

Clare and Gilbert Valleys Council

Stage 2 SMPs for 7 Townships

MANOORA STORMWATER MANAGEMENT PLAN

APPROVED FINAL

July 2020



CLARE & GILBERT
VALLEYS COUNCIL



Government of South Australia
Stormwater Management Authority

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**Australian
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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 Manoora. 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.

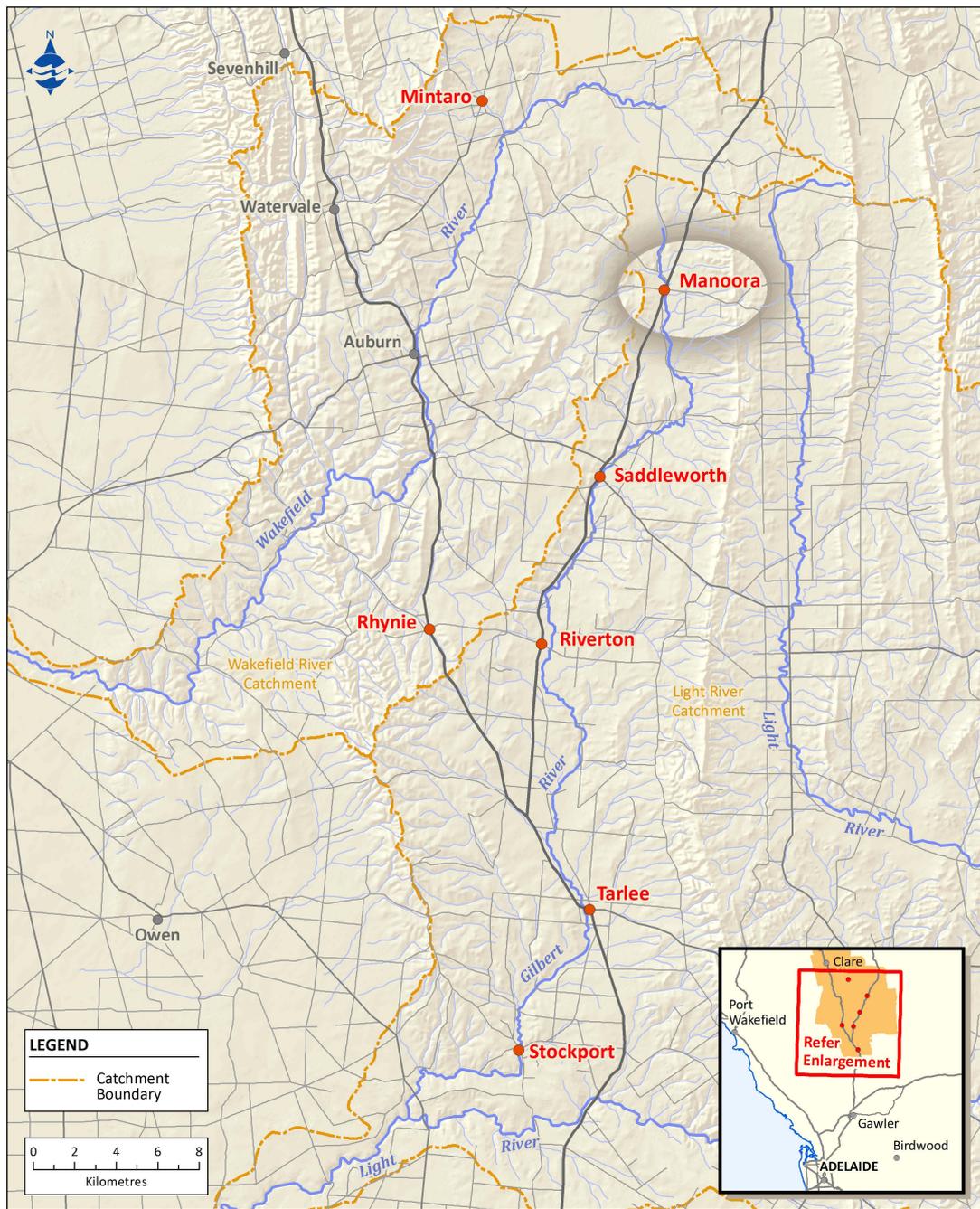
This SMP has been developed in conjunction with developing SMPs for six additional townships for the Council, including: Tarlee, Saddleworth, Riverton, Stockport, Mintaro, and Rhynie. These towns are located approximately 85 km – 130 km north of Adelaide, as shown in Figure 1-1 on the following page.

Manoora, Saddleworth, Riverton, Tarlee 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 v2 Location Plan 140611
Last Updated: 11/06/2014

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 many of 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. In some townships (such as Manoora and Mintaro) flooding occurs at least once a year, often twice a year. 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 Stormwater Management Authority's (SMA) 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 NRM 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 establishes 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.

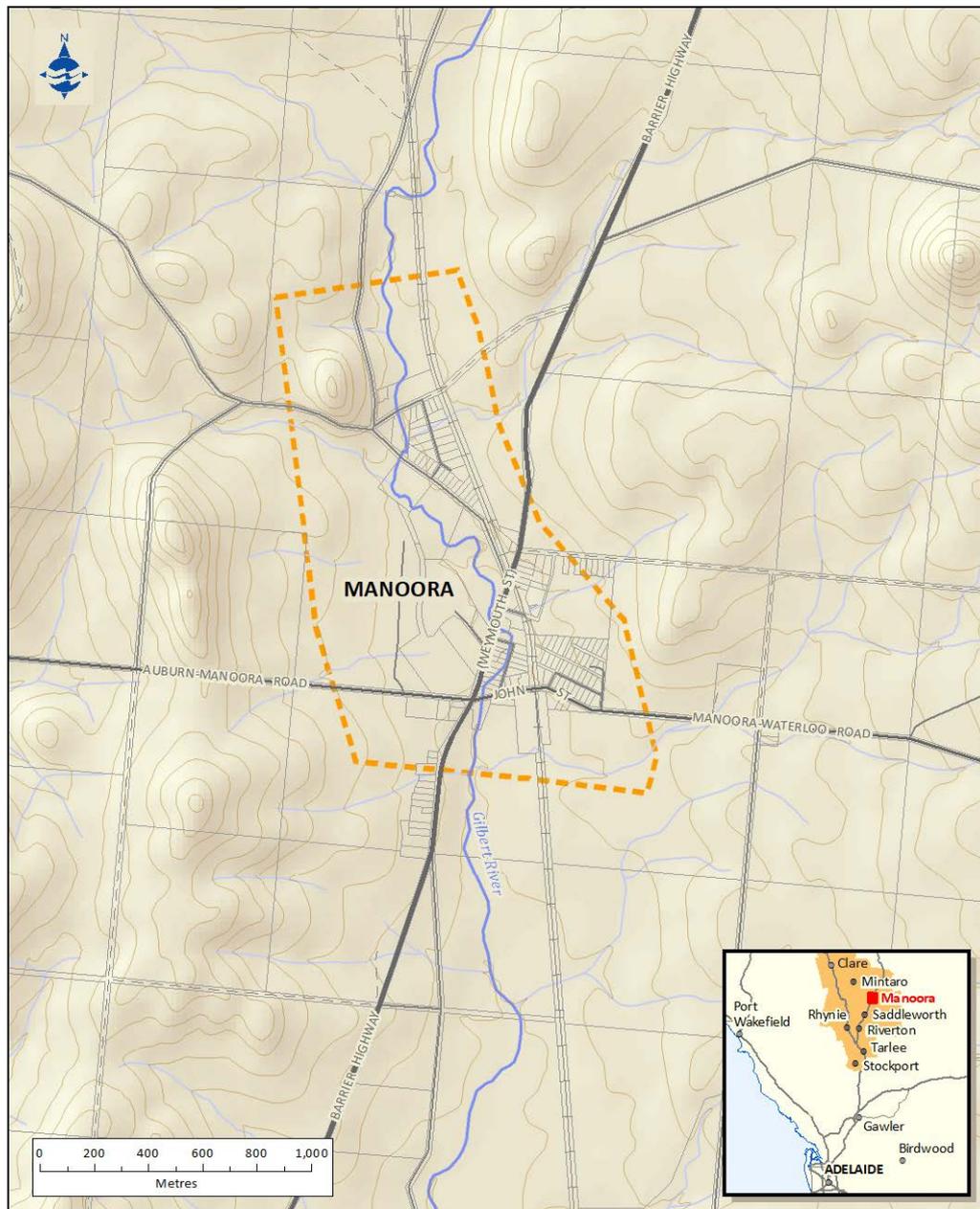
One of the key mechanisms for achieving the desired outcomes of integrated water management is to ensure that the objectives of the stormwater management plan meet and contribute to other State and National natural resource management policies and strategies. These strategies in turn assist in the implementation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

Manoora is located approximately 100 km north from Adelaide in the Mid North region of South Australia. The town is situated on the Barrier Highway, adjacent to the Gilbert River with most residential properties located on the eastern banks of the river. The small town is a gateway to the heritage area of Mintaro and passes the mansion of Martindale Hall (Strategic Directions Report 2012/13). The area for the stormwater management plan is shown as outlined 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 and 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 in Figure 2-2.

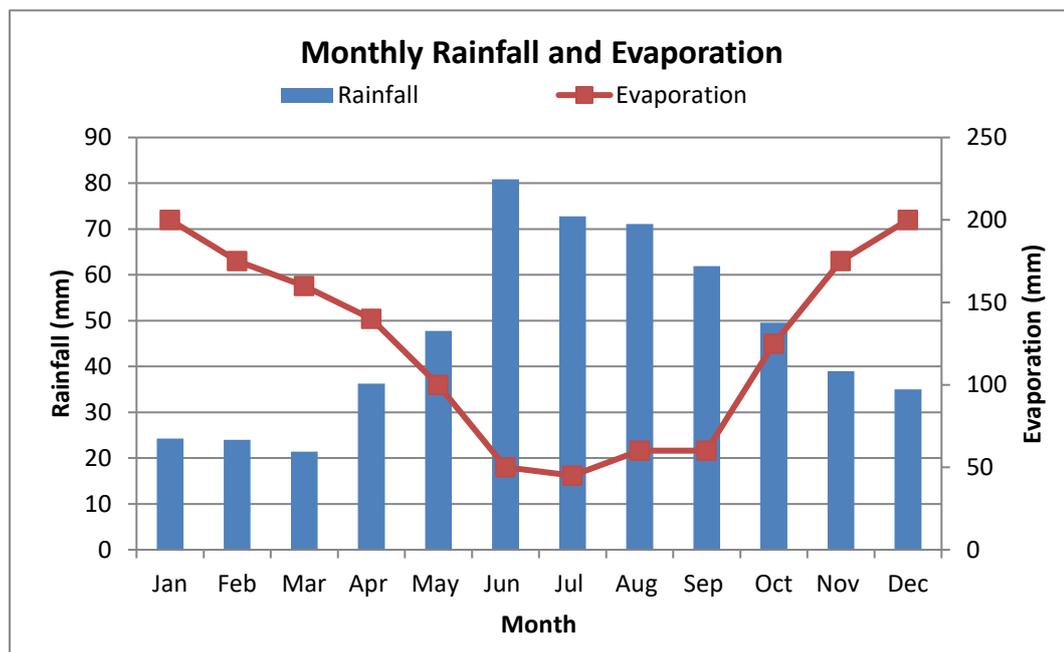


FIGURE 2-2: MONTHLY RAINFALL AND EVAPORATION

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.

Manoora is located within the Gilbert River catchment. 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 of a herbland/sedgeland 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, macroinvertebrates 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 but there are some areas of good sedgelands (Rural Solutions, 2005).

2.4 Hydrology of the Catchment

Manoora is located in the upper reaches of the Gilbert River catchment. The dominant land use for the catchment is rural activities and therefore 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'. The catchment area for Manoora is 30 km².

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).

There are several small tributaries which contribute to the Gilbert River within the study area.

Topographical features within the study area include:

- The main channel of the Gilbert River is approximately 5m wide through most of the township;
- Gilbert River flows under a series of road culverts and a ford;
- There is limited other stormwater infrastructure, typically single link networks/culverts under roads;
- Two flow paths join near the junction of Mintaro-Manoora Road and Merilden-Manoora Road in the north of the township. One is from the north (catchment 25.2km²) and one is from the north west (catchment 4.5km²);
- Just downstream of this junction there is a diversion structure which splits flow from the Gilbert River. The diversion channel is an artificial structure which flows to an old railway dam; and
- Drainage from the south east enters downstream of the township (having a catchment area of 4.2km²). This flows under the railway line through a series of culverts/bridges.

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 Manoora along with the other 6 townships in the project is shown in the table below:

TABLE 2-1: PROJECTED POPULATION

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

According to Council's Strategic Directions Report 2012/13, Manoora is not anticipated to expand in the immediate to medium term and the 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.

2.6 Existing Stormwater Assets

- Manoora has limited formal stormwater infrastructure which includes the following:
- Typically single link networks/culverts under roads, including a series of culverts under the railway line (e.g. two culverts directing flows to Elizabeth and Thomas Street);
- Diversion structure splitting flows from the Gilbert River – this artificial structure diverts flows to the old railway dam;
- The dam's overflow path is through properties across the Barrier Highway to the south west; and
- One ford crossing.

Informal stormwater infrastructure includes:

- Overland flow routes from the rise between Commercial Road and Manoora-Waterloo Road towards the south west, near the junction of John Street and the railway line; and
- Roadway and road verges.

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

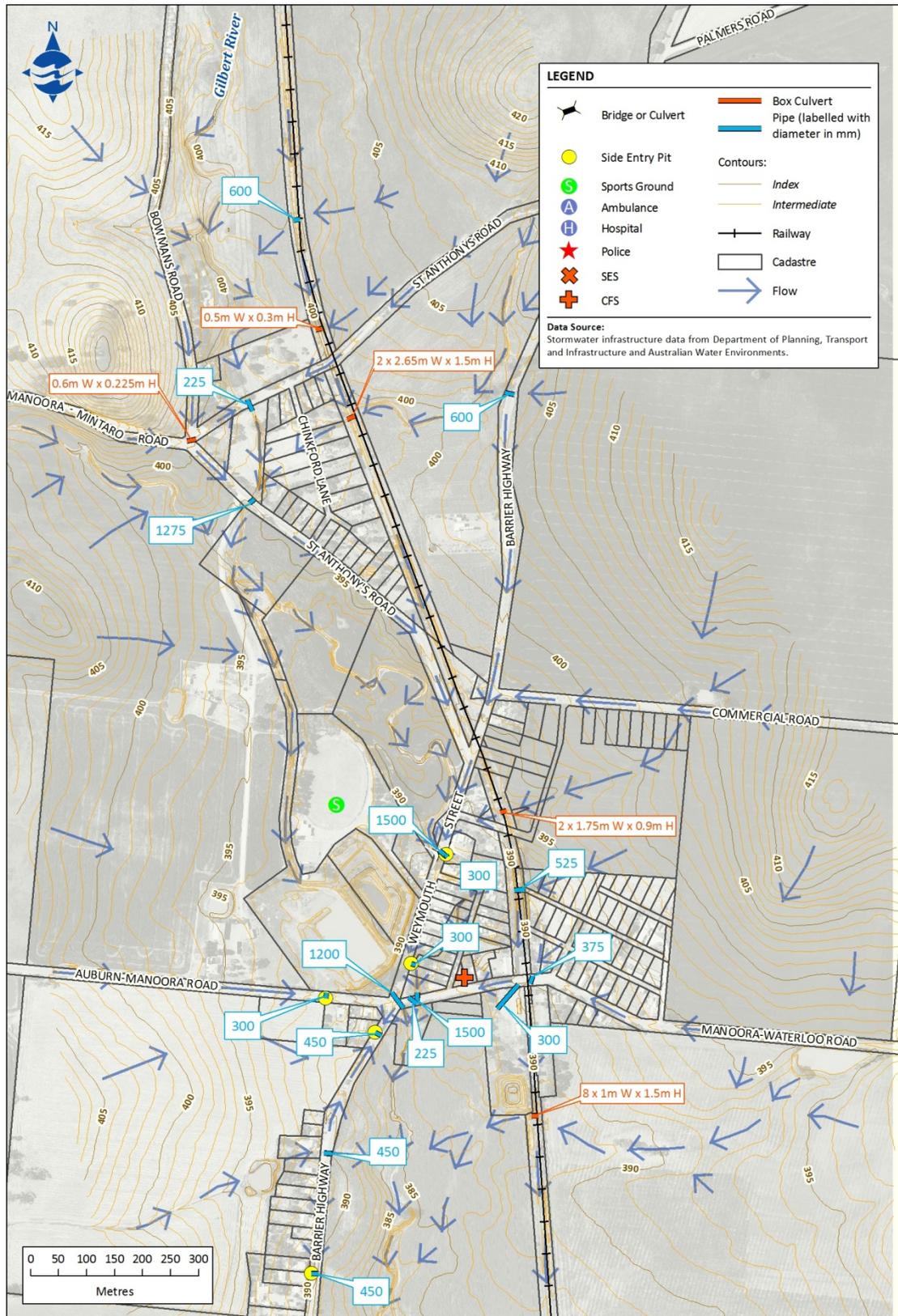


FIGURE 2-3: EXISTING STORMWATER ASSETS

3 Identification of Problems and Opportunities

3.1 Economic, Social and Environmental Issues

3.1.1 Economic

In September 2010, flooding affected approximately 10-15 houses in Manoora, as well as Mintaro, plus Council infrastructure (cost to Council approximately \$330,000). In December 2010, flooding again occurred in the area and other towns such as Stockport, Riverton, Rhynie and Tarlee. 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 (Council infrastructure: \$2.5 million in bridge damage and \$3 million to roads).

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. The ecological diversity of the region has been significantly altered and overall the ecological health of the systems is highly degraded. Erosion and sedimentation caused by stormwater and flooding in Manoora can result in a decline in water quality and ecological health of 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, as shown in Table 3-1. These values reflect the community's value of the watercourses. Management actions need to safeguard these values.

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 Manoora which can help protect water quality and ecological health of the downstream environments. To this end it can support the actions of others in advocating a higher end state value downstream.

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 direct rainfall. This is summarised below and also shown in flood inundation maps for the 100 year ARI event which are provided in Appendix A.

3.2.2 Riverine Flooding

20 year ARI event

During the 20 year ARI event the Gilbert River upstream of St. Anthony's Road inundates a number of properties past Chinkford Lane. There are several small breakouts within the agricultural land upstream of Weymouth Street. Many properties on Weymouth Street are inundated in the area downstream of Weymouth Street and upstream of John Street.

50 to 500 year ARI events

The depth and area of inundation increases with the higher ARI events. There are no additional breakouts that occur.

3.2.3 Local Flooding Assessment¹

Land north of Manoora is located at the confluence of several channels and flooding in this region is dominated by external catchment flow. Southern parts of Manoora have several steep catchments to the east and west. Overland flow from the rise between Commercial Road and Manoora-Waterloo Road is predominantly to the south west near the junction of John Street and the railway line. This overflow is predominantly sheet flow.

There are two culverts through the railway line to Elizabeth Street and Thomas Street. A dam's overflow path is through properties across the Barrier Highway to the south west.

3.3 Properties and People at Risk of Flooding

Flood maps (based on riverine flooding) and aerial photography were used to identify properties 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 properties at risk of flooding and the average number of people per property.

The population and number of properties in Manoora 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	Med	High	Total
115	12	5	7	24 <i>(excluding undeveloped allotments)</i>
Local Rainfall Flooding				
47	4	5	1	10 <i>(excluding undeveloped allotments)</i>

There are no properties are at risk of inundation from direct rainfall (local rainfall) only that are not also affected by riverine flooding.

3.4 Impacts of Future Development on Flooding

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

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.

As outlined previously in chapter 2.5 of this SMP, Manoora 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.

The township is zoned as 'Township' and is surrounded by land 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 a 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 stream rehabilitation, e.g. weed and exotic tree management programs and rock scour protection at stormwater outlets along main roads.

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.

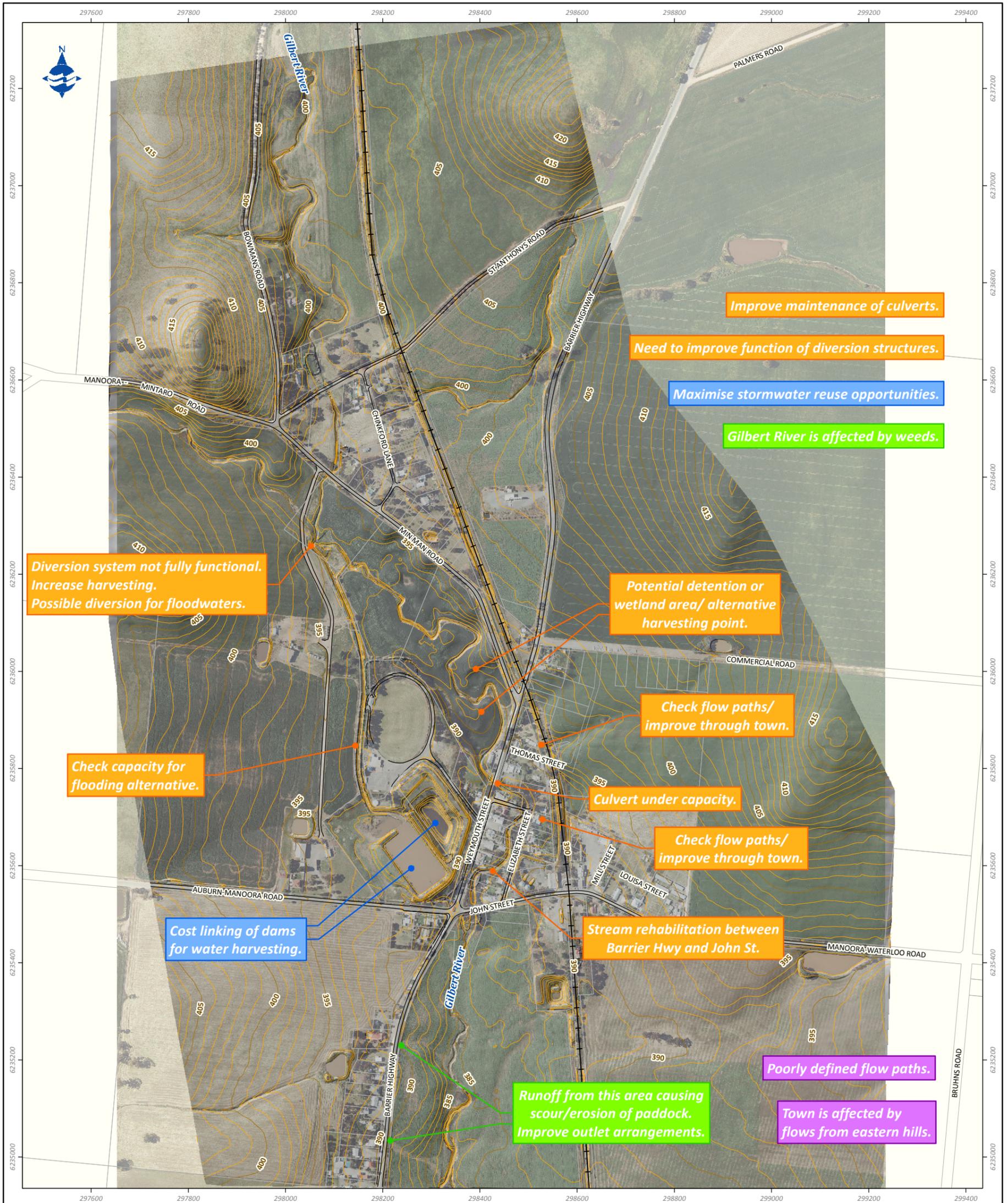
Consultation with the Manoora community was undertaken in August 2013 to identify issues and opportunities for stormwater and flood management. This information helped to determine the objectives of the SMP. A summary of the issues raised by the community is shown on the following page in Figure 4-1,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

- Reduce the impact of nuisance local flooding, such as pooling water adjacent Weymouth Street;
- Provide an acceptable level of protection of assets from local and regional flooding (from Gilbert River and from drainage from the east of the town);
- 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 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.

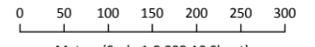
A brief description of these objectives follows.



LEGEND

- Contours:
 - Index
 - Intermediate
 - Railway
 - Road Edge
 - Cadastral
-
- Flood control/management
 - General comment
 - Water reuse
 - Water quality/biodiversity/erosion control

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



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

Manoora

Issues and Opportunities Raised by the Community

4.2.1 Local Flooding

The following criteria were adopted:

Formal Infrastructure to Remain Effective

Formal infrastructure, such as culverts, ford, dam and diversion structure (lock) should be functional and able to cope with design flows.

Informal Infrastructure to Remain Effective

The informal infrastructure (such as the roadways, 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 road side 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 $0.09 \text{ m}^2/\text{s}$. 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 $0.09 \text{ m}^2/\text{s}$.

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

Manoora experiences flooding from the Gilbert River during events of 20 year ARI or higher. During these floods water tends to inundate the main road (Weymouth Street). SMP objectives include

providing protection to properties from flooding within the identified township boundary. The SMP can assist with achieving this by providing guidance on:

- Formulating drainage paths to limit flooding of properties in the township;
- Ensuring drainage infrastructure is appropriate for conveying flows, eg culvert capacities;
- Appropriate finished floor levels to prevent flooding from Gilbert River and from other flows into the town;
- Reducing any congestion in flows caused by inefficient drainage system; and
- Options for mitigating flooding.

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 1 in 100 year average return interval flood event; and*
 - b) *Buildings are designed and constructed to prevent the entry of floodwaters in a 1 in 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 1 in 100 year average return interval flood.*
- *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 NRMB's Regional Plan (Volume D) 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 NRMB'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.

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 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.

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.

Some allotments in the township are currently affected by flooding, such as those adjacent to the main watercourse channels and those situated to the east of the town which experience sheet flow coming down the eastern slopes towards the town.

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.

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

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

Recommended non-structural measures include a flood preparedness program and planning/development controls.

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 Manoora.

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 Manoora 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 Manoora, there is approximately 6 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.

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 Manoora 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, and ensuring that finished floor levels where buildings can be constructed are above the predicted 100 year ARI event flood level. In addition, in areas outside of designated flood areas, it is recommended that finished floor levels of new developments are 300mm above surrounding land levels, in order to avoid buildings being constructed too low and thus potentially at risk of unforeseen flooding,

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:

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

Improvements to water quality, stream rehabilitation, and actions to reduce the risk of flooding 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 list of recommendations as option P2 in Table 6-1.

5.3 Management of Flood and Local Runoff

Management strategies have been developed that focus on improving the performance of the existing diversion channel and adding a new eastern swale. Mitigation measures aimed at protecting properties from inundation in the 100 year ARI event were extensive and considered cost prohibitive and therefore the suggested measures are based on a level of protection for the 50 year ARI event. There are 22 properties at risk in the 50 year ARI event.

The recommended measures are described below and shown in Figure 5-1 on the following page. This figure also shows the effectiveness of these recommendations on flood inundation.

In some cases, the works required would be on private land. In these cases Council may require access agreements, an easement or land acquisition so that Council can access and maintain infrastructure in the future. Section 7.3 outlines responsibilities for future maintenance of works.

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 plan.

5.3.1 Modification to the Existing Diversion Channel and Dam

The existing diversion channel directs some of the flow from the Gilbert River into an existing detention dam/basin, which is located to the west of Weymouth Street and immediately north of the Auburn-Manoora Road. To help facilitate flows into the dam/basin, a new diversion weir (0.9m high) is recommended at the beginning of the diversion channel (near the river). The invert of the existing diversion channel is to be lowered by 0.3m, and the channel is to be enlarged (12m wide (top) x 4.8m wide (bottom), 1.2m high and 1:3 side slopes).

It is also recommended that additional storage is provided by enlarging the existing detention dam/basin (by increasing its spatial area and depth) to 85ML and provide an overflow swale to redirect flows to the main channel. The embankment of the existing dam and detention basin also need to be raised by between 0.4 to 1.8 metres. (This may involve works on private land, requiring easements or land acquisition to provide for future maintenance).

It is recommended that the dam is to be lined for the purpose of preventing any leakage and impact to other properties. It is also recommended that the dam be fenced to prevent unauthorised access, and a levee be placed around the northern edge of the dam to increase its effective detention area and prevent out flanking.

The connectivity between the dam and detention basin is improved by the insertion of 2 x 3.6 x 1.2 culverts. Outflows from the basin are via a 1.8 W by 1.5 H box culvert that then extends along the road reserve (whilst avoiding a fibre optical cable) and crosses the main road along with the other culverts under the Barrier Highway.

Additional culverts are also recommended at the intersection of the Barrier Highway and the Auburn-Manoora Road (upgraded to 5 x 1.5m diameter). The additional culverts are needed to accommodate flows (approximately 6m³/s) along Auburn-Manoora Road as well as flows from the north along the proposed Weymouth Street swale. The end result is nearly 30 m³/s being directed towards the dam and detention basin with only 8 m³/s continuing down the main Gilbert River during a 50 year ARI flood event. The peak outflow from the detention basin is 16.9 m³/s.

The catchment area associated with these works is greater than 40ha.

In developing the SMP an alternative option of enlarging main river channel of the Gilbert River through the town was considered. The above scope of works was however preferred because it supports water quality and reuse opportunities for the township as well as improving exposure to flooding. It also avoids rebuilding two main road crossings (including the Barrier Highway) that would be required to enlarge the main watercourse flowing through Manoora and whilst minimising the number of property acquisitions required. Hence, the community had a strong preference for the preferred option included herein rather than the channel widening (or other canvassed options). Nevertheless, the cost of works is significant, and hence a preliminary design task has been incorporated within the scope of works for this item to further optimise the design and re-evaluate its cost effectiveness in comparison with other options when the time comes to proceed with further design work.

This measure is included in the list of recommendations as option F1 in Table 6-1.

5.3.2 Proposed Eastern Swale and Associated Works

The existing stormwater drainage path either side of the railway line is recommended to be formalised by providing a swale (5.2m wide (top) x 2.5m wide (bottom) x 0.45m high and 1:3 side slopes). The western swale is to run alongside of the railway line and around the southern boundary of allotment 16. (This may involve works on private land). The eastern side swale is to direct water towards a new 525 mm pipe under the railway line that would connect the two swales across the railway line. The railway line and eastern swale effectively act as detention systems.

The existing culvert under the railway line located approximately 100m south from the intersection of Mintaro-Manoora Road and Barrier Highway is to be made redundant. If this culvert is blocked off water will run southwards into the proposed upgraded eastern swale towards the new 525 mm pipe.

Water from the swale would over top Elizabeth Street via an existing ford/sag crossing and then spill into the Gilbert River.

The catchment area associated with these works is greater than 40ha.

This measure is included in the list of recommendations as option F2 in Table 6-1.

5.3.3 Improved Drainage/Protection in Vicinity of Chinkford Lane

Recommendations include creating/upsizing the swale running across Chinkford Lane – approximate dimensions: 6.3m wide (top), 3.4m wide (bottom), 0.7m high, 1:2 side slopes. (This may involve works on private land)

The following works are also required to cater for the increase in capacity:

- Cap off one of the culverts under the railway line to avoid excessive flows flowing east to west towards properties east and west of this road. The railway line then help to detain water to the east and acts as an informal detention system with water pooling behind the railway line. (This may involve works on private land);
- Provide a culvert crossing under Chinkford Lane (2 x 0.6 x 1.5m box culvert);
- Modify (widen) a section of the main Gilbert River channel by 4.5m just upstream from Mintaro-Manoora Road to provide additional capacity to channel (this may involve works on private land);
- Provide a levee 1.3m along eastern bank of main channel at this location;
- Provide additional culvert crossings on Mintaro-Manoora Road (2 x 1.2m diameter); and
- Provide a low levee (500 mm including freeboard) along the western boundary of the property fronting St Anthonys Road adjacent Gilbert River (involves work on private land).

The catchment area associated with these works is greater than 40ha.

These works are included in the list of recommendations as option F3 in Table 6-1.

It is possible that if there were interest in developing the vacant lots in this area that are presently flood prone, then Council may wish to consider an arrangement whereby the developer contributed to the works so that the lots could be developed.

5.3.4 Other Options Explored

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 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 are 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 Flood event are simply too great for these measures to be effective. Their effectiveness is usually limited to floods up to the 5 year or occasionally the 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 flows of a 50 year ARI event were modelled with the recommended management measures in place. The difference of flood inundation 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, some areas that were once dry are now seen to be wet or flooded in the 50 year ARI event but these are located outside of areas where this could cause harm.

There are 24 properties at risk of flooding in the 100 year ARI event, however due to the extensive works (and costs) that would be required to protect those properties in this flood event, it was determined that recommendations would aim at protecting properties in the 50 year ARI event, in conjunction with non-structural measures. There are 22 properties at risk in the 50 year ARI event and the recommended works are expected to protect all of these properties.

A breakdown of the number of properties protected in a range of ARI events (with the recommendations in place), is provided below.

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

ARI event	20 year	50 year	100 year
Number of Properties Currently at Risk	13	22	24
Number of properties protected	13	22	<22

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 will improve the trafficability of the road network. There were only two locations where flood water would overtop the road. This is where St Anthony's Road meets the Gilbert River, and on the Manoora-Waterloo Road. The depth of this is less than 50mm. These roads are therefore still considered to be trafficable.

Road trafficability and locations of where water overtops the road 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.

In a 50 year ARI event, the proposed works are expected to reduce the velocity of flows leaving the town by 5% compared to the existing situation. This will help protect downstream environments by reducing the risk of stream instability and erosion.

5.5 Regular Maintenance of Drainage Infrastructure and Watercourses

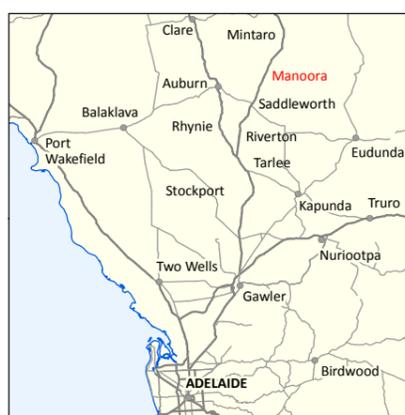
The effectiveness of stormwater drainage infrastructure and watercourses is influenced by whether or not they are maintained and free of blockages. It is recommended that Council maintain the drainage paths and infrastructure in a manner to ensure they perform as designed, i.e. to enable efficient flow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

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

In relation to fences across watercourses, it is also recommended that Council, in conjunction with the NRM Board, assesses the suitability of stream fencing that may be in place, and identifies 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 F4 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.



LEGEND

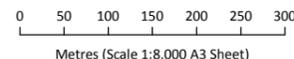
Proposed Remediation Options:

- Upgraded Culvert
- Roadside Swale
- Regraded Road
- Channel Modification
- Levee
- 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

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



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

Manoora

Recommended Measures and Effectiveness on Flood Inundation

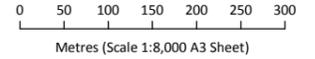


LEGEND

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

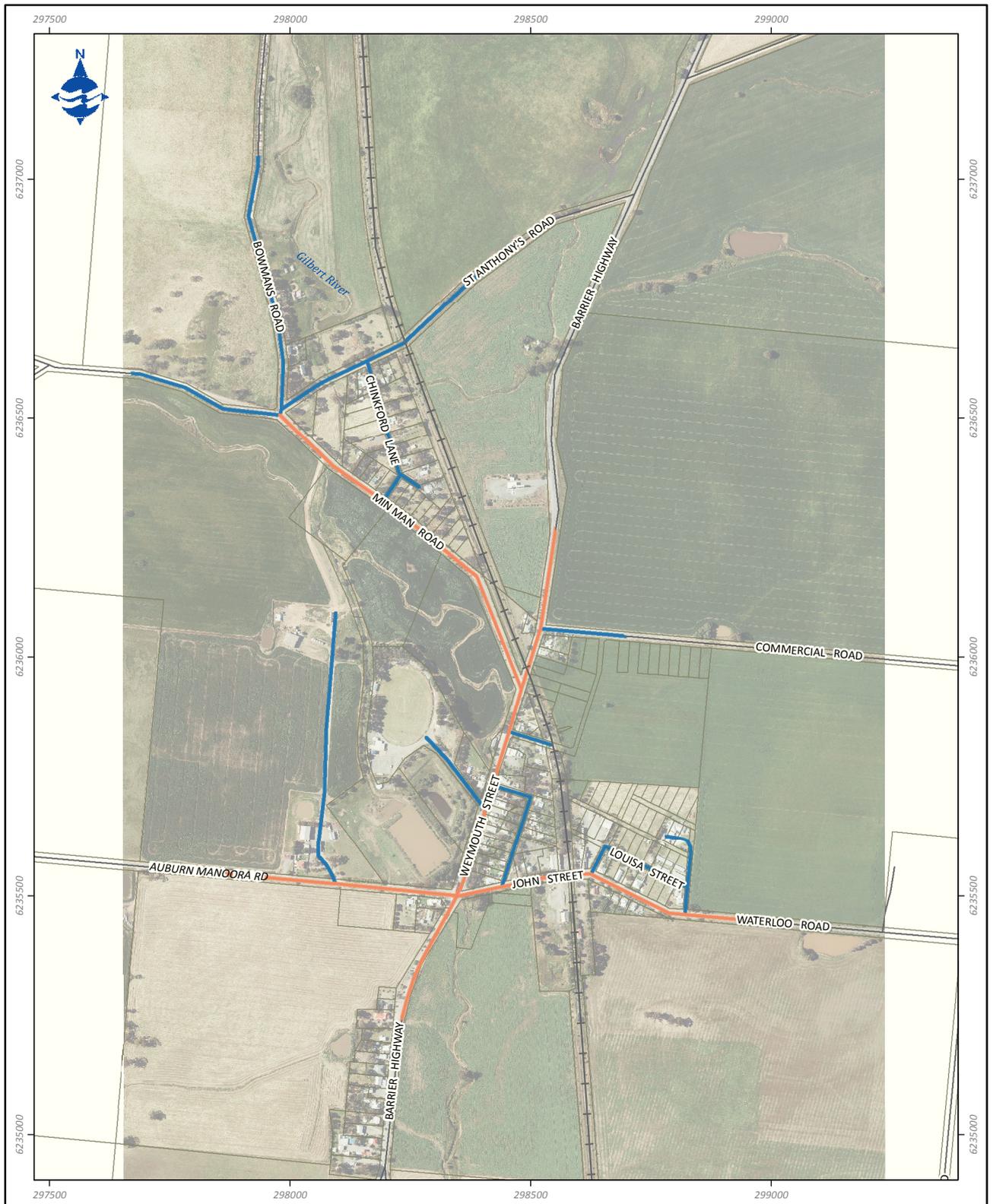
Note: Flood difference was determined by subtracting mitigation data from the current scenario therefore negative values represent a greater depth in mitigation data.

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



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

**Manooora
50 Year ARI Event Inundation Difference**

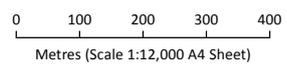


LEGEND

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.



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

**Manoora
Trafficability of Roads**

5.6 Water Quality Assessment

Recommendations for improving water quality include establishing a sedimentation area in the existing flood detention basin, and rehabilitating the stream.

This investigation is described below.

5.6.1 Detention Basin

Analysis of the catchment area and land uses was undertaken to determine the likely pollutants at Manoora. 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.

Stormwater issues and opportunities arising from floodplain mapping and community consultation were explored to identify water treatment options. This process identified land adjacent to the football oval and existing dam that may be suitable to provide some water treatment, as shown in Figure 5-4.

The treatment system would incorporate a sedimentation area within the flood detention basin to improve the water quality and provide additional storage for stormwater water flows from the northern catchments of Manoora, as well as a potential stormwater reuse opportunity through the irrigation of the football oval.

The primary roles of the basin are as follows:

- Provide treatment for the stormwater flows from the northern urban catchments of Manoora;
- Improve the local amenity of the Manoora landscape;
- Provide storage capacity;
- A potential reuse opportunity; and
- Reduces runoff rates which will help to minimise adverse impacts to watercourses and receiving waters.

For water quality improvement purposes, the recommended surface area of the basin is 4000m² and assumed it will have an operating depth of 1.5m and a maximum depth 3m respectively. The assumed operating depth of 1.5m for the detention basin will improve the sediment removal function of the system.

The pollutant load of stormwater entering the detention basin would be reduced. In fact, the performance of the basin would meet (exceed) the pollutant reduction percentage targets of the South Australian Government (Water Sensitive Urban Design, 2013), as shown in the following table.

TABLE 5-2: COMPARISON AGAINST POLLUTANT LOAD REDUCTION PERCENTAGE TARGETS

	Treatment system – Surface Area (m ²)	% Reduction		
		TSS	TP	TN
State Government target	-	80	60	45
Wetland/Detention Basin	4000	91	71	54

A flow weighted mean concentration (mg/L) was calculated for the outflow from the proposed basin 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 as per the Environment Protection (Water Quality) Policy 2003 for fresh water. TSS was the only pollutant that did not specifically meet the Policy requirement. Notwithstanding this, there would be a reduction compared to existing conditions. These results are summarised below in Table 5-3.

TABLE 5-3: COMPARISON OF WATER QUALITY AGAINST ENVIRONMENT PROTECTION (WATER QUALITY) POLICY (2003)

Treatment System	Pollutant	Policy (2003) Fresh Water Criterion (mg/L)	Flow Weighted Mean Concentration (mg/L)
Basin	TSS	20	23
	TP	0.5	0.4
	TN	5	3

The water quality improvements of the detention basin would also result in an overall reduction in pollutant loads for the town as a whole, as shown below in Table 5-4.

TABLE 5-4: EFFECTIVENESS OF WATER QUALITY TREATMENT FOR WHOLE OF TOWN

	Average Pollutant Loads (kg/yr)		
	Total Suspended Solid (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)
Water quality with no treatment	8050	17	116
Water quality with treatment	725	5	54

The results of the MUSIC modelling for the basin suggest that the proposed works would make a substantial difference to pollutant loads and, along with ongoing improvement in upstream land management practices, would go a long way to achieving the water quality targets of the State Government.

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.

Given the proximity of the basin to the football oval and the existing irrigation dam this would allow for effective irrigation connection to the football oval, if stormwater reuse is considered in the future for irrigation purposes.

The catchment area associated with these works is greater than 40 ha.

This measure is included in the recommendations in Table 6-1 as option WQ1.

5.6.2 Stream Rehabilitation

In addition to these water quality treatment measures, stream rehabilitation measures are also recommended to control exotic vegetation in the river and to reduce scouring at stormwater outlets, particularly along the Barrier Highway. (this may involve works on private land).

It is recommended that Council:

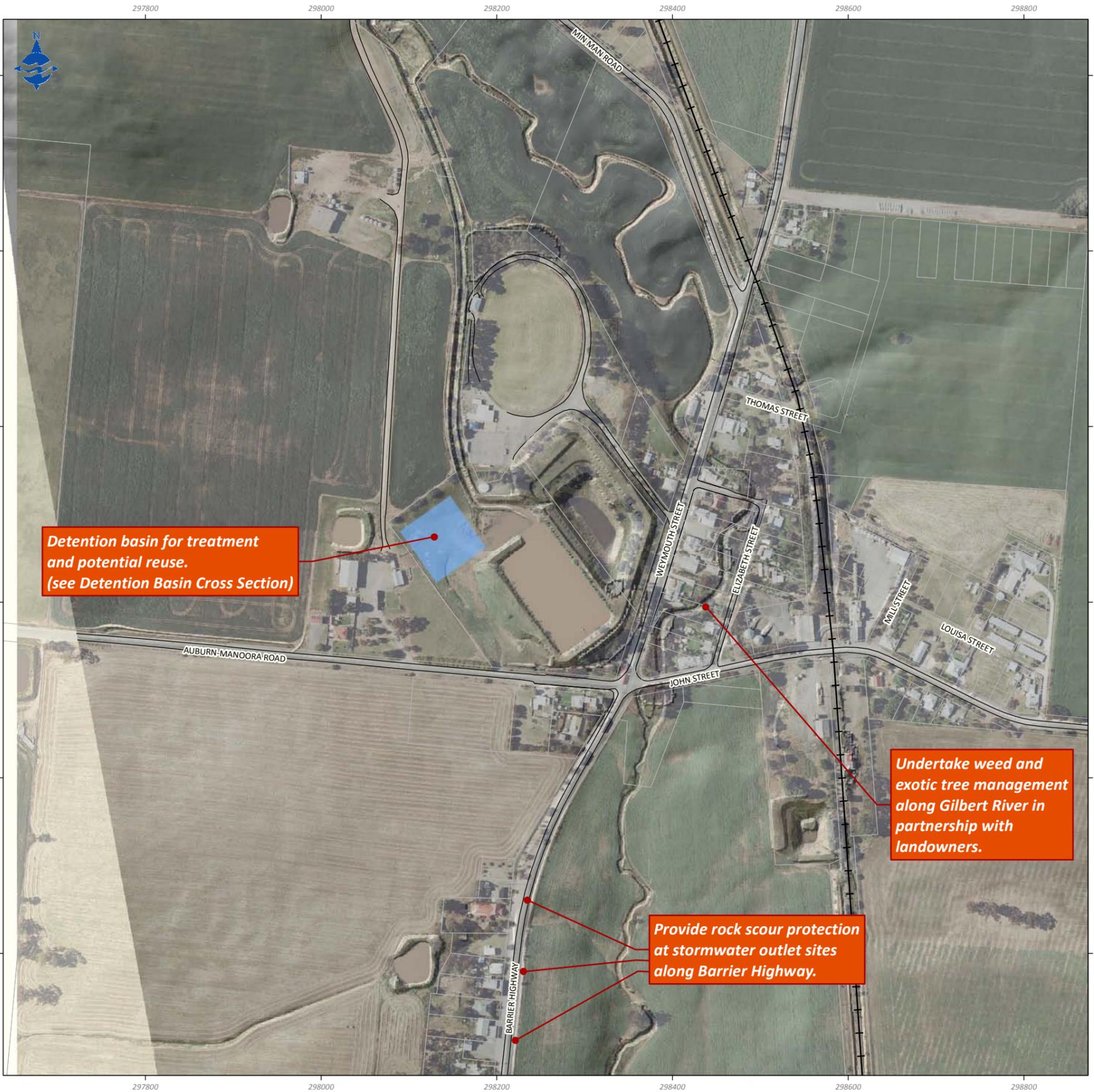
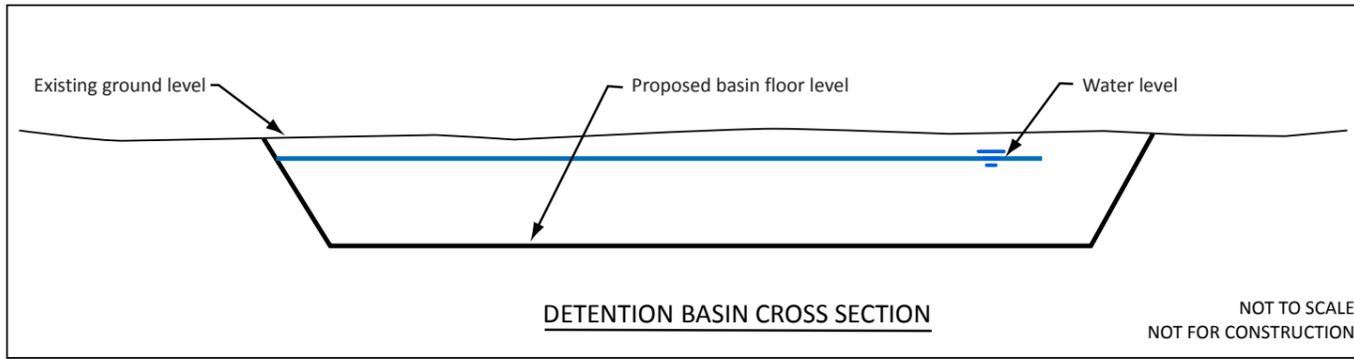
- Undertakes weed and exotic tree management along Gilbert River in partnership with landowners.
- Provide rock scour protection at stormwater outlets along Barrier Highway.

These are shown in Figure 5-4.

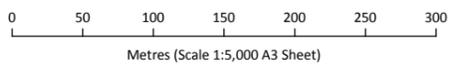
Stream rehabilitation will also improve stream bank stability, thus reducing the risk of erosion, which will minimise adverse impacts to watercourses and receiving waters.

These measures would also help to improve biodiversity values of the river and surrounds.

These are included in the recommendation in Table 6-1 as option WQ2.



- LEGEND**
- Railway
 - Road Edge
 - Cadastre
 - Potential Detention Basin



Data Source:
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

Manoora

Stormwater Treatment, Harvest and Reuse

5.7 Stormwater Harvesting and Reuse

5.7.1 Overview

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 detention basin described in the previous section for treatment purposes also provides an opportunity for storage for future reuse, such as supplementing the oval irrigation.

A preliminary assessment of MAR was also undertaken to determine the feasibility of a MAR scheme in Manoora, however due to the uncertainties of the scheme's effectiveness it has not been identified as a high priority at this time (refer section 5.6.3).

The investigations are summarised below.

5.7.2 Detention Basin

At this point in time there does not appear to be sufficient demand to reuse stormwater to water parklands and gardens in the township. However, pending further investigations, it may be more worthwhile reusing stormwater to supplement existing irrigation of the football oval. More detailed water balance investigations are recommended should the community decide to pursue this option.

The option of incorporating a water harvesting system within the existing flood detention basin for storage and stormwater reuse was explored. This option would alleviate some of the storage and conveyance issues associated with the external flows from the northern catchments of Manoora and supplement existing irrigation supply for the football oval.

A high level water balance assessment was undertaken to assess the potential for stormwater reuse. The stormwater volumes generated as part of the MUSIC Modelling for the northern township catchments of Manoora were used to understand the potential harvestable stormwater volumes. The first component of this water balance assessment involved determining the average annual yield of stormwater generated from the catchment draining into the detention basin. This is summarised in the table below.

TABLE 5-5: AVERAGE CATCHMENT STORMWATER RUNOFF YIELDS

System	Surface Area (m ²)	Average Catchment Stormwater Yields (kL/yr)
Detention Basin	4000	23,000

The next step of the water balance assessment involved determining the indicative harvestable volume of stormwater of the detention basin. As part of acquiring a permit to construct a water storage such as a detention basin, 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 Plan 2004). Table 5-6 below summarises the median annual and harvestable volume respectively based on the requirements for obtaining a permit.

TABLE 5-6: STORMWATER RUNOFF YIELDS FOR REUSE

System	Median Annual Volume (kL)	Harvestable Annual Volume (kL)
Detention Basin	20,000	5,000

It is expected that the detention basin could be used primarily for providing additional storage capacity and be used intermittently for reuse depending on existing dam storage levels next to the football oval and the need/demand for a supplement supply for irrigation of the football oval.

The results indicated that there was not sufficient demand to reuse stormwater to water parklands and gardens in the township however there is potentially an option to irrigate the football oval using an adjacent detention basin, supplementing the existing dam in dry periods. There may also be potential for supplying towns people with an off take point for water carting for garden watering. It is understood that this is not an uncommon practice for people in Manoora.

It is recommended as part of subsequent stages that more detailed water balance investigations which consider the following:

- Actual reuse demands for the irrigation of the football oval;
- Existing irrigation regimes;
- Evaporation and rainfall; and
- Detailed design detention basin configuration.

5.7.3 Managed Aquifer Recharge (MAR)

As there is an existing stormwater reuse scheme for the football oval and a lower priority for stormwater reuse in Manoora compared to addressing flood control issues, it was determined that a high level assessment for MAR was not deemed to be a priority at this time.

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.

The aquifers within and around Manoora region are typically fractured rock aquifers. The fractures act as channels which convey the groundwater within and around the matrix of the rock. The rock matrix acts as the storage reservoir of the groundwater. The yield is dependent on the orientation and the amount of fractures that contain groundwater. Typically a fractured rock system poses uncertainties in the ability of injecting and recovering water from the aquifer. Further detailed investigations would need to be undertaken to understand the aquifer properties and to determine the likely performance of an MAR scheme at Manoora.

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 provided on the following page 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 measures	Preliminary construction/ program cost estimate	Benefits	
		Number of buildings protected	Other
F1 - Modification to the Existing Diversion Channel and Dam <i>Breakdown of tasks and costs provided below:</i>	\$3,160,000	13	Improved road trafficability
<ul style="list-style-type: none"> Develop detailed concept design utilising detailed engineering survey to optimise scope and re-evaluate main watercourse enlargement as an alternative option to ensure final option is the most cost effective one 	\$40,000		<i>Ensures final adopted solution is as cost effective as it can be.</i>
<ul style="list-style-type: none"> Establish a diversion weir at the beginning of the diversion channel (near the river) (catchment area is greater than 40ha) 	\$45,000		(as above)
<ul style="list-style-type: none"> Enlarge the existing diversion channel (catchment area is greater than 40ha) 	\$170,000		(as above)
<ul style="list-style-type: none"> Enlarge existing detention basin to provide more storage (catchment area is greater than 40ha) 	\$1,350,000		(as above)
<ul style="list-style-type: none"> Provide an overflow swale to redirect flows to the main channel (catchment area is greater than 40ha) 	\$30,000		(as above)
<ul style="list-style-type: none"> Lining the dam (catchment area is greater than 40ha) 	\$1,150,000		(as above)
<ul style="list-style-type: none"> Fence the dam to prevent unauthorised access (catchment area is greater than 40ha) 	\$75,000		(as above)
<ul style="list-style-type: none"> Place a levee to north of the dam (catchment area is greater than 40ha) 	\$90,000		(as above)
<ul style="list-style-type: none"> Add a roadside outlet culvert along western side of the Auburn-Manoora Road (catchment area is greater than 40ha) 	\$90,000		(as above)
<ul style="list-style-type: none"> Add culverts at the intersection of the Barrier Highway and the Auburn-Manoora Road (catchment area is greater than 40ha) 	\$120,000		(as above)

Recommended measures	Preliminary construction/ program cost estimate	Benefits	
		Number of buildings protected	Other
F2 - Proposed eastern swale and associated works (<i>catchment area is greater than 40ha</i>)	\$60,000	6	Improved road trafficability
F3 - Improved drainage/protection in vicinity of Chinkford Lane (<i>catchment area is greater than 40ha</i>)	\$130,000	5	Improved road trafficability
WQ 1 - Water Treatment: Wetland/basin (<i>catchment area is greater than 40ha</i>)	\$70,000		Reduced pollutant loads. Potential to improve aesthetics, community pride and biodiversity.
WQ2 - Stream rehabilitation: <ul style="list-style-type: none"> Weed and exotic tree management with landowners Scour protection at stormwater outlets along Barrier Hwy 	- \$8,500		Reduce scouring and rehabilitate Gilbert River, increase biodiversity.
F4 - Regular maintenance of stormwater drainage infrastructure and watercourses	\$5000 (ongoing cost)		An effective drainage system.
P1 – Flood preparedness <ul style="list-style-type: none"> 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. Reduce risk and impacts of flooding. Gain community support for stormwater management. Build capacity of the community to prepare for floods. Improve community's sense of worth and feeling of security.
P2 – Development / planning controls: <ul style="list-style-type: none"> 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. Protection of health of watercourses and receiving waters as a result of detaining flows and reducing runoff rates by the detention basin, and the stream rehabilitation will also improve stream bank stability, thus reducing the risk of erosion, which will minimise adverse impacts to watercourses and receiving waters. Improvements to water quality, stream rehabilitation, and actions to reduce the risk of flooding, will also help to achieve better planning outcomes associated with improving the values of open space, recreation and amenity for the community.

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 be benefits to watercourses and receiving waters as a result of detaining flows and reducing runoff rates by the detention basin, and the stream rehabilitation will also improve stream bank stability, thus reducing the risk of erosion, which will minimise adverse impacts to watercourses and receiving waters. Channel improvements will benefit riparian environments to support native vegetation and wildlife, which would also improve the amenity of the town. These actions will benefit the town as a whole as well as 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.

The improved infrastructure aimed at flood control recommended in this SMP will provide 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.

Inclusion of water reuse and treatment objectives in Council's Development Plan will help to ensure the protection of these downstream environments. Developing a wetland will provide an opportunity to detain flows, reduce pollutant loads and alleviate peak flows further downstream. The wetland area has the potential to improve aesthetics, community pride and biodiversity.

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 and resilience 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.

These improvements to water quality, stream rehabilitation, and actions to reduce the risk of flooding, 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 improvements to stormwater management may have a positive impact on business confidence and attract future economic investment in the area.

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	F4	Regular maintenance of stormwater drainage infrastructure and watercourses	-	\$5,000
1	0 – 1	P2	Development / planning controls: <ul style="list-style-type: none"> Enforcement and inclusion of flood maps in Council's Development Plan. Ensure 300 mm freeboard for finished floor levels in floodplains. Ensure siting of developments 300mm above surrounding land level if not in flood plain. 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 	-	-
1	0 – 1	P1	Flood preparedness program - <ul style="list-style-type: none"> Establish a total flood warning system for Gilbert River Community education program 	\$30,000 \$10,000	\$5,000 \$1,000
1	1 – 5	F2	Proposed eastern swale	\$60,000	\$2,000
2	1 - 5	F3	Improved drainage/protection in vicinity of Chinkford Lane	\$130,000	\$2,000
2	5 - 10	F1	Modification to existing diversion channel and dam	\$3,160,000	\$50,000
3	5 - 10	WQ2	Stream rehabilitation: <ul style="list-style-type: none"> Weed and exotic tree management with landowners Rock scour protection at stormwater outlets along Barrier Hwy 	- \$8,500	- \$680
4	5 - 10	WQ1	Water Treatment – detention basin	\$70,000	\$6,000

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, as described below. The availability and timing of funding and resources will determine the order and staging of the works.

A stormwater management plan that has been 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 IMPLEMENTATION AND POTENTIAL FUNDING/ PARTNERSHIP OPPORTUNITIES

Recommendations		Responsibilities for Implementation and Potential Funding
F4	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)
F2	Proposed eastern swale	Council to lead design, consultation and construction processes, with potential funding from SMA
F3	Improved drainage/protection in vicinity of Chinkford Lane	Council to lead design, consultation and construction processes, with potential funding from SMA
F1	Modification to existing diversion channel and dam	Council to lead design, consultation and construction processes, with potential funding from SMA
WQ2	Stream rehabilitation	Council to lead design, consultation and construction processes, with potential funding from NRM Board
WQ1	Water Treatment – detention basin	Council to lead design, consultation and construction processes, with potential funding from NRM Board

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 landowner's 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 NRM'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 stormwater infrastructure works in private land are provided below:

- A new low levee along St Anthony's Road adjacent Gilbert River
- Widening of sections of the River
- Upgrading of the swale near Chinkford Lane
- A new diversion weir on the River (south of the Manoora-Mintaro Road)
- Formulating the drainage path on either side of railway line
- Increasing the storage of detention basin and adding a levee (private and public land)

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.

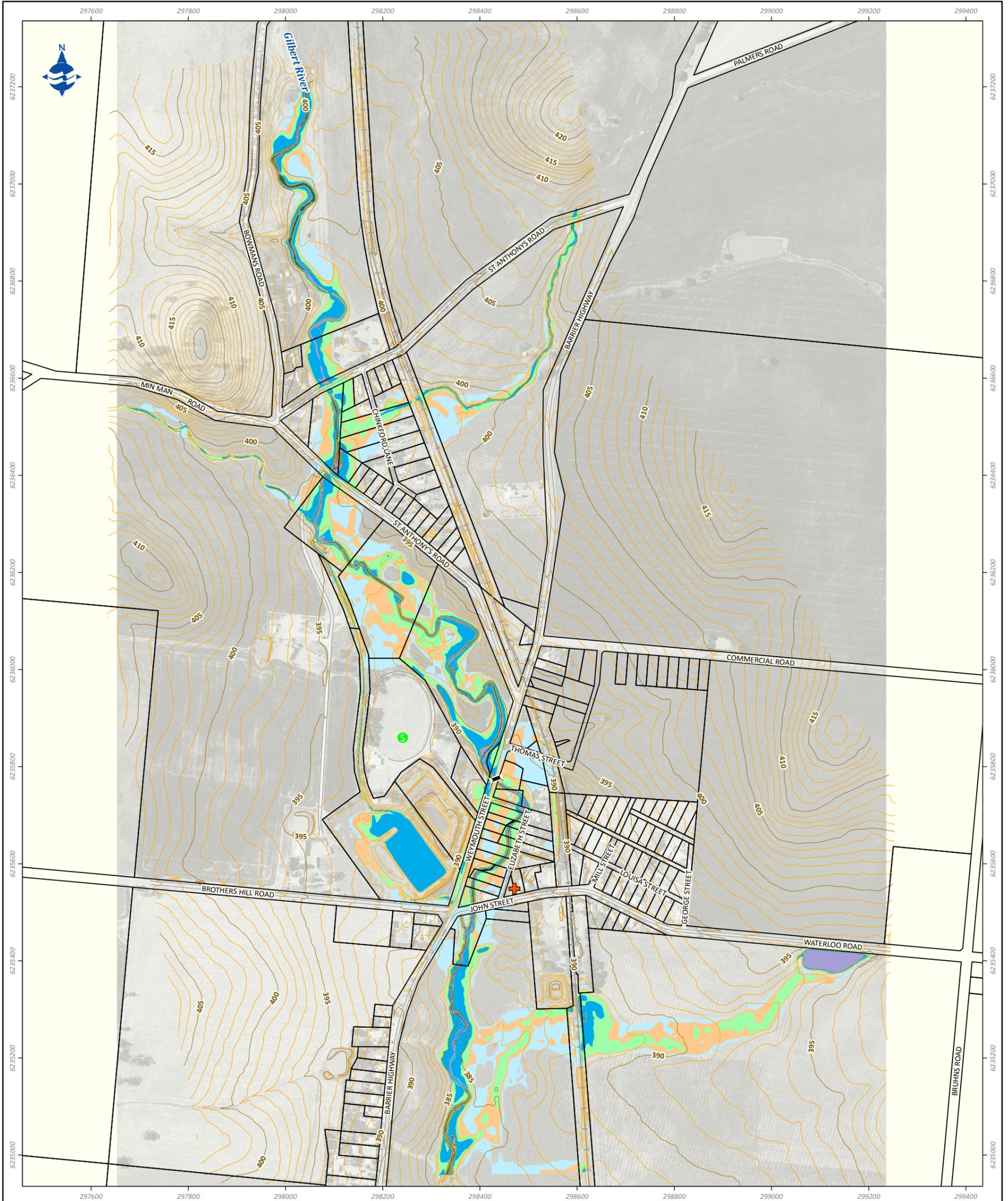
To ensure that this occurs, it is expected that Council initiates a review of this Plan at least every 5 years and that the proposed works and strategies to be adopted for the subsequent 10 year period will be identified.

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

- Australian Water Environments (2013) Floodplain Mapping for Seven Townships, prepared for the Clare and Gilbert Valleys Council
- Bureau of Transport Economics (2001) Economic Costs of Natural Disasters in Australia
- Clare and Gilbert Valleys Council - Strategic Directions Report 2012/13
- Clare and Gilbert Valleys Council (2011) Water Security Plan
- Commonwealth of Australia (2009) Flood Preparedness, Manual 20 Australian Emergency Manual Series
- Department for Water (2011) Stormwater Strategy - The Future of Stormwater Management, Government of South Australia
- Department of Environment, Water and Natural Resources (2013) Water Sensitive Urban Design – Creating more liveable and water sensitive cities in South Australia, Government of South Australia
- Department of Water, Land and Biodiversity Conservation (2004) *A River Management Plan for the Light Catchment*. Report, DWLBC 2004/17
- Northern and Yorke Natural Resources Management Board (2009) Northern and Yorke Regional NRM Plan – Volume B: Strategic Plan 2009 – 2018, Government of South Australia
- Northern and Yorke Natural Resources Management Board (2009) Northern and Yorke Regional NRM Plan – Volume D: Regulatory and Policy Framework, Government of South Australia
- Rural Solutions SA (2005) Gilbert River Salinity Management Plan
- SCARM (2000) Floodplain Management in Australia: Best Practice Principles and Guidelines. SCARM Report 73, CSIRO Publishing, Australia.
- Water for Good (2009) Government of South Australia

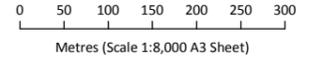
Appendix A : Flood Inundation Maps



LEGEND

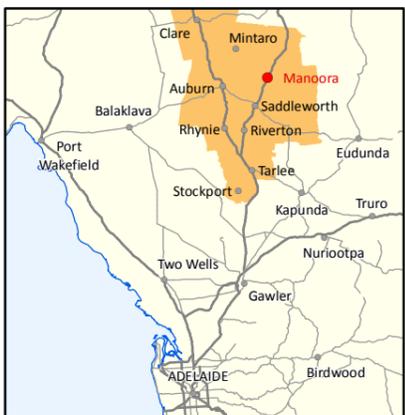
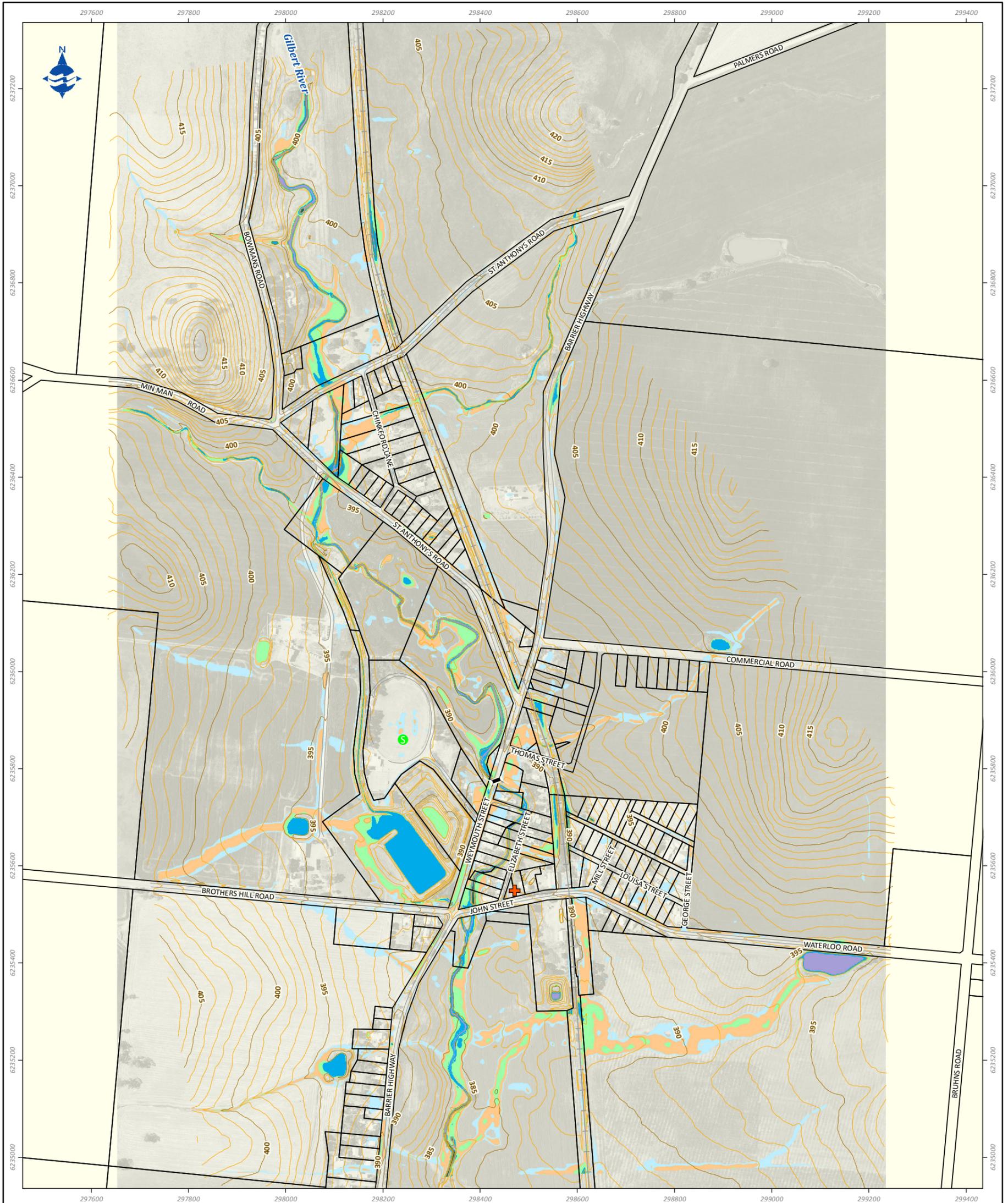
	Bridge or Culvert		Water Main Crossing		Road Edge
	Sports Ground		Diameter (mm): 63; 80; 100; 150		Flood Depth (m): 0 - 0.10
	Ambulance		200; 250; 375		0.11 - 0.25
	Hospital		600; 750		0.26 - 0.50
	Police		Contours: Index		0.51 - 1.00
	SES		Intermediate		1.01 - 1.50
	CFS		2.51 - 5.00		1.51 - 2.50
	Cadastral		Railway		2.51 - 5.00
					Greater than 5.00

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 Cadastral 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

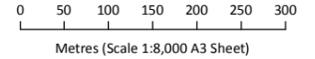
Manoora (Riverine)
100 Year ARI Event Inundation



LEGEND

	Bridge or Culvert		Water Main Crossing		Road Edge
	Sports Ground		Diameter (mm):		0.05 - 0.10
	Ambulance		63; 80; 100;		0.11 - 0.25
	Hospital		200; 250; 37		0.26 - 0.50
	Police		600; 750		0.51 - 1.00
	SES		Contours:		1.01 - 1.50
	CFS		Index		1.51 - 2.50
	Cadastral		Intermediat		2.51 - 5.00
			Railway		Greater than 5.00

Data Source:
 Flood Data, Sports Ground and Railway Extent from AWE; Road Edge, Aerial Imagery and Contours from Aerometrix; Water Mains from SAWater; Bridges from DPTI; Roadnames, Bridges and Cadastral 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

**Manoora (Direct Rainfall)
 1 in 100 ARI Flood Inundation**

Appendix B : Community Feedback



Manoora Stormwater Management Plan

Community Consultation

Identification of Issues

Consultation with the Manoora 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:

- The main area of flooding is just west of Weymouth Street and east of Gilbert River;
- The flow path is poorly defined from the railway line and Gilbert River;
- The town can be affected by flows from the eastern hills;
- Some stormwater infrastructure is blocked (e.g. culverts) and may be under capacity, such as Weymouth Street, the old slate drains are not capable of managing the flows (don't work, undersized, are not maintained), and the Gilbert River has weeds;
- The area of impervious surfaces has increased and this has affected run off. This needs to be better managed as it flows onto the landscape; and
- Council's diversion structure (lock) is inefficient and needs to be improved.

Aspirations and Opportunities:

- Maximise effectiveness of diversion structures and improve the maintenance of culverts so they are more effective in managing flows;
- Redefine flow paths, e.g create drainage swales;
- Alleviate flows from east by improving flow management;
- Explore opportunities to detain water upstream and use of existing dams for flood control;
- Maximise stormwater reuse opportunities;
- Rehabilitate Gilbert River to reduce flow velocities and to improve water quality (control/exotic plants; revegetate).

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 Manoora (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 Manoora on 6th May 2014 and approximately 15 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.

Do you think the measures address stormwater and flooding issues?

- Yes – enlarging the dam and modifying the diversion structure (raise height of weir), and the proposed channel along the railway line sound like good ideas.
- Concerned about flooding from the east in the vicinity of Elizabeth Street. Suggest that the culvert along Elizabeth Street is extended, i.e. the proposed realignment may require more works. However need to be mindful of the close proximity of existing sheds, etc.
- Concern about potential flooding of properties on Chickford Lane and on St Anthony's Road.
- If the unused dam is to be used for flood control (and lined) then it should be fenced to prevent people, stock, etc gaining access to it if it (due to safety concerns).
- The unused dam is on private property and so discussions will need to be held with that owner.

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

- Might need a trash rack near the entrance to the dam to capture rubbish.
- Would like to reuse the water in the dam to irrigate the oval and possibly gardens and street trees.
- There is an existing tap at the dam which could be used as part of a reuse system in the future.

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

- The unused dam is in private ownership and so Council will need to hold discussions with that owner.
- If the dam water is to be part of a reuse system in the future then Council needs to be mindful of potential multiple reuse interests (not just their own).
- Some drainage channels have trees within them.
- Elizabeth Street – check ways of realigning the drainage channel to see if there is a more effective and efficient way of doing this.

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 following table.

Table - Community Feedback - Most Important Measures

Recommended measures	Which suggested measures do you think are most important? (percentage of people's preference)
<p>Stormwater and flooding measures:</p> <ul style="list-style-type: none"> • Modify diversion weir located south of Manoora-Mintaro Rd and modify existing diversion channel. • Enlarge existing detention basins and provide a liner to prevent leakage. • Create associated overflow swale. • Provide levee around detention basin. • Create roadside swale along western side of Auburn-Manoora Rd and upgrade culverts on the intersection of Barrier Hwy and Auburn-Manoora Rd. <p>(Cost \$3,000,000; protection to 13 properties)</p>	63%
<ul style="list-style-type: none"> • Provide a swale along the railway line • Cap off redundant culverts under northern section of railway line • Upgrade culvert under southern section of railway line. <p>(Cost \$60,000; protection to 6 properties)</p>	9%
<p>Water Treatment – Wetland/basin (Cost \$70,000; capture flows, improve water quality, local amenity and biodiversity)</p>	2%
<p>Regular maintenance of stormwater drainage infrastructure (Cost \$5,000)</p>	5%
<p>Establishment of a flood warning system for the Gilbert River (Cost \$30,000)</p>	2%
<p>Enforcement and inclusion of flood maps in Council's Development Plan</p>	2%
<p>Community education program - e.g. Floodsafe (Cost \$10,000)</p>	

Feedback forms were also available for people to provide comment on the draft strategies. A total of 2 forms were received by Council. Key issues raised:

- Property owners need to take responsibility for riverbed rehabilitation – need better NRM practices throughout the catchment.
- Important to implement the measures, particularly improved drainage along the railway line as this will help to protect houses and businesses.

Appendix C : Assessment of Priorities

Criteria:	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 50 ARI	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: Manoora												
Recommendation	Current flood exposure	Number of properties protected	Number of properties/dwellings protected (% of 22)	Cost	Cost per property	Cost effectiveness	Catchment area greater than 40ha	Water quality improvement		Water harvesting and reuse	Community aspiration	Recommended Priority: Low, Medium, High
								Catchment wide benefit	Township only benefit			
F1 - Modification to the Existing Diversion Channel and Dam	High	13	High	\$3,120,000	\$240,000	Medium	High				High	Medium
F2 - Proposed Eastern Swale	High	6	Medium	\$60,000	\$10,000	High	High				Low	High
F3 - Improved drainage/protection in vicinity of Chinkford Lane	High	5	Low	\$130,000	\$26,000	High	High				Low	Medium
WQ1 - Water Treatment – Wetland/basin				\$70,000		High		Low	Medium	Low	Low	Medium
WQ2 - Stream rehabilitation: • Weed and exotic tree management with landowners				n/a				Low	Low		Low	Low
WQ2 - Stream rehabilitation: • Rock scour protection at stormwater outlets along Barrier Hwy				\$8,500				Low	Low		Low	Low
F4 - Regular maintenance of stormwater drainage infrastructure and watercourses	High			\$5,000		High					High	High
P1 - Flood Preparedness - Flood warning system	High			\$30,000		High					Low	High
P2 - Development/Planning Controls	High					High					Low	High
P1 - Flood Preparedness - Community education program	High			\$10,000		High					Low	Medium
<i>total</i>				\$3,433,500								

Appendix D : Implementation Plan

Manoora – Implementation Plan

Priority	Timeframe 0 - 1 yr 1 - 5 yrs 5 - 10 yrs	Project/ Activity and Location	Capital Cost (\$)	Recurrent Cost (\$ pa) (based on 8% of capital cost)	Flood Mitigation Benefit <i>Measures:</i> <i>(P) – Properties Affected</i> <i>(properties protected by measures in the 50 year ARI event)</i>	Water Harvesting Benefit <i>Measures:</i> <i>(V) – Volumetric</i> <i>(Q) – Qualitative</i>	Water Quality Benefit			Other Benefits <i>Rating:</i> <i>(H) - High</i> <i>(M) - Medium</i> <i>(L) – Low</i> Qualitative description of benefit	Potential funding partners with Council
							<i>Rating:</i> <i>(H) - High</i> <i>(M) - Medium</i> <i>(L) – Low</i> Low = <20%, Medium = 20%-50%, High = >50% of proportion of catchment/township benefiting from treatment	Benefit to whole of catchment	Benefit to township only		
1	0 - 1	F4 - Regular maintenance of stormwater drainage infrastructure and watercourses	-	\$5,000	Effective drainage and therefore reducing risk of flooding.	-	-	-	-	Improved sense of security and wellbeing amongst the community.	-
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.	-
1	0 - 1	P1 - Flood Preparedness - Community education program - e.g. Floodsafe (Community/education officer role and associated materials)	\$10,000	\$1,000	Reduce the risk of flooding and impacts of flooding.	-	-	-	-	Gain community support for 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
1	0 - 1	P1 - Flood Preparedness - Flood warning system	\$30,000	\$5,000	Reduced impact of flooding to properties and people.	-	-	-	-	Warning of flood events provides time for preparation and thus reduces impacts. 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	F2 - Proposed Eastern Swale	\$60,000	\$2,000	6 properties protected.	-	-	-	-	Improved road trafficability	SMA
2	1 - 5	F3 - Improved drainage/protection in vicinity of Chinkford Lane	\$130,000	\$2,000	5 properties protected.	-	-	-	-	Improved road trafficability	SMA
2	5 - 10	F1 - Modification to the Existing Diversion Channel and Dam	\$3,120,000	\$50,000	13 properties protected	-	-	-	-	Improved road trafficability	SMA
3	5 - 10	WQ2 - Stream rehabilitation: • Weed and exotic tree management with landowners • Rock scour protection at stormwater outlets along Barrier Hwy	- \$8,500	- -	-	-	Low	Low	Improve water quality through enhanced bank stabilisation and reduced scouring.	Reduce scouring and erosion, improve bank stability, reduce weed infestation and improve biodiversity.	NY NRMB
4	5 - 10	WQ1 - Water Treatment – Wetland/basin	\$70,000	\$5,600	-	Median Annual Volume: 20,000 kL Harvestable Annual Volume: 5,000 kL Community would like to reuse water for the oval however reuse was not seen as a higher priority than flood/stormwater control measures.	Low	Medium	Meets the State Government targets (Water Sensitive Urban Design, 2013) for whole of town reduction in pollutant loads. Meets the Environment Protection (Water Quality) Policy 2003. Supports Council's Development Plan principles for managing and improving quality of stormwater runoff. Also helps support s NRMB's resource condition targets for maintaining and improving water quality in aquatic environments.	Reduced pollutant loads. Potential to improve aesthetics, community pride and biodiversity values.	NY NRMB