funding from BoM and SMA (flood warning system); and SES (community education program)
F4	Regrading of Horrocks Highway and add culvert	Council to lead design, consultation and construction processes, with potential funding from DPTI
F1	New and upgraded infrastructure to the north and east of Tarlee	Council to lead design, consultation and construction processes, with potential funding from SMA
F2	Removal of the old stone Bridge	Council to lead design, consultation and construction processes, with potential funding from SMA/ DPTI
F3	New and upgraded infrastructure to the south of Tarlee	Council to lead design, consultation and construction processes, with potential funding from SMA
C1	Water Treatment - 4 verge infiltration systems	Council to lead design, consultation and construction processes, with potential funding from NRM
R1	Rain garden and small scale MAR scheme feasibility assessment	Council

7.3 Responsibility for Maintenance

The maintenance of watercourses and stormwater infrastructure that is located in **road reserves and council owned land** is normally the responsibility of the council concerned. For **other land** however, there is no legislation specifically identifying this as council's responsibility. Instead, it is the landowners responsibility under the *Natural Resources Management Act* to maintain their land and watercourses in good condition in line with natural resource management practices. Any stormwater infrastructure constructed on **other land** is not the responsibility of the council to maintain unless the council has an interest in the land through an easement etc.

Maintenance of watercourses in good condition may include actions such as removal of weeds and removing any obstacles to flow (e.g. fallen branches, poorly constructed / inappropriate fencing). The NRM Board could also assist landowners by providing information on appropriate natural resource management practices including information on best practice for the maintenance of watercourses.

Information on watercourse management can be found on the following page of the Northern and Yorke NRMB's website:

http://www.naturalresources.sa.gov.au/northernandyorke/water/managing-water-resources/watercourses/Managing_watercourses

Councils may also acquire, through an approved and gazetted stormwater management plan, the legislative responsibility to maintain watercourses in other land, including the power to enter such land (with reasonable notice) and to carry out works and infrastructure in accordance with the approved stormwater management plan. The legislative provision for this is contained in the Local Government (Stormwater Management Agreement) Amendment Act 2016.

It is important that the council puts in place the appropriate administrative arrangements to facilitate ongoing maintenance of any permanent infrastructure established on other land as part of this stormwater management plan. Unless otherwise agreed with the landowner, council must take on responsibility for permanent stormwater infrastructure that is to be placed on other land by taking an interest in the land. Examples of such an interest include an easement, a Land Management Agreement (under the Development Act) with the landowner (which would go on the title of the land), or land acquisition.

Examples of recommended stormwater infrastructure works in private land that may benefit from a formal arrangement with the landowner, such as creating an easement, land acquisition or a Land Management Agreement, are provided below:

- Formulising the drainage path of Shannon Creek to the Gilbert River
- A new grass swale along Charles Street
- A new levee at the creek crossing on Kapunda Road to the east of the town
- Formalising the drainage path(grass swale) along Bond Street and Horrocks Highway

8 Review of the Stormwater Management Plan

It is anticipated that this Stormwater Management Plan will be a 'living document' that is periodically reviewed to take account of current knowledge, changing conditions within the catchment and changing community attitudes to the management of stormwater and other water resources making up the urban water cycle.

To ensure that this occurs, it is expected that Council initiates a review of this Plan at least every 5 years and that the proposed works and strategies to be adopted for the subsequent 10 year period will be identified.

The SMA recognises that the Plan may need to be amended to account for modifying or elevating the priority of the recommended actions as a result of unforeseen circumstances, provided that the proposed changes are consistent with the overall strategy and properly integrate with any existing or proposed infrastructure, including any Stormwater Management Plan for an adjoining catchment

9 References

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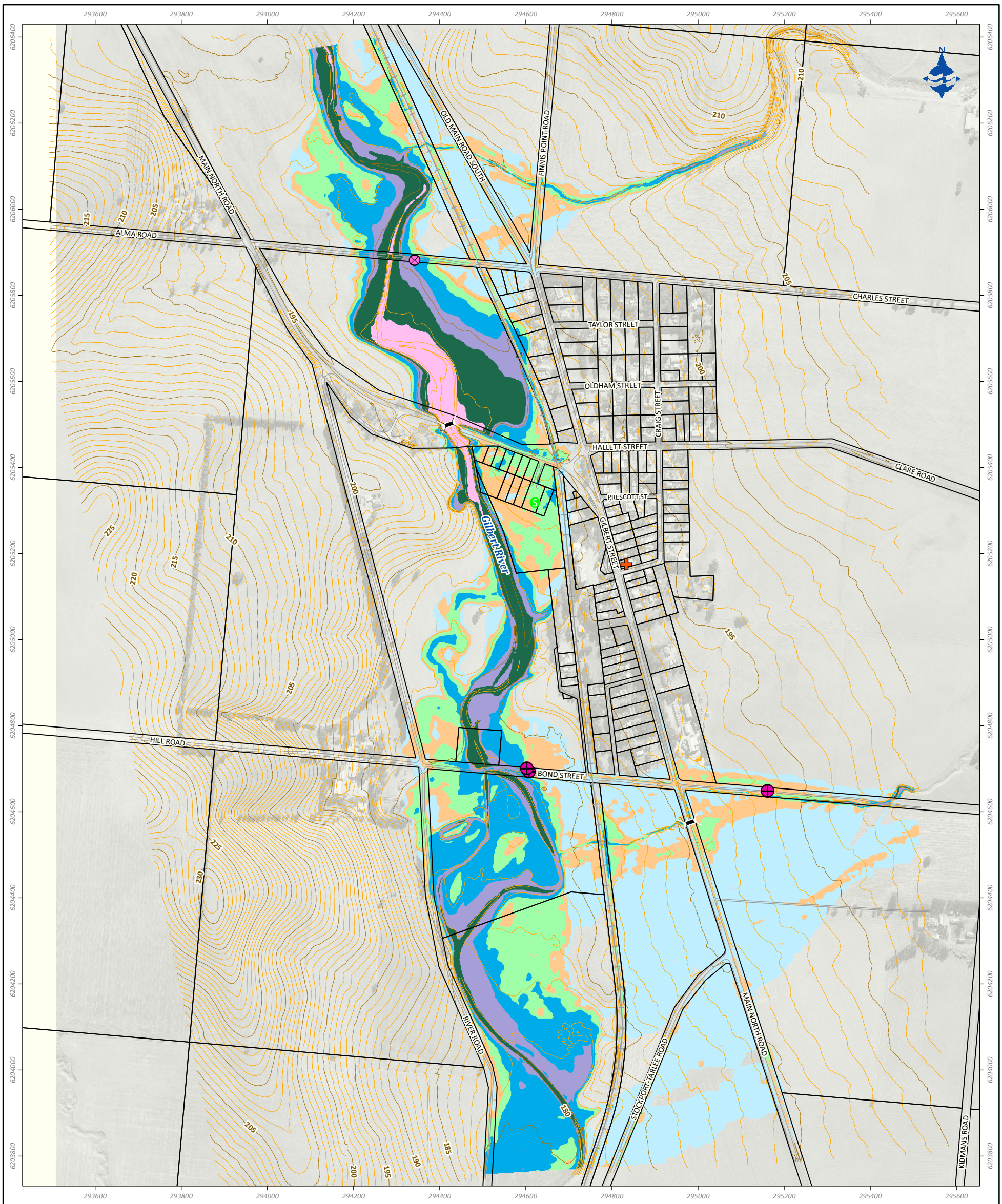
Water for Good (2009) Government of South Australia

Appendix A : Flood Inundation Maps



LEGEND

- Bridge or Culvert
- Sports Ground
- Ambulance
- Hospital
- Police
- SES
- CFS
- Cadastre

Water Main Crossing

Diameter (mm):

- 63; 80; 100; 150
- 200; 250; 375
- 600; 750

Contours:

- Intermediate Contour
- Index Contour
- Railway
- Road Edge

Flood Depth (m):

- 0 - 0.10
- 0.11 - 0.25
- 0.26 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.50
- 2.51 - 5.00
- Greater than 5.00

0 50 100 150 200 250 300

Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

Data Source:

Flood Data, Sports Ground and Railway Extent from AWE; Road Edge, Aerial Imagery and Contours from Aerometrex; Water Mains from SAWater; Bridges from DPTI; Roadnames, Bridges and Cadastre from Clare & Gilbert Valleys Council; CFS from South Australian Country Fire Service; SES from South Australian State Emergency Service; Police Stations from South Australia Police; Hospital from Australian Institute of Health and Welfare; Ambulance from SA Ambulance Service; Watercourses from Geoscience Australia.

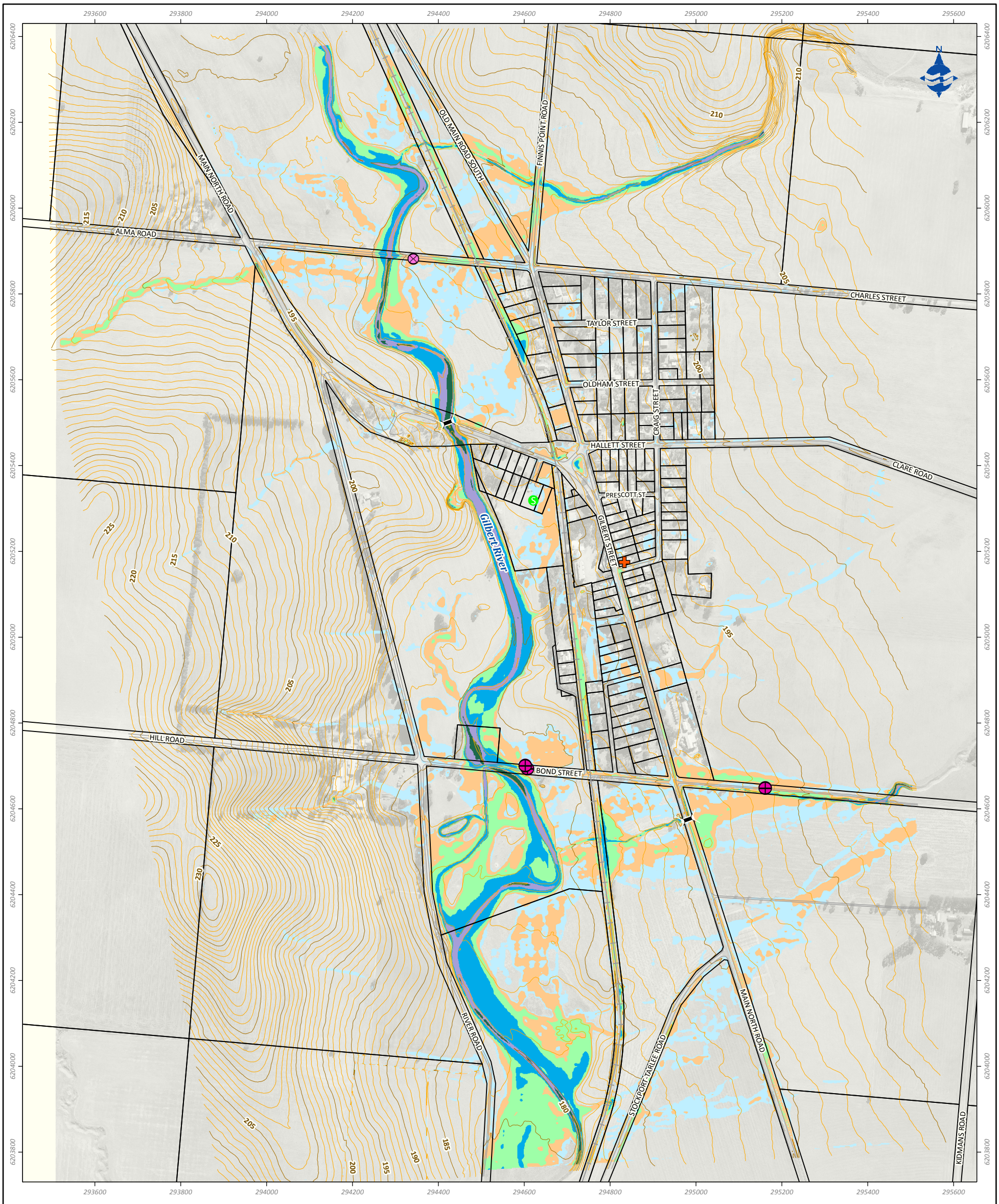
Floodplain Mapping for Seven Townships
Clare and Gilbert Valleys Council

Tarlee (Riverine)

100 Year ARI Event Inundation

12186 D053 v1 Tarlee Riverine Flood Maps 130405
Last Updated: 30/05/2013

Figure x.x



LEGEND

- Bridge or Culvert
- Sports Ground
- Ambulance
- Hospital
- Police
- SES
- CFS
- Cadastre

Water Main Crossing
Diameter (mm):
- 63; 80; 100; 150
- 200; 250; 375
- 600; 750

Contours:
- Intermediate Contour
- Index Contour
- Railway
- Road Edge

Flood Depth (m):
- 0.05 - 0.10
- 0.11 - 0.25
- 0.26 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.50
- 2.51 - 5.00
- Greater than 5.00

0 50 100 150 200 250 300
Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

Data Source:
Flood Data, Sports Ground and Railway Extent from AWE; Road Edge, Aerial Imagery and Contours from Aerometrex; Water Mains from SAWater; Bridges from DPTI; Roadnames, Bridges and Cadastre from Clare & Gilbert Valleys Council; CFS from South Australian Country Fire Service; SES from South Australian State Emergency Service; Police Stations from South Australia Police; Hospital from Australian Institute of Health and Welfare; Ambulance from SA Ambulance Service; Watercourses from Geoscience Australia.

Floodplain Mapping for Seven Townships
Clare and Gilbert Valleys Council

Tarlee (Direct Rainfall)

100 Year ARI Event Inundation

12186 D061 v1_3 Tarlee Direct Rainfall Flood Maps 130429
Last Updated: 30/05/2013

Appendix B : Community Feedback

Tarlee Stormwater Management Plan

Community Consultation

Identification of Issues

Consultation with the Tarlee local community was undertaken early in the project (August 2012) to identify their issues and opportunities for stormwater and flood management. The community meeting also provided the opportunity to confirm the accuracy of the modelled flow paths with the community.

A summary of the main issues raised by the community is provided below.

Stormwater and flooding issues:

- Charles Street acts as a stormwater drainage flow path;
- Drainage paths from the east affect the town;
- Insufficient stormwater infrastructure;
- Blocked culvert under Main North Road – cannot cope with high flows;
- Blocked drains and rubbish in creeks;
- Possibly some alterations to the creek by a landowner has resulted in changed flow path and flooding – Charles Street, Craig Street and Oldham Road;
- Railway line affects flow paths;
- Craig Street and Taylor Street are flooded during high flows – possibly due to alterations to creek to the east;
- Raising of road and surfacing of road (Charles Street) has created flooding problems for properties;
- Persistent pooling of stormwater adjacent Main North Road;
- Turbid stormwater, sediment transported through the system; and
- Ground has been raised over time between Main North Road and the silo – has affected drainage flow.

Aspirations and Opportunities:

- Currently no stormwater reuse and the potential for MAR is not fully known, however previous investigations about 3-4 years ago were not very successful;
- Remove rubbish from creeks and unblock culverts;
- Reinstate creek lines (Shannon Creek) – this should result in less water flowing along Charles Street;

- Spoon drain needs ongoing maintenance;
- Explore opportunities to create water detention areas – e.g. along creek North East of town (Shannon Creek);
- Upgrade drainage along Charles Street so it can cope better with flows – e.g. build up and maintain embankment to the north of Charles Street (and downstream flow paths need to cope with flows);
- Landowner discussions regarding potential management works – flood control, rehabilitation.
- Discussions need to be held with owners of railway line to explore drainage improvements;
- Look into placing a drain under the railway line;
- Houses in low lying areas – look into flood control measures;
- Explore storage areas for MAR, e.g. near Main North Road and Hallett Road, or near Tarlee Hall;
- Potential for and reuse for bowling green, school area (?), street tree watering;
- Need to check ownership of land titles – south of Main North Road / Hallett Road.

Consultation on Draft Strategies

Feedback on the draft strategies was provided by the Project Steering Committee and the Elected Members. A meeting was held in Tarlee (May 2014) to gain feedback from the local community on the draft strategies. This feedback helped to finalise the recommendations of the SMP.

A summary of the community consultation is provided below.

A meeting was held in Tarlee on 8th May 2014 and approximately 9 members of the community attended. Feedback forms were made available to the wider community to provide the opportunity for others to comment.

During the meeting AWE presented the key issues and draft suggested measures, including the impact to controlling flood. The feedback is summarised below.

Discussion:

- Need to open up the creek on Clarke St (extension of Charles St) because the landowner has blocked it up – very concerned about landowner changing the creek and putting other properties at risk of flooding.
- Make sure that the water coming along the Clare/Kapunda Rd towards the town is addressed/managed better.

Do you think the measures address stormwater and flooding issues?

- Yes – seem to be addressing the main areas of flood/main drainage paths.
- Concerned that the works proposed along Charles St won't adequately protect the houses on the southern side of the road. (Check the model again).
- Look at taking water straight across from Charles St to Gilbert River instead of taking water along Charles St up to Shannon Creek and then to Gilbert River.
- No concern that the old stone bridge is recommended to be removed.
- Concern that a large tree stump in the watercourse crossing at Clare/Kapunda Rd is blocking flows resulting in water flowing along the road instead of staying in the

watercourse. This needs to be included and addressed in the stormwater management plan.
- Need to improve drainage adjacent the Highway (just north of Sanders Rd) to address stormwater pooling.

Do you think the measures address water quality, local amenity and reuse options?

- Like the idea of street verge watering systems but they need to be located with care.
- Check if an MAR scheme can be located near the corner of Hallett St and Highway to possibly irrigate bowling green.
- An old bore exists in the town but not sure where it is. There used to be an old line of bores along Oldham St. An old bore is near the silo but this is very salty.

Are there any issues that Council should be aware of in implementing the suggested measures?

- A better maintenance program for stormwater infrastructure is required by Council
- Land in private ownership – need to liaise with landowners where works are proposed.

What are the most important measures?

The community members present at the meeting were asked to indicate what they thought were the most important suggested measures, as shown in the table on the following page.

Feedback forms

Feedback forms were also available for people to provide comment on the draft strategies. A total of 3 forms were received by Council. Key issues raised:

- Encourage further investigations into the reuse of stormwater, particularly for irrigating the Tarlee Bowling Club and Soldiers Memorial Garden.
- Prefer the water along Charles Street is not diverted northwards but rather is taken under the railway line and through to the river.
- Need to address the flooding issues on the southern side of Charles St. Suggest a drain along the southern side of the road to prevent water flooding properties.
- Mixed feelings about removing the old stone bridge, but suggest if it is removed then it is replaced with a footbridge to maintain pedestrian access here.
- Need to address rubbish and debris in watercourse to the east of town that ended up blocking the Kapunda Rd bridge and sent flood waters along the road into the town. Need to ensure this area flows in a way that doesn't create flooding problems for others.

Table: Community Feedback - Most Important Measures

Recommended measures	Which suggested measures do you think are most important? (percentage of people's preference)
Stormwater and flooding measures: *Added by the community at the meeting -* • *Kapunda Road bridge – maintenance required (remove obstructions)* • *Clarke Road ford/waterway – maintenance required (concern about landowners affecting drainage paths)*	42%
Stormwater and flooding measures: • Create swale along northern verge of Clarke Rd and create swale from Finnis Point Rd all the way to discharge point at the Gilbert River. Upgrade culvert road crossings on Finnis Point Rd, Old Main Rd and under railway line. *($460,000 - 5 properties protected)*	24%
• Create ford crossing on Bond St/Sanders Rd. Create swale along southern verge of Bond St and Horrocks Hwy. Create small levee on northern verge of Bond Street. Upgrade culvert crossing on Horrocks Hwy and under the railway line. *($280,000 - 3 properties protected)*	5%
• Demolition and removal of existing stone bridge downstream of Main North Road. *($210,000 - 8 properties protected)*	0%
Water treatment, harvest and reuse: • Street verge watering (4 systems) *($15,000 –capture runoff, improve water quality, local amenity, biodiversity)*	5%
Regular maintenance of stormwater infrastructure *($5,000)*	24%
Flood warning system for Gilbert River *($30,000)*	0%
Enforcement and inclusion of flood maps in Council's Development Plan	0%
Community education program – (Floodsafe) *($10,000)*	0%

Appendix C : Assessment of Priorities

Determining priorities - Tarlee Stormwater Management Plan

Considerations:	Ranking system:
Level of flood risk	Low = 100 year ARI event, Medium = 50 year ARI event, High = 20 year ARI event
Number of properties protected (%age) - based on properties at risk in 1 in 100ARI	Low = <20%, Medium = 20%-50%, High = >50% properties protected
Cost effectiveness ($ per property)	Low = >$250,000, Medium = $100,000-$250,000, High = <$100,000
Catchment area greater than 40ha	Low = <40ha, High = >40ha
Water quality improvement	Low = <20%, Medium = 20%-50%, High = >50% of proportion of catchment/township benefiting from treatment
Water harvesting and reuse	as per community aspiration
Community aspiration	Low = <20%, Medium = 20%-50%, High = >50% importance

Town: Tarlee

Recommendation	Current flood exposure	Number of properties protected	Number of properties protected (% of 16)	Cost	Cost per property	Cost effectiveness	Catchment area greater than 40ha	Water quality improvement		Water harvesting and reuse	Community aspiration	Priority - Low Medium High
								Catchment wide benefit	Township only benefit			
F1 - New and upgraded infrastructure to the north and east of Tarlee	High	9	High	$590,000	$65,556	High	High				Medium	H
F2 - Removal of the old stone Bridge	High	8	Medium	$210,000	$26,250	High	High				Low	H
F3 - New and upgraded infrastructure to the south of Tarlee	High	3	Low	$280,000	$93,333	High	High				Low	M
F4 - Regrading Horrocks Highway and add culvert	High	0		$20,000		High	Low				Low	M
C1 - Water Treatment – verge infiltration pit systems (4)				$24,000		High		Low	Low-Med		Low	L
F5 - Regular maintenance of stormwater drainage infrastructure and watercourses	High			$5,000		High					Medium	H
P1 - Flood preparedness - Flood warning system	High			$30,000		High					Low	M
P1 - Flood preparedness - Community education program	High			$10,000		High					Low	M
P2 - Development / planning controls	High					High					Low	H
R1 - Feasibility assessment of rain garden and small scale MAR scheme	Low		Low	$10,000		Low	High	Low	Medium		Medium	M
total				*$1,179,000*								

Appendix D : Implementation Plan

Tarlee – Implementation Plan

Priority	Timeframe 0 - 1 yr 1 - 5 yrs 5 - 10 yrs	Project/ Activity and Location	Capital Cost ($)	Recurrent Cost ($ pa)	Flood Mitigation Benefit *Measures:* *(P) – Properties Affected* *(properties protected by measures in the 1 in 100 ARI event)*	Water Harvesting Benefit *Measures:* *(V) – Volumetric* *(Q) – Qualitative*	Water Quality Benefit *Rating:* *(H) - High* *(M) - Medium* *(L) – Low*			Other Benefits *Rating:* *(H) - High* *(M) - Medium* *(L) – Low* Qualitative description of benefit	Potential funding partners with Council
							Benefit to whole of catchment	Benefit to township only	Qualitative description of benefit		
1	0 - 1	F5 - Regular maintenance of stormwater drainage infrastructure and watercourses	$5,000	$3,000	Effective drainage and therefore reducing risk of flooding.	-	-	-	-	Improved sense of security and wellbeing amongst the community.	-
1	1 - 5	F1 - New and upgraded infrastructure to the north and east of Tarlee	$590,000	$1,000	9 properties protected	-	-	-	-	Improved road trafficability	SMA
1	1 - 5	F2 - Removal of the old stone Bridge	$210,000	-	8 properties protected.	-	-	-	-	Pedestrian access maintained and improved road trafficability	SMA, DPTI
1	0 - 1	P2 - Development / planning controls	-	-	Reduced risk and cost of flooding to properties and people.	-	-	-	-	Better planning and development outcomes. Improved sense of security and wellbeing amongst the community.	-
2	1 - 5	F3 - New and upgraded infrastructure to the south of Tarlee	$280,000	$1,000	3 properties protected.	-	-	-	-	Improved road trafficability	SMA
1	1 - 5	P1 - Flood preparedness - establish a total flood warning system for Gilbert River	$30,000	$5,000	Reduced impact of flooding to properties and people.	-	-	-	-	Provides a warning for flood events which provides time for preparation and therefore reduces the risk and impact of flooding. Community awareness raised and people are empowered to protect their properties and response – thereby significantly reducing flood damages. Improved sense of security and wellbeing amongst the community.	BoM, SMA
1	1 - 5	P1 - Flood preparedness - community education program - e.g. Floodsafe	$10,000	$1,000	Reduce the risk of flooding and impacts of flooding.	-	-	-	-	Gain community support for implementation and ongoing management of the stormwater management measures. Build the capacity of the community to prepare for floods as well as reduce risk of flooding. Improve the community's sense of worth and feeling of security.	SES
3	1 - 5	R1 - Feasibility assessment of rain garden and small scale MAR scheme	$10,000	-	-	-	-	-	-	Potential water supply for Bowling Club and community landscaping	-
3	5 - 10	F4 - Regrading Horrocks Highway and add culvert	$20,000	$500	0 properties protected. Reduce flooding of Horrocks Highway	-	-	-	-	Reduce flooding of Horrocks Highway, reduced risk of road damage, alleviate community frustration and improves road trafficability & safety.	DPTI

Priority	Timeframe 0 - 1 yr 1 - 5 yrs 5 - 10 yrs	Project/ Activity and Location	Capital Cost ($)	Recurrent Cost ($ pa)	Flood Mitigation Benefit *Measures:* *(P) – Properties Affected* *(properties protected by measures in the 100 year ARI event)*	Water Harvesting Benefit *Measures:* *(V) – Volumetric* *(Q) – Qualitative*	Water Quality Benefit *Rating:* *(H) - High* *(M) - Medium* *(L) – Low*			Other Benefits *Rating:* *(H) - High* *(M) - Medium* *(L) – Low* Qualitative description of benefit	Potential funding partners with Council
4	5 - 10	C1 - Water Treatment – 4 verge infiltration pit systems	$24,000	$1,000	-	4 systems (in total) can capture 1150 kL/yr for watering road side vegetation. Community would like to reuse water for the Bowling Club however reuse was not seen as a higher priority than flood/stormwater control measures.	Low	Low-Medium	Expected treated water quality (based on flow weighted mean concentration) meets Environment Protection (Water Quality) Policy 2003 criterion for TSS, TP and TN. The improved water quality supports Council's Development Plan principles relating to managing and improving the quality of stormwater runoff. It also helps support the NRMB's resource condition targets relating to maintaining and improving water quality in aquatic environments.	Reduced pollutant loads. Potential to improve aesthetics, community pride and biodiversity values. Provides some flood detention.	NY NRMB