Adelaide Plains Council

STORMWATER MANAGEMENT PLAN FOR TWO WELLS

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Disclaimer

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1 Introduction

1.1 Background and Purpose

Australian Water Environments (AWE) was engaged by the Adelaide Plains Council (formerly the District Council of Mallala) to prepare an updated Stormwater Management Plan (SMP) for Two Wells so that it is compliant with the requirements of the Stormwater Management Authority (SMA) and the Adelaide and Mount Lofty Ranges Natural Resources Management Board (NRM). Compliance with these bodies is particularly relevant when seeking their funding.

Two Wells is a regional hub located on the Northern Adelaide Plains approximately 38km north of Adelaide. The Light River is situated to the north of Two Wells and the Gawler River is to the south. The location of Two Wells within these river catchments and associated drainage areas (Gawler Basin) is shown in Figure 1-1.

Two Wells and its surrounding area is experiencing substantial development pressure, especially of a residential nature. This trend is likely to continue and it is having ramifications on infrastructure and flooding issues. Two Wells has no formalised minor (underground piped drains) drainage system, with virtually all urban stormwater runoff directed along the roads via kerb and gutter systems. Further expansion of the present rural living areas and associated infill developments within these areas will need to address the constraints imposed by flooding, stormwater management and lack of infrastructure provision.

A Stormwater Management Plan for Two Wells was first prepared in November 2007 but that plan was prepared before the introduction of the SMA's Stormwater Management Plan Guidelines and as such cannot be considered nor endorsed by the SMA. In addition, there have been changes to regulatory requirements and development planning strategies. These changes have resulted in the need to update the existing SMP to cover the extended area of interest (the 30 Year Growth Area) and to meet the SMA's guideline requirements.

1.2 Scope of Work

A review of the 2007 SMP identified the following issues that the updated SMP needed to address:

- Provide greater background details on issues and constraints;
- Review existing township modelling and integrate with the 30 Year Growth Area information along with floodplain mapping data recently prepared;
- Develop integrated drainage standard maps for the existing and new areas;
- Identify private and public assets at risk, such as the number of properties and essential services;
- Determine benefits of stormwater strategies to the above risks;
- Determine water quality and potential benefits;
- Determine environmental enhancements as a result of strategies;
- Identify social impacts and benefits;

- Undertake additional water balance modeling to determine technical feasibility of stormwater harvesting, storage and reuse options for both the 30 Year Growth Areas and the existing township;
- Review and possibly revise the costings provided in the 2007 SMP for each strategy;
- Consult with community and stakeholders (e.g. SMA, NRM Board, Council staff and elected members) to seek their concerns about stormwater and their expectations (e.g. prevent flooding, desire to reuse stormwater), and to confirm technical methodologies;
- Identify any new legislation, policies and plans since 2007 that need to be considered, e.g. Adelaide and Mount Lofty Ranges NRM Plan (2008);
- Prepare an implementation table of the actions and responsibilities identified in the Plan (over no more than a 10 year planning horizon);
- Prepare the SMP document.

1.3 Legislative Context

There are several key legislative requirements, policies and plans that the SMP is to have regard to, as listed below. This includes a description of several changes to legislation and policies since the 2007 SMP was prepared.

Legislation -

- Local Government Act 1999 (requires local government to form long term strategic and asset management plans);
- Water Resources Act 1997;
- Development Act 1993 and Development Regulations 2008

  An Act to provide for planning and regulate development in the State; to regulate the use and management of land and buildings, and the design and construction of buildings; to make provision for the maintenance and conservation of land and buildings where appropriate; and for other purposes.
- Northern Adelaide Plains Prescribed Wells Area Water Allocation Plan (WAP) (2000);
- Environment Protection Act (1993);
- Environment Protection (Water Quality) Policy 2003;
- Natural Resources Management Act (2004);
- Environment Protection and Biodiversity Conservation Act (1999);
- Development Act (1993) and the associated Development Plan for the Adelaide Plains Council (consolidated 21 April 2016);
- South Australian Local Government (Stormwater Management) Amendment Act 2007

  An Act to amend the Local Government Act 1999; and to make related amendments to the Natural Resources Management Act 2004. The Act established a statutory authority, the Stormwater Management Authority, to give effect to the Stormwater Management Agreement entered into by the Government of South Australia and the Local Government Association. The Stormwater Management Authority was given power to apply funding out

of the Stormwater Management Fund, which is also established by the Amendment Act for various purposes.

- Crown Land Management Act 2009 and the Crown Land Management Regulations 2010; and
- Natural Resources Management (Review) Amendment Act 2010

  Natural Resources Management (Review) Amendment Act 2010, which will refine, simplify and clarify a number of key sections of the original NRM Act (2004). The changes aim to help the State's NRM Boards to improve their operations and activities.

Policies, Strategies, Guidelines, Plans -

- Stormwater Management Strategy, Local Government Association of South Australia (June 2003) - Strategy was prepared to provide a constructive means to address the significant challenges and opportunities in relation to stormwater management in metropolitan Adelaide.
- Urban Stormwater Management Policy for South Australia, Local Government Association (June 2003) – Policy to facilitate the delivery of outcomes for stormwater management in Adelaide and regional cities and towns. The Policy applies in all incorporated areas and provides a forward looking, multi-objective management framework for stormwater in the urban setting through local and state government.
- The Adelaide Coastal Waters Study, Final Report, Volume 1 Summary of Study Findings, November 2007
- Stormwater Management Authority's Stormwater Management Planning Guidelines (2007)

  The Local Government Authority (LGA) and the Stormwater Management Authority (SMA) aim to achieve more consistent management of stormwater across South Australia, and in the process ensure they address existing problems and capitalise on opportunities for providing a range of benefits through multi-objective planning, including reuse where feasible.

  The Stormwater Management Planning Guidelines (2007) provide a consistent framework within which planning and implementation of stormwater management projects and measures are able to occur that provide for community and environmental benefits.

  Support funding from the SMA for stormwater works and measures will not be available unless a Stormwater Management Plan for the catchment has been prepared and approved under Stormwater Management Planning Guidelines, including formal endorsement by the relevant Natural Resources Management Board.

- Adelaide and Mount Lofty Ranges NRM Plan (2008)

  Two Wells sits within the Adelaide and Mount Lofty Ranges NRM Plan. The Plan provides information on the state of the natural resources of the region and the threats to these resources. It provides a vision and goals for natural resource management and guides action for protecting the resources.

  The objectives of Two Wells SMP will have consideration of goals/actions of the NRM Plan.

- Guidelines for the Implementation of Water Sensitive Urban Design, Department of Planning and Local Government (July 2009)

Water Sensitive Urban Design (WSUD) is an important component of the integrated management of water resources because it incorporates all aspects of water management into the planning and design of urban requirements. This ensures development takes appropriate regard of the total water cycle and can provide a mechanism that allows for the management of water issues associated with urban infrastructure to commence at their source.

The development of stormwater strategies for the Two Wells SMP will seek opportunities for applying WSUD.

- 30-Year Plan for Greater Adelaide (2010)

  The Plan is a long-term vision for the future and sets out the land-use policies to manage the growth and change that is forecast to occur in the region, such as housing and the protection of natural resources. The township of Two Wells has been identified as one of the areas that can meet the future housing growth in the State Government's 30 year Plan for Greater Adelaide.

  The SMP will need to understand the implications of growth in Two Wells, such as increased urban development, stormwater runoff and greater demand on stormwater infrastructure.

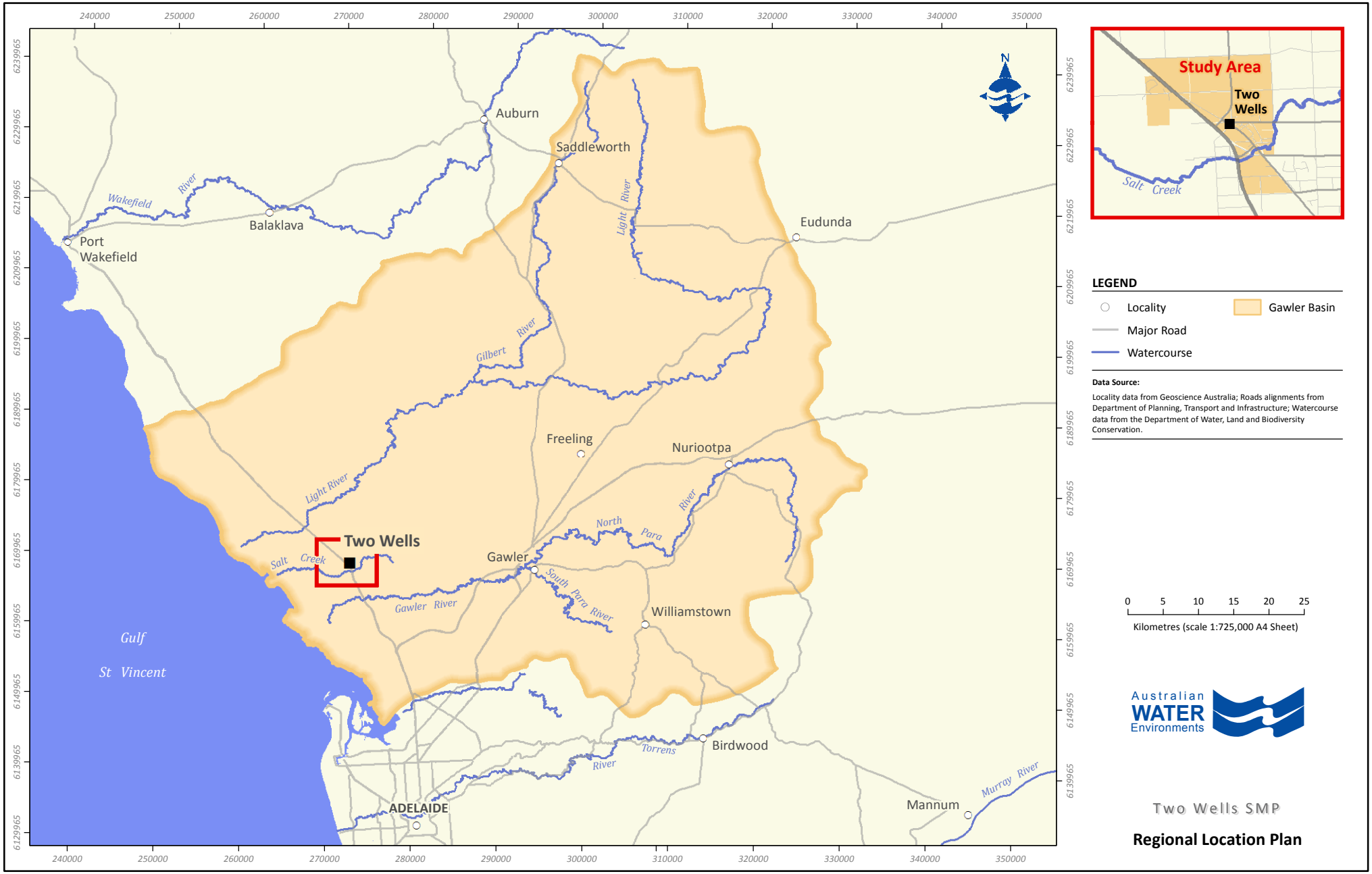
- Two Wells Township Expansion, Connor Holmes (2011)

  Report was prepared to inform the preparation of a future Development Plan Amendment (DPA) for the Two Wells Study Area by recommending planning directions to achieve the objectives set out in the 30 Year Plan for Greater Adelaide.

- Two Wells – Structure Planning and Rezoning Investigations – Hydrology, AWE (2011)

  Development of flood and stormwater management associated with potential future housing developments to the northwest and north of Two Wells.

- Mallala Council Development Plan, Consolidated – May 2014.



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Last Updated: 1/08/2014

Figure 1-1

2 Description of the Study Area

2.1 Township and Catchment Description

The township of Two Wells is located approximately 38 km north of Adelaide. Whilst the existing township is relatively small, a substantial expansion of the township is expected over the next 30 years.

2.1.1 Potential for Urban Growth

Two Wells is a regional hub and has been identified as a future urban growth area in the 30-Year Plan for Greater Adelaide. The 30-Year Plan has a large portion of land at Two Wells which is anticipated to be developed within the next 15 years. The location and general layout of the township and proposed 30-Year Growth Areas (as of December 2011) is illustrated in Figure 2-1.

Of particular interest to this SMP are the proposed growth areas north of Gawler Road and south of Temby Road. The area contained within the magenta coloured boundary in Figure 2-4 is the proposed land affected and is under the control of Hickinbotham Group. The Hickinbotham Group is proposing to create a major residential development of approximately 418 hectares.

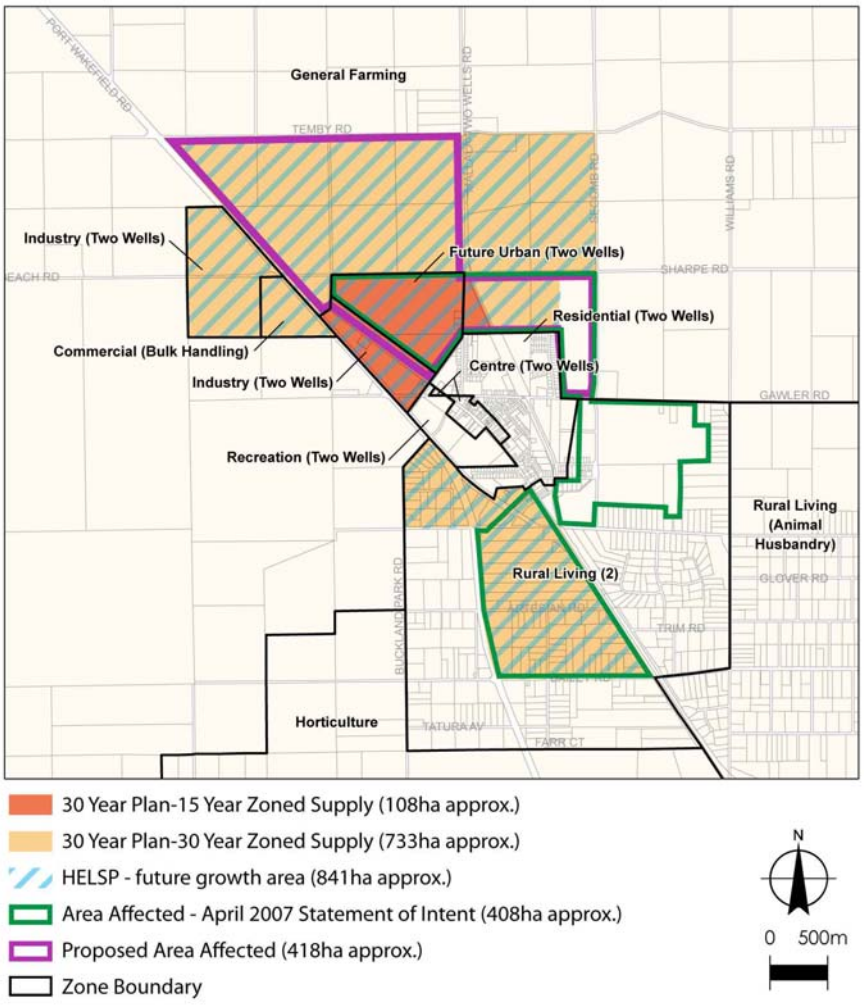


FIGURE 2-1 : TWO WELLS TOWNSHIP AREA AND 30 YEAR GROWTH PLAN

The location and general layout of the development proposed by the Hickinbotham Group is illustrated in Figure 2-2 below. Whilst also important, the remaining growth areas are designated as being of lesser intensity development (rural living) or industrial and the expectation for these areas is that any stormwater impacts associated with those areas would be managed on site.

FIGURE 2-2 : TWO WELLS DRAFT CONCEPT PLAN (SOURCE: HICKINBOTHAM GROUP)

2.1.2 Study Area

Selection of Study Area Boundary

Given the nature of future residential development within Two Wells and in consultation with the Adelaide Plains Council (Council), the study boundary was agreed to align with the proposed 30 Year Growth Area boundary (HELSP 2010) with the exception of the area to the east of Secomb Road.

The area to the east of Secomb Road (Salt Creek) was not been included in the SMP boundary because it lies within the flood flow path of both the Light and the Gawler Rivers. It is considered unlikely that this flow path can be effectively managed within the timeframe of the SMP. Hence further intensification of residential development in this area with is considered problematic and should not be encouraged.

Whilst the study area boundary follows land use planning rather than topographical features the key existing and future hydrological catchments in the urbanised area in and surrounding Two Wells have been included.

The study area covers 10.4 km^2 and is shown in Figure 2-3.

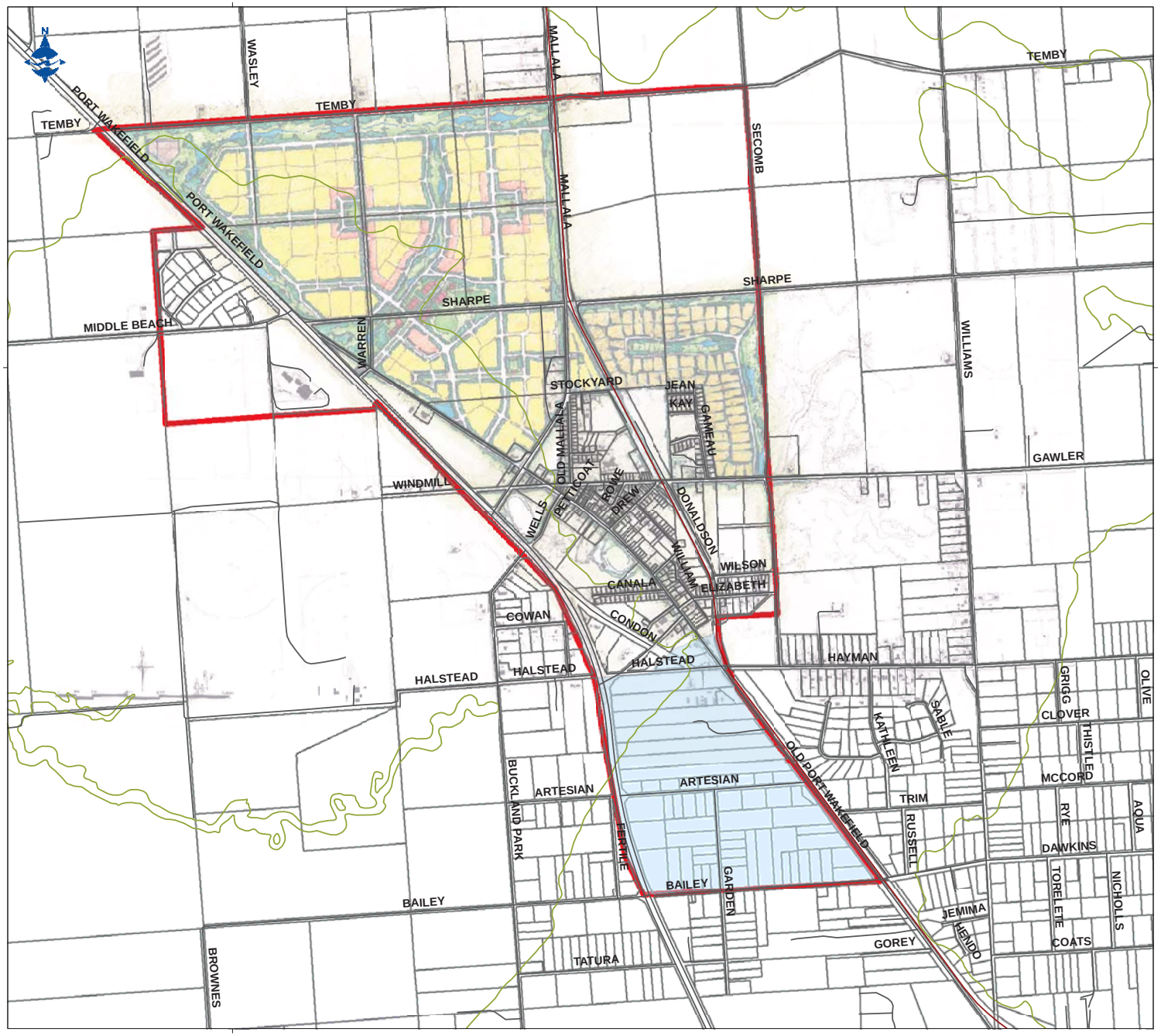
Description of Drainage

The general topographical fall of the land of the study area is from the north east to the south west with a general grade of <1%. There is a ridge running through the Two Wells township.

The main river systems which are situated in and/or located near Two Wells are the Gawler River and Salt Creek. Whilst remote from the township, floodwaters from the Light River would also encroach on the township during a large flood event on the Light River.

Runoff created during storm events from areas south and east of the ridge eventually enters Salt Creek. Salt Creek flows through private land and hence Council has no formal management measures in place for this important drainage path. (Note this is not unusual in South Australia and is also that case for the Gawler and Light Rivers and Templers Creek all of which feed floodwaters towards Salt Creek).

The area north and west of the central ridge drains west, towards Port Wakefield Road. There is no formal discharge point for this water; it simply flows into private property.



LEGEND

- Roads
- Railway
- Contours (5m interval)
- Cadastre
- SMP Boundary
- Not included in Water Balance

Data Source:

...

Australian WATER Environments

Two Wells SMP

Study Area

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Figure 2-3

2.2 Land Use

The general region has been largely cleared with a mix of land uses such as cropping, horticulture and livestock grazing. However there is some scattered remnant vegetation contained within small isolated pockets, road reserves and watercourses, such as Salt Creek. The receiving environment is mainly Salt Creek, which flows to Middle Beach then into Gulf St Vincent.

2.3 Gawler River

The Gawler River is also a physical feature of the region whose characteristics, and propensity for flood, demand closer investigation regarding the effect on hydrology of the Two Wells area. The Gawler River and its floodplain are subject to flooding to various degrees when the Gawler River overflows. Flooding has been recorded many times since settlement, the largest flood being in 1889, which has been estimated to be of similar magnitude to the 1 in 100 Annual Recurrence Interval (ARI) flood. The 1889 flood claimed two lives. Stock and property losses over the years have been considerable. The most recent major flooding occurred in the Two Wells area in 1992 and this also resulted in significant damage to property. There have been other more recent floods that have caused the closure of the Port Wakefield Highway south of Two Wells near Virginia and Buckland Park.

2.4 Climate

The study area has a Mediterranean type climate with dry summers (low rainfall), and rainfall generally occurring in the winter months.

The long term average rainfall information is based on information provided by Bureau of Meteorology (BOM) and is approximately 400 mm/year. The average precipitation and evaporation for each month is shown in Figure 2-4.

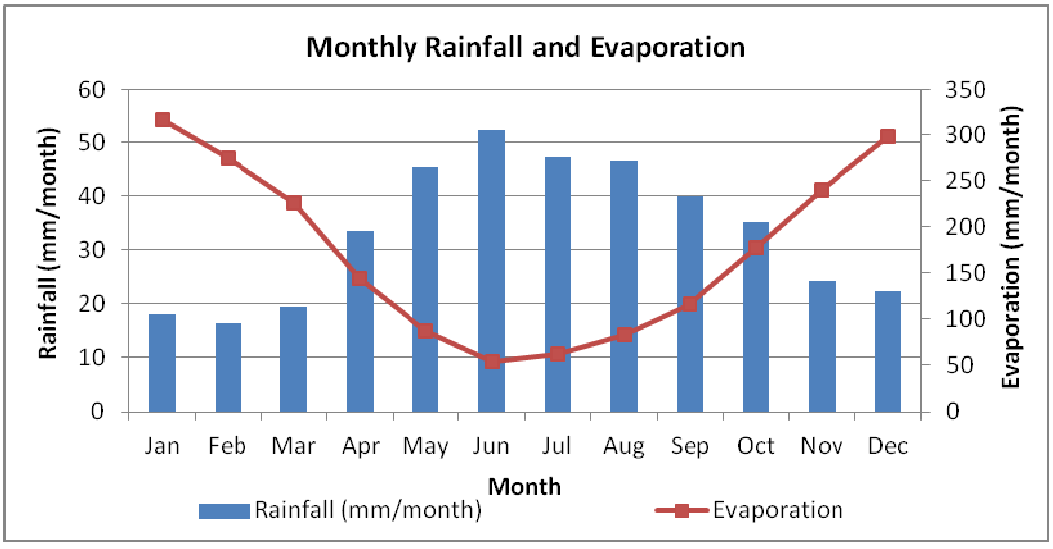


FIGURE 2-4 : RAINFALL AND EVAPORATION AT TWO WELLS

3 Stormwater Management Objectives

3.1 Public Consultation and Engagement

Council recognises the importance of public involvement in planning, which should, in theory, provide several practical advantages. First, where the public is properly informed, opportunities for misconceptions can be minimised and any unfounded negativity within communities can be addressed. Second, where communities become involved in planning, this can foster shared responsibility between the relevant authorities and the public. Finally, by engaging with the planning process, members of the public can play an active role in decision-making. When the voice of the local community is heard and respected, this engenders the very real sense that it can contribute to the success of a programme. Public consultation is therefore an important step in the acceptance and implementation of the Two Wells Stormwater Management Plan.

Earlier consultation

Community consultation was undertaken on behalf of the Hickinbotham Group as part of investigations into the Two Wells township expansion and a future Development Plan Amendment (Conner Holmes, 2011). Although the community was not directly asked to comment on stormwater and flooding issues, the community expressed aspirations for wetlands and open space linkages.

Consultation on the draft SMP

The draft SMP was made available for agency and public comment during February and March 2014. During this time letters were sent by Council to the following agencies to seek feedback on the draft SMP:

- Stormwater Management Authority;
- Environment Protection Authority;
- Department of Environment, Water and Natural Resources;
- Gawler River Floodplain Management Authority;
- City of Playford;
- Town of Gawler; and
- Light Regional Council.

Hard copies of the SMP were made available at the Adelaide Plains Council offices in Mallala and Two Wells, and the Council library in Two Wells. The draft SMP and a Fact Sheet were made available on Council's website. Advertisements were lodged in the Plains Producer and the Bunyip regional newspapers to advise people of the opportunity to review and comment on the draft SMP, as well as to provide information on historical flood events and on-going stormwater issues in Two Wells.

Feedback was received, such as from the SMA and the EPA, and this has been taken into account when finalising this report.

The final SMP is to be lodged by Council to the NRM Board for review, then lodged with SMA for review and approval for gazettal. Council is then in a position whereby it can approach the SMA and NRM Board for funding to support the implementation of recommendations contained within the SMP.

3.2 Social, Environmental and Economic Benefits of Effective Stormwater Management

Managing urban runoff in a water sensitive manner not only resolves problems associated with stormwater, but it enhances the social and environmental amenity of the urban landscape.

3.2.1 Better Management of Flood Hazard

Effective stormwater management mitigates community distress that is often associated with extreme flood events and creates a sense of security and well being due to improved infrastructure that considers public safety, protecting property and ensuring continuity of community services. Effective and efficient stormwater management and flood mitigation can:

- Help to improve amenity of a township;
- Reduce demands on financial assistance required post flooding;
- Reduce demand on emergency services;
- Help to retain property values; and
- Potentially reduce capital and maintenance costs of drainage infrastructure.

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 include:

- Loss of life;
- Personal injury and associated losses and expenses;
- Destruction of memorabilia (e.g. family photos);
- Loss of heritage and cultural features;
- 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 that can stem from a number of experiences associated with 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.

In monetary terms poor stormwater management and localised flooding can lead to:

- Damage to buildings and infrastructure;
- Reduced access to properties and services;
- Disruption to traffic flow in, out and around the township; and
- Disruption to businesses.

3.2.2 Enhanced Public Open Space

Stormwater management and stormwater reuse may help to improve the amenity of a locality through the creation of open green spaces and a reduction poorly managed and often odorous low lying stormwater pools.

Given that water plays a significant role in supporting the social fabric of small regional towns such as Two Wells, the potential reuse of stormwater for improved maintenance of parks, ovals and other recreational areas adds value and minimises the need to depend on limited resources such as mains water or groundwater. If planned correctly, areas for stormwater detention may also be used for passive recreational open space and habitat corridors.

3.2.3 Water Quality and Ecological Health

The protection of the region's natural resources, including the agricultural land and watercourses surrounding Two Wells as well as the estuarine and marine environments further downstream are important for supporting the ongoing social, economic and environmental wellbeing of the Two Wells region.

The primary receiving environment for stormwater flows from the existing township of Two Wells is Salt Creek. Runoff from the study area flows through the highly modified drainage lines of this watercourse to finally enter estuarine and then marine environment at Middle Beach and Gulf St Vincent. .

A formal process to determine the ecological values of Salt Creek and its estuary has not been completed. However, despite its currently poor state, it is understood that Council and its community value Salt Creek and wish to see its condition improved.

Stormwater management planning has the potential to improve the condition of receiving environments by increasing public awareness, education, and accountability; and improving compliance with stormwater regulations.

Works to improve stormwater management have the potential to provide benefits to the health of Salt Creek by changing the hydrological regime of and reducing the pollutant loads from urban runoff entering the watercourse. Works associated with regional and local flood management also have the potential to facilitate a change in land use along Salt Creek from private to public.

3.3 Objectives

Objectives for stormwater management have been developed for Two Wells through the consultation process described above and technical assessments.

These objectives are aspirational. Achievement of these objectives will require efforts far exceeding the life (10 years) of this SMP. These objectives have nonetheless guided the development of stormwater management criteria and actions for this SMP to ensure these long term aspiration goals are not impeded by shorter term initiatives.

The objectives include:

- Manage flood waters so as to minimise the risks and potential for damage from flooding;
- Manage the catchment to improve the condition of receiving environments;
- Minimise the impact development has on flooding and water quality within developed areas and on receiving environments;

- Council to lead and advocate the sustainable use of water, and in particular the sustainable management of stormwater infrastructure, including maintenance;
- Desirable planning outcomes associated with new development, open space, recreation and amenity;
- Manage water use to benefit the community; and
- Maximise the opportunity for private and partnership investment in and management of infrastructure and the natural systems.

The following sections describe the stormwater management criteria used to the direct investigations that ultimately inform the SMP.

3.3.1 Local Flooding

The drainage design criteria adopted for this SMP are intended to cater for all design storms, up to and including a 1 in 100 ARI event. The following criteria were adopted:

- All roads are required to be trafficable. (This requires as a minimum 2.5 m wide clear lane width for 1 in 5 ARI, depth no greater than 300mm in 1 in 100 ARI event).

  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 0.3 m 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 0.3 m and a velocity less than 0.3 m/s i.e. a maximum DxV of 0.09 m^2/s. This value of the DxV relationship is also supported by the data in SCARM (2000) which specifies low hazard flows to have a DxV value of less than or equal to 0.09 m^2/s.
- 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.
- Formal infrastructure to remain effective.
- Formal infrastructure (i.e. pits, culverts and pipes) should be functional and not cause nuisance (e.g. through up welling).
- Informal infrastructure to remain effective.
- The informal infrastructure should remain effective with only standard maintenance activities.
- New development should not increase peak flow rates above those associated with predevelopment conditions.

3.3.2 Regional Flooding

Ideally properties within the identified township boundary and developed growth areas should be protected from flooding arising from a 1 in 100 ARI event.

The SMP can assist with achieving this by providing guidance to developers on appropriate finished floor levels to prevent flooding as well as identifying flood management strategies that Council should pursue in partnership with other beneficiaries and potential funding partners.

3.3.3 Water Quality

Stormwater runoff from new development should meet state government pollutant removal targets. Where possible runoff from existing development should be managed to improve the condition of downstream receiving environments. The SMP can assist this by:

- Providing guidance to Council on the type and magnitude of works that would be required to achieve pollutant removal targets in existing development areas. This may be helpful targeting funding for these works when the opportunities arise;
- Providing guidance to Council on the type and magnitude of works required to achieve pollutant removal targets for new development;
- Identifying opportunities where water quality improvement works can be incorporated in stormwater network upgrades; and
- Providing information on infrastructure options which integrate stormwater quantity, quality and public amenity (WSUD).

The South Australian Government (Water Sensitive Urban Design, 2013) reduction targets are provided below:

- 80% reduction in Total Suspended Solids;
- 60% reduction in Total Phosphorous; and
- 45% reduction in Total Nitrogen.

3.3.4 Stormwater Harvesting and Reuse

Harvesting of stormwater is desirable to provide water for irrigating public open space, including the proposed recreation facilities within the 30 Year Growth Area. One of the objectives in Council's Development Plan is to maximise the harvest and use of stormwater. In line with this objective are principles of development control to promote reuse (refer to section 7 of this SMP).

The SMP promotes stormwater harvesting so that as a minimum 75% of water generated by existing and new urban development is captured and reused.

Whilst harvesting of stormwater is to be promoted, any scheme should also have regard to water dependent ecosystems (surface water catchments and groundwater), the economic feasibility of the scheme, the potential to attract funding for capital works and the community's priorities for investment in stormwater management.

The development of any stormwater harvesting or reuse schemes should have regard to the Water Allocation Plan for the Western Mount Lofty Ranges (Department of Environment, Water and Natural Resources, 2013) and the Water Allocation Plan for the Northern Adelaide Plains Prescribed Wells Area (Northern Adelaide and Barossa Catchment Water Management Board, 2000)

3.3.5 Summary of Primary SMP Objectives and SMP Objective Criteria

The primary SMP objectives and SMP objective criteria are summarised in Table 3-1.

TABLE 3-1 : SUMMARY OF PRIMARY SMP OBJECTIVES AND SMP OBJECTIVE CRITERIA

Primary SMP Objective	SMP Objective Criteria

Manage flood waters.	• Local Flooding:
	  • All roads are required to be trafficable, (2.5 m wide lane width for 1 in 5 ARI, depth no greater than 300mm in 1 in 100 ARI event).
	  • Stormwater flows should be contained in the road reserve.
	  • No increase in peak flows as a result of development.
	• Regional Flooding:
	  • Existing and new properties to be protected from the 1 in 100 ARI event.

Manage the catchment to improve the condition of receiving environments.	• Water Quality:
	  • Achieve the following reductions in pollutant loads from newly developed areas:
	  o 80% reduction in SS
	  o 60% reduction in TP
	  o 45% Reduction in TN
	  • Identify opportunities for works to reduce pollutant loads from existing areas to meet the above criteria.
	• Biodiversity:
	  • Improve the condition of Salt Creek.
	  • Stormwater harvesting to have regard to water dependent ecosystems downstream, as well as the ongoing wellbeing of the groundwater resources beneath Two Wells.

Manage water use to benefit the community.	As a minimum 75% of water generated by existing and new urban development is captured and reused.
Council to lead and advocate the sustainable use of water, and in particular the sustainable management of stormwater infrastructure, including maintenance.	Infrastructure to remain effective.
Desirable planning outcomes associated with new development, open space, recreation and amenity. Minimise impact of new development on stormwater and receiving environments.	Provide guidance to developers on appropriate finished floor levels to prevent flooding. Require developers to meet SMP targets for local drainage, water quality and reuse.
Maximise opportunity for private and partnership investment in and management of infrastructure and natural systems.	Identify flood management strategies that Council should pursue in partnership with other beneficiaries and potential funding partners.

4 Assessment of Local and Regional Stormwater

4.1 Introduction

There are no specific existing water quality treatment or stormwater harvesting systems within the Two Wells SMP area and hence this section focuses primarily on flooding issues. Strategies for dealing with stormwater on a holistic basis are outlined in subsequent sections.

This assessment of flooding and drainage deficiencies addresses the risk from flooding from regional flood waters associated with the Light River, Gawler River, and Salt Creek as well as deficiencies in the local drainage systems within Two Wells. The latter assessment is complicated by the expected expansion of Two Wells as identified in the 30 Year Growth Plan for Greater Adelaide.

There is limited information available for the expansion area. High level structure planning has been undertaken that covers the whole area but this only provides generalised information on the nature and from of the proposed stormwater system. Whilst more detail information is available for parts of the expansion area, the areas to which this applies are small and cannot be readily extrapolated across the whole area. The approach applied therefore was to:

- Update the deficiency information for the existing township area in recognition of development that has taken place since the initial modelling work was completed;
- Determine if there are any impacts on the existing infrastructure that might be associated with the expansion area development; and
- Establish performance standards for the expansion area so as to ensure these areas are afforded suitable levels of protection whilst also protecting the integrity of the existing infrastructure where there are any interfaces.

4.2 Existing Township Stormwater Infrastructure

4.2.1 Description of Key Infrastructure

Two Wells has very limited stormwater drainage infrastructure. The main stormwater conveyance device for the town is the roadways themselves.

Kerb and gutter systems are located throughout most parts of the town however these systems are not connected to a stormwater network and appear to purely serve the purpose of acting as a boundary between the road and adjacent property and pedestrian footpaths. The kerbs do however act to contain the stormwater runoff within the roadway to the equivalent level of the kerb system. There are also several areas where there is a direct transition from the road to the verge. The limited stormwater infrastructure components aside from the roads and associated features consist of:

a) Old Port Wakefield Road box culvert system;

b) Tangari Estate (Stage 1) stormwater system;

c) Tangari Estate Stage 2 (Gullaci Development);

d) Donaldson Road Development;

e) Chapman Street spoon drain; and

f) Drew Street intersection pit.

In addition to these systems is Salt Creek. Salt Creek is a natural, highly ephemeral stream that runs along the eastern and southern side of Two Wells. This stream receives some runoff from the township but its primary hydrological function is to transfer flood waters from upstream catchments to the east, past Two Wells, and out to the sea.

KEY INFRASTRUCTURE ASSETS ARE DESCRIBED BELOW AND SHOWN IN FIGURE 4-1.

(a) Old Port Wakefield Road Box Culvert

A box culvert (900 mm x 450 mm) exists at the intersection of Old Port Wakefield Road and the Two Wells – Gawler Road. Stormwater runoff enters the culvert at the northern side of the intersection on the Two Wells – Gawler Road through a double bay stormwater entry pit. The culvert passes under Old Port Wakefield Road and discharges into an equivalent sized concrete lined open channel that runs along the entire length of Windmill Road.

(b) Tangari Estate (Stage 1) Stormwater System

The stormwater management of Tangari Estate was designed to be fairly autonomous from the rest of Two Wells. Roads on the estate had a traditional kerb and gutter system that feeds stormwater into a limited number of double bay stormwater entry pits.

Comparable with stormwater management practices throughout the rest of Two Wells, the roads are used as the principal collection and conveyance device for stormwater runoff with the pits used as part of the stormwater disposal mechanism. Stormwater is discharged into a retention basin on the western side of the development or into an open channel along the eastern side of the development. The retention basin collects stormwater from the houses on the western side of Gameau Road. The water collected in this basin dissipates over time through infiltration into the soil or evaporation. An overflow facility is provided that connects to the detention basin that was recently constructed as part of the Tangari Estate Stage 2 (Gallaci) Development. The houses on the eastern side of Gameau Road discharge their stormwater to the back of block open channel running parallel to the fence line. This open channel eventually feeds into Salt Creek via a small detention basin.

The internal road drainage design meets Council's design standard whereby 1:100 ARI flows are contained within the road reserve and depth and velocities criteria are also met.

(c) Tangari Estate Stage 2 (Gullaci Development)

The Gullaci Development is located immediately east of the railway line and north of Gawler Road. It consists of a 43 residential allotment development. Stormwater drains from the subdivision via a formal pit and pipe system to a detention basin to the far south of the development near Gawler Road. The detention system has a pump out arrangement that discharges to Salt Creek. House site areas are located above the 1 in 100 ARI flood level but the blocks are terraced down towards the railway line to allow flood waters from the Gawler River to push up behind the properties adjacent the railway line.

The internal road drainage design meets Council's design standard whereby 1:100 ARI flows are contained within the road reserve and depth and velocities criteria are also met.

(d) Donaldson Road Development

The Donaldson Road Development is located immediately east of the railway line and south of Gawler Road. It consists of a 60 residential allotment development. Stormwater drains from the subdivision via a formal pit and pipe system to a detention basin towards the southern end of the

development. The detention system has a pump out arrangement that discharges to Salt Creek via a rising main along Wilson Road. House site areas are located above the 1 in 100 ARI flood level but the internal roads are lower in level and would allow flood waters from the Gawler River to inundate them to a depth of up to 300 mm. A major flow path would also persist along the Donaldson Road alignment adjacent the railway line.

The internal road drainage design meets Council's design standard whereby 1:100 ARI flows are contained within the road reserve and depth and velocities criteria are also met.

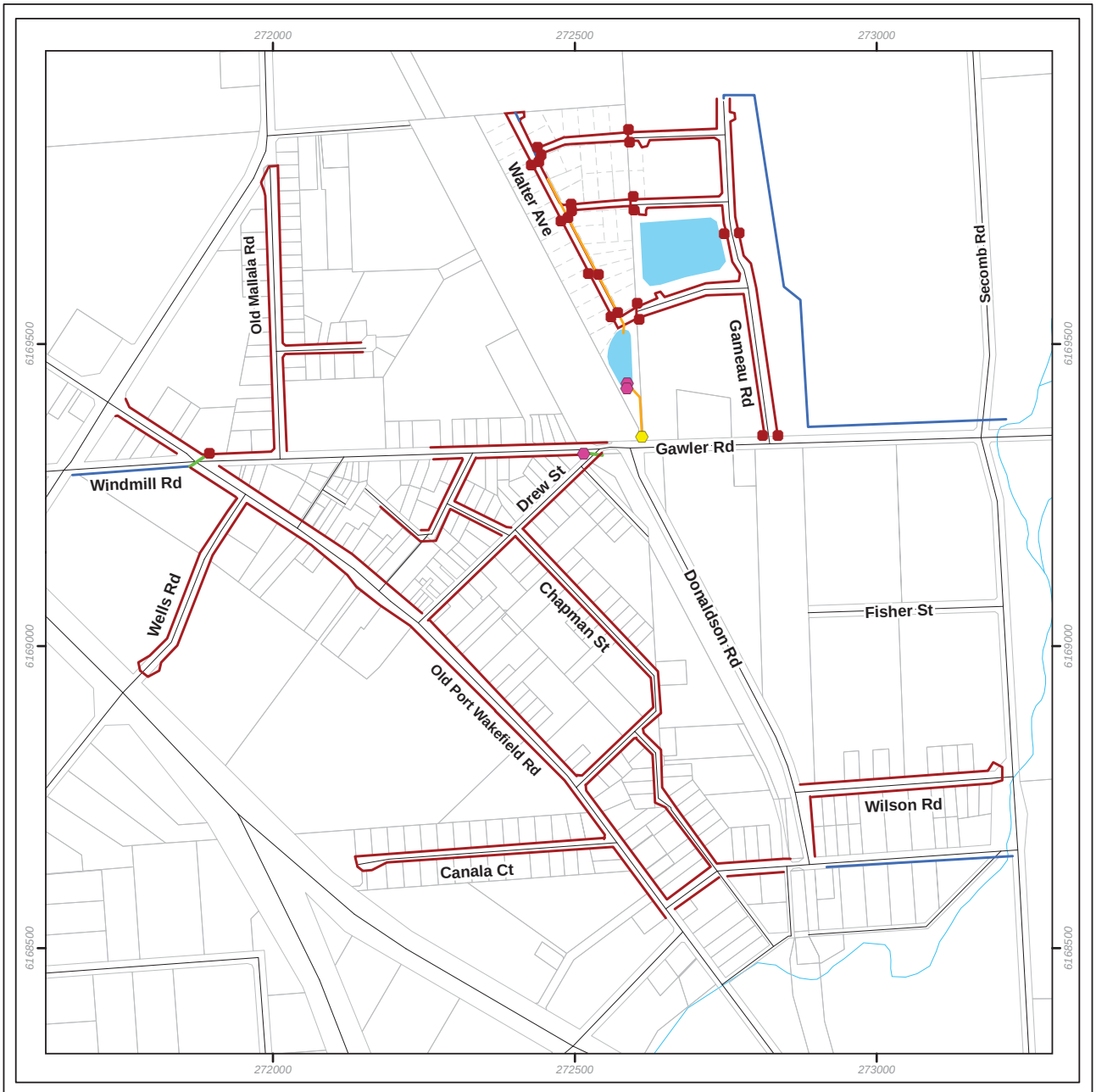
(e) Chapman Street Spoon Drain to Oval

A spoon drain runs across Chapman Street approximately 85 m from the Drew Street intersection. The spoon drain feeds into a covered drain that runs past two properties out to a box culvert drain on Old Port Wakefield Road near the Commercial Hotel. This drain goes under Old Port Wakefield Road to an open drain between the cemetery and football oval grounds where it runs around the oval to the rear of the community centre and towards the Highway where the water sits until it dissipates.

(f) Drew Street Intersection Pit

A pit is located to the west of the intersection of Two Wells – Gawler Road and Drew Street, refer to Figure 4-1. The stormwater collected by this pit feeds into a box culvert system that discharges the water to a parcel of land adjoining the railway line to the east of the intersection.

Recently the road shoulders at this intersection have been sealed, increasing the amount of runoff generated at this location.



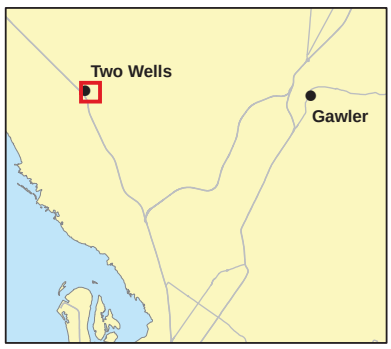
N
W
E
S

200 100 0 200 400 600

Metres

Legend

- Watercourse
- Road
- Box Culvert
- Open Channel
- Kerb/Gutter
- Stormwater Pipe
- Cadastre
- Retention Basin
- Grated Inlet Pit
- Double bay Stormwater Entry Pit
- Stormwater Pit



Data Source:
Road surveyed by AWE.
Major road of the location plan -
Geoscience of Australia Series 3.
Cadastre - District Council of Mallala

Adelaide Plains Council

Australian WATER Environments

Two Wells SMP

Existing Stormwater Infrastructure

Figure 4.1

Job No. 12197 - 026
131204

4.2.2 Existing Township DRAINS Modelling

The DRAINS modelling platform (www.watercom.com.au) was used to undertake the hydrological/hydraulic modelling and analysis of the study area. DRAINS is a windows-based program for designing and analysing urban stormwater drainage systems. DRAINS utilises the time-area hydrological method.

DRAINS uses a visual display to model the components of the system, as such the model can be set out spatially as it would be seen in real life. DRAINS models traditionally consist of nodes and drainage links. The nodes represent infrastructure such as stormwater entry pits, grates and junction boxes. The drainage links represent items such as pipes, channels and overflow paths.

Catchments are used to designate the inflow of water into the nodes. Catchment data required by the model includes percentage pervious and impervious area, times of concentration, lag time and total catchment size.

The ARIs selected for analysis were 1, 2, 5, 10, 20, 50, and 100 years with storm durations ranging between 5 minutes and 6 hours. The modelled ARIs comply with the Guidelines for Stormwater Management (Planning SA, 2001). The intensity and duration of the storms were determined using standard Australian Rainfall & Runoff (Engineers Australia, 2001) methods. Storm Intensity, Frequency and Duration (IFD) calculations were undertaken in AUS-IFD Version 2.0.1 following the methods prescribed in Australian Rainfall & Runoff (Engineers Australia, 2001), and included in the development of the storm models.

For the Two Wells case the main stormwater conveyance devices were the roads themselves. Therefore an analysis of the overland flow paths was undertaken for the township. The road centreline survey and additional data points collected during the survey were used to develop a model of the surfaced road network in the study area. The extra data points were taken at locations where there was deemed to be a notable change in the road morphology, for example where there was a change in road width. Typical cross sections were developed using these extra data points and then applied to the appropriate sections of the hydrologic model. For the purposes of the model, vertical walls were added at the extremes of the cross sections. This is a requirement of the modelling program, and is typical in these applications. As such water is contained in the overflow paths and the model does not indicate lateral flooding outside of the designated cross section. Therefore the model may indicate some deficiencies that may not represent a hazard to the public due to dissipation of flows from the road over open paddocks, for example.

Detailed catchment analysis was undertaken using aerial imagery from Google Earth to determine the percentage of impervious area in the sub catchments. Sub catchments were defined using the topographic and built environment constraints of the town.

4.2.3 Summary of Existing Township Drainage Deficiencies

The model of the existing township was constructed and calibrated using anecdotal evidence gathered from on-ground Council staff. Therefore drainage deficiencies identified by the hydrological model tend to be supported by the anecdotal evidence. A drainage standard map highlighting the identified deficiencies and the hydrological model results is presented in Figure 4-2.

The key criteria used in this map (Figure 4-2) centred around identifying where the road cross section capacity would be exceeded (as the road was the main flow conveyance mechanism) and water could spill into adjoining properties. A second map was subsequently developed to also consider road traffic ability requirements (refer Section 4.2.5 and Figure 4-3).

4.2.4 Council Identified Drainage Problems

Council identified drainage problems are described below.

(a) Old Mallala & Two Wells – Gawler Road Intersection

In the past stormwater runoff from Hart Reserve and Old Mallala Road tends to pond against the western kerb of the road and the adjacent brick fence. The ponded stormwater runoff extends to the crown of Old Mallala Road and the edge of seal on the Two Wells – Gawler Road. Council has undertaken works at this location including the construction of a 300 mm underground drain from this intersection to Old Port Wakefield Road to the west. This site should be monitored to determine if the works undertaken have successfully addressed this issue.

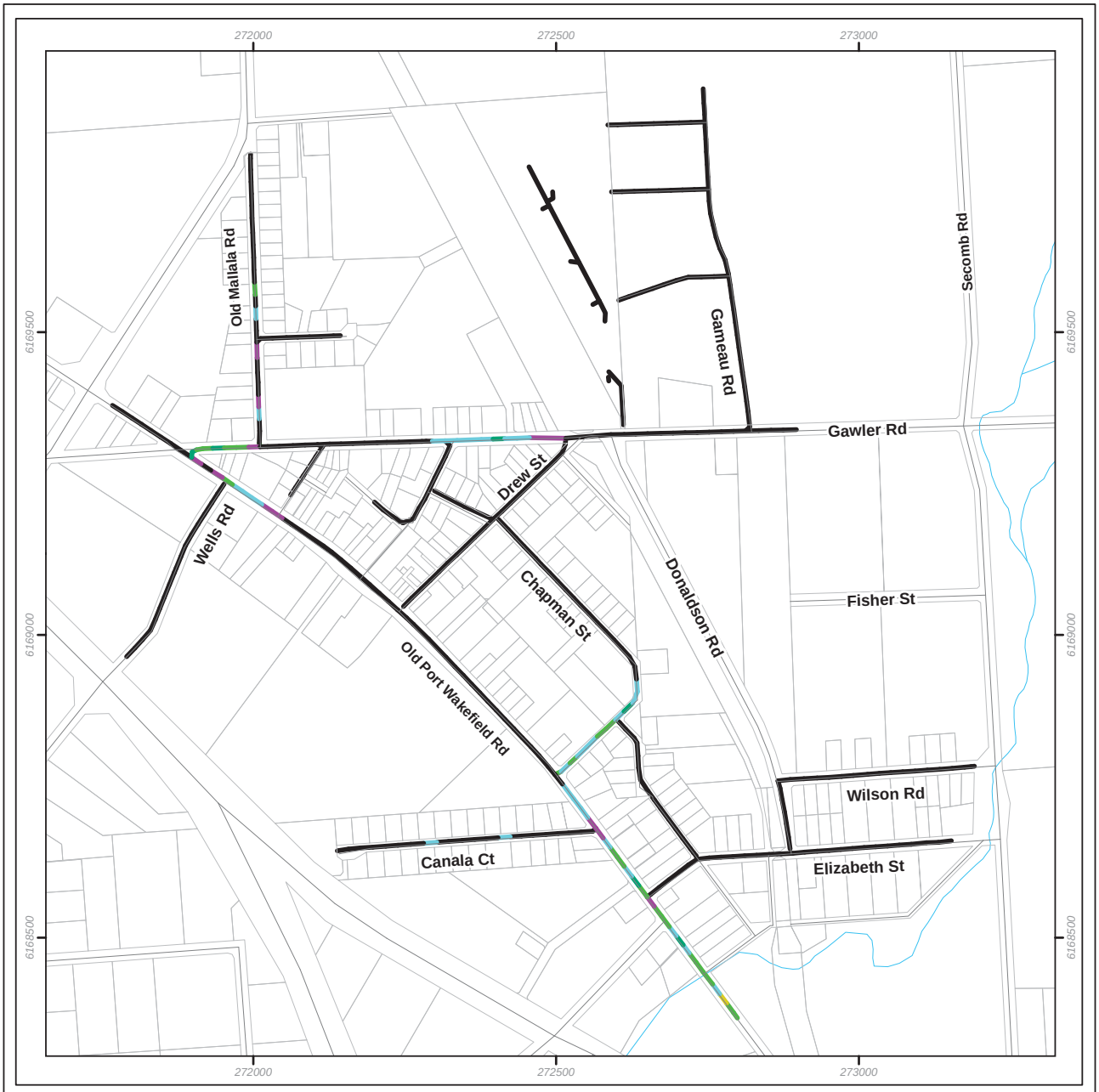
(b) Two Wells – Gawler Road & Drew Street Intersection

Stormwater runoff holds on the road verges with possible intrusion into surrounding dwellings. Recent sealing and grading the road shoulders may have compounded the problem by increasing the impervious surface area and reducing storage capacity.

Council has since undertaken additional works to increase the volume that can be ponded adjacent to the intersection and incorporated a concrete spillway to direct overflow water into the Drew Street drainage system (via a grated inlet pit on the western side of the intersection). Council has also reviewed an option to extend the drain along rail reserve but that was opposed by ARTC. No further works are proposed by Council for this location. Council estimated frequency of the deficiency is 2 year ARI.

(c) Chapman Street Spoon Drain

Stormwater runoff holds in and around the spoon drain on Chapman Street until the capacity of the downstream system allows dissipation. There was evidence of flooding on Chapman Road and Drew Street as a result of a heavy rain event in November 1992, however inundation of private residences has not been recorded in the past. Infill development in the area will result in more capacity pressure on the system. Council estimated the frequency of the deficiency is 2 year ARI.



200 100 0 200 400 600

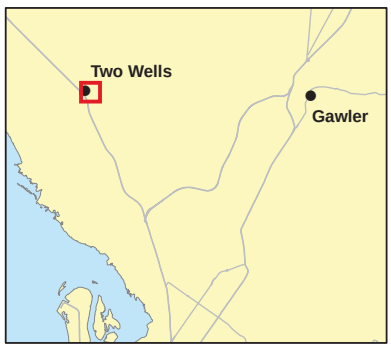
Metres

Legend

Drainage Standard ARIn (Year)
- < 1
- 1
- 2
- 5
- 10
- 20
- 50
- 100

- Cadastre
- Watercourse
- Road

Data Source:
Road surveyed by AWE.
Major road of the location plan - Geoscience of Australia Series 3.
Cadastre - District Council of Mallala



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Drainage Standard Map

Figure 4.2

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4.2.5 Hydrological Modelling Results

The earlier floodplain mapping project for the Light River (AWE, 2011) determined that the appropriate level of flood protection is the 1 in 100 ARI and assumed that the Light River and the Gawler River are two independent systems.

That same mapping project (2011) determined the drainage standard as based on the safe depth and safe flow rates for stormwater conveyance along the roadways. Safe depth of 0.3m was selected based on the Hazard Zone definitions of the Gawler River Floodplain Policy Area in the Adelaide Plains Council Development Plan (consolidated 21 April 2016) and supported by the recommended default values for road sections in the DRAINS modelling program. Safe flow rates vary depending on the section under consideration and are controlled by a function of the user defined Safe Depth x Velocity (m2/s). The value of Safe Depth x Velocity selected for the Two Wells analysis was 0.4 m2/s, in line with the default values suggested for use in the modelling package.

Drainage deficiencies were identified by the hydrological modelling where the safe flow and/or the safe depth of stormwater across the overland flow paths (i.e. roads) were exceeded for ARIs of 5 years or less.

The required road drainage (flood protection standard) includes a 2.5m trafficable lane width in the 1 in 5 ARI event, and no more than 300mm depth in the 1 in 100 ARI event. This standard of road drainage is achieved in the newly developed areas. Exceptions are limited to the older areas of Two Wells which are highlighted in this report. It is recommended that Council carries out a series of infrastructure inspections during storm events to identify and verify drainage problems.

A description of each deficiency identified by the modelling process follows.

Old Port Wakefield Road (optwkfld70)

The deficiency occurs at the end of the modelled extent of Old Port Wakefield Road to the south eastern end of the road. A frequency of 1 year ARI was estimated from the model for exceeding both safe depth and safe flow rate. This result was due to the change of gradient and very small slope value at this location, encouraging ponding of upstream flows at this point in the model. It was expected that any flow shown to accumulate at this location in the model would likely in reality drain into Salt Creek, but was prevented from doing so in the model by the boundary conditions. Nevertheless this should be checked in the field during storm events to ensure stormwater is effectively dissipated at this location.

(b) Two Wells – Gawler Road (gawler19)

A deficiency was noted on the Two Wells – Gawler Road west of the intersection with Drew Street. This deficiency was also noted by Council Officers and was used as one of the calibration locations in the development of the model. A frequency of 5 year ARI was estimated for this deficiency from the model for exceeding both safe depth and safe flow rate.

(c) Two Wells – Gawler Road & Old Port Wakefield Road Intersection (gawler43, gawler46)

The hydrological modelling indicated deficiencies at the intersection of the Two Wells – Gawler Road and Old Port Wakefield Road. This area had been identified by Council as a nuisance due to ponding of stormwater at this high traffic intersection. These locations were used as a part of the calibration process. A frequency of 5 year ARI was estimated for this deficiency from the model for exceeding both safe depth and safe flow rate for section gawler43 and for exceeding safe flow for gawler46.

(d) Chapman Street (chapman21)

A drainage deficiency was detected by the hydrological modelling to the north east of the William Street intersection on Chapman Street. The model indicated that water ponds on the verge of the southern side of Chapman Street. A frequency of 5 year ARI was estimated for this deficiency from the model for exceeding both safe depth and safe flow rate.

It should be noted that inherent limitations with the 1 dimensional modelling approach may cause some overestimation of the flooding depth and extent where stormwater network geometry such as the overflow routes in this location occur. However, anecdotal information from Council (section 4.2.4) indicating a deficiency in this area generally supports the modelling outcome.

Site inspections indicated that the deficiencies noted at this location could be the result of the poor condition of the infrastructure. The empty paddock adjacent the drain was densely covered in exotic weeds. If the infrastructure has been infiltrated by the vegetation growth it is possible that the capacity of this system has been reduced from its original design. There may also be sediment build up at the box culvert which may affect drainage performance of the infrastructure.

(e) Old Port Wakefield Road (optwkfld58)

The modelling identified drainage deficiency on Old Port Wakefield Road north west of the Elizabeth Street intersection. The model indicated the ponding of water on the road verges. A frequency of 5 year ARI was estimated for this deficiency from the model for exceeding both safe depth and safe flow rate. This was due to the low gradient of the area around the intersection causing the water to collect. The assumptions required in the development of the model have in this case overemphasized the collection of water at this point.

The model is very sensitive to changes in slope along the overland flow paths and indicates the ponding of water backing up at locations where there is little slope. This is exacerbated by the model boundary conditions which assume that water does not spread out laterally outside of the road cross section. Therefore it is unlikely that there is a drainage deficiency at this location, but the area should be monitored in storm events to check that stormwater is dispersed rather than ponding.

(f) Old Port Wakefield Road (optwkfld64)

A drainage deficiency was identified at the intersection of Old Port Wakefield Road with Brooks Road. The model shows water collecting on the road shoulders. A frequency of 5 year ARI was estimated for this deficiency from the model for exceeding both safe depth and safe flow rate. This result was due to the change of gradient and very small slope value at this location, encouraging ponding of upstream flows at this point in the model. The assumptions required in the development of the model have in this case overemphasized the collection of water at this point.

Similar to the situation described above for the Old Port Wakefield Road north of the Elizabeth Street intersection, the model is very sensitive to changes in slope along the overland flow paths and indicates the ponding of water backing up at locations where there is little slope. This is exacerbated by the model boundary conditions which assume that water does not spread out laterally outside of the road cross section. Therefore it is unlikely that there is a drainage deficiency at this location, but the area should be monitored in storm events to check that stormwater is dispersed rather than ponding.

100 50 0 100 200 300 400

Metres (Scale 1:7,500 Sheet A3)

LEGEND

Traffic Standard

- 1
- 2
- 5
- 10
- 20
- 50
- 100

- Watercourse
- Road
- Road unformed
- Railway
- Cadastre

Data Source:

Data Source:
Town road profiles surveyed by AWE in 2007.
Road alignments and cadastre - District Council of Mallala

Adelaide Plains Council

Australian WATER Environments

Two Wells SMP

Traffic Standard Map

12197 D043 v4 TrafficStandardMap 150202
Last Updated: 3/02/2015

Figure 4.3

4.3 Existing Township Infill Development

The effect of infill development on the hydrology of Two Wells was assessed using three infill development scenarios:

- Scenario 1: 5% increase in catchment imperviousness;
- Scenario 2: 10% increase in catchment imperviousness; and
- Scenario 3: 60% maximum catchment imperviousness (the upper limit of surface coverage specified in the Development Plan).

The catchment analysis undertaken in the development of the base model was used as the basis for the scenarios. For Scenarios 1 and 2, the appropriate percentage increase was added to the base model impervious area to a maximum of 100%, except in cases where the sub catchment was already completely impervious. For Scenario 3 all sub catchments were set to have a maximum of 60% imperviousness unless the sub catchment imperviousness exceeded this value in the base model.

The results of these assessments are illustrated in Figure 4-4 below. The statistics in the figure use the term number of occurrences in relation to the number of occurrences of flow paths with a particular ARI drainage standard.

The existing Two Wells township has a significant capacity for infill development. However, a comparison of the drainage standards for safe flow and safe depth conducted for the various infill development scenarios showed a noted impact on the hydrology of the catchment. Figure 4-4 illustrates the shift in the drainage standard of the system with the increase in runoff across the catchment seen in the form of increased peak flows and depths. This was demonstrated by the decreased occurrence of overflow paths with a drainage standard of 20, 50 and 100 year ARIs for the increased development cases, and further reflected in the increase of the number of occurrences in the below 5 year ARI drainage standards.

These findings indicate that for the infill of the town to continue proper procedures and planning need to be in place now to reduce the occurrence of future drainage issues and deficiencies in the stormwater system. This includes ensuring that the provisions in Council's Development Plan are adhered to, particularly in relation to principles of WSUD, the use and maintenance of rainwater tanks, ensuring land is not over-developed, and looking into ways to 'green' the township.

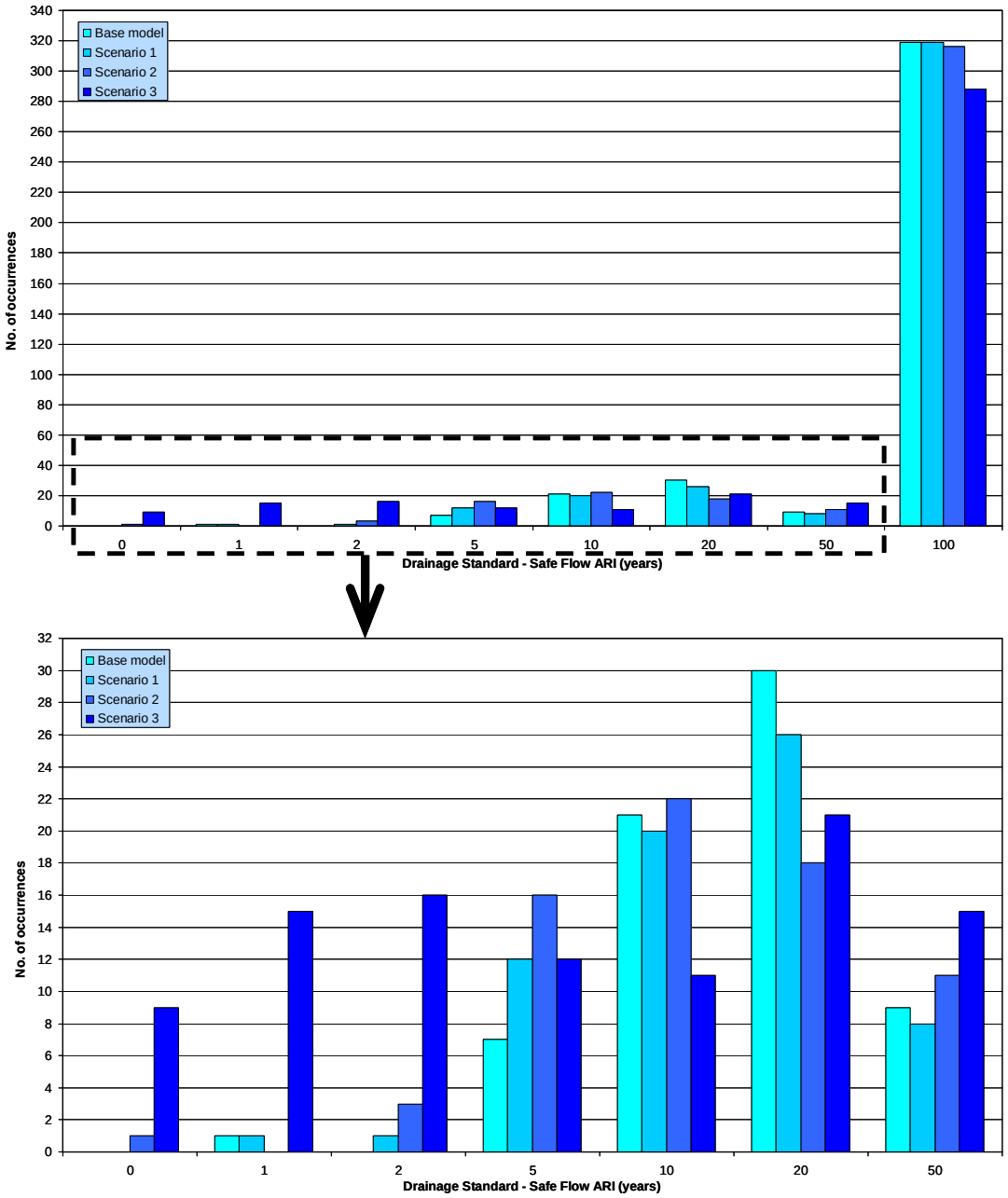


FIGURE 4-4 : INFILL DEVELOPMENT PEAK FLOW SENSITIVITY

4.4 Stormwater Management within the 30 Year Growth Area

Modelling of the urban growth areas was also undertaken using the modelling software program 'DRAINS'. This model was firstly used to estimate the predevelopment runoff rates and then the post development no mitigation runoff rates based on assumed development densities (as outlined in Table 6-1).

These results were then used to guide the assessment of areas and volumes of detention required to ensure post development flows did not exceed the predevelopment flow rates over a range of ARI flood events.

4.5 Review of Regional Flooding Issues

Flooding of Two Wells can arise from long duration storm events over many hours in the upper portions of the Gawler and Light River catchments. Flood waters are expected to take up to a day or more to reach Two Wells and the extent of flooding is heavily influenced by the volume of the floodwaters that breach the river banks, many kilometres away from Two Wells.

The flood analysis for Two Wells indicates that the critical maximum flood depths south of Gawler Road are associated with the Gawler River flows whereas north of Gawler Road the Light River tends to be more critical.

Constrictions at the railway line and at Port Wakefield Road influence the flow of floodwaters causing them to push northwards from Salt Creek into the existing township and beyond into the northern industrial area and the area to the north of Two Wells within the nominated 30 Year Growth Area.

A description of the flooding mechanism for each river system follows.

The extent of flooding from either the Light River or the Gawler River for the 1 in 100 ARI flood event is illustrated in Appendix A (in the form of composite flood maps). Composite flood maps are provided which assume that the flood peaks from the Gawler River and Light River will not coincide. There is sufficient historical evidence to support this assumption and furthermore the critical storm durations and travel times are different for the two river systems (AWE 2008, 2011a).

4.5.1 Gawler River

Floodplain mapping of the Gawler River (AWE, 2008) demonstrated that in large flow events major breakouts from the Gawler River near Wingate Road, Hillier can be expected. These flood waters would flow towards Two Wells and into Salt Creek.

Flood events exceeding the 1 in 50 (2%) Annual Exceedance Probability (AEP) event from the Gawler River are expected to flood portions of the residential area of the existing Two Wells township as well as portions of the proposed 30 Year Growth Area.

Flood waters from the Gawler River enter and then flow along Salt Creek until they come to the railway line crossing. This has insufficient capacity to cater for the full flood flow in a 1 in 100 ARI event and flood waters backup and push north and south along the railway line embankment. Overtopping of the railway embankment to the north is to be expected, primarily as a result of the railway line ballast material being displaced by the flood waters and effectively reducing the effective height of the embankment (by as much as 500 mm). This then causes flooding of the township. Flood waters that can pass through the railway line crossing are then likely to be impeded by the Port Wakefield Road crossing because the culverts under the main highway are not of sufficient capacity to convey the floodwaters. This then causes floodwaters to backup and either push south, but mainly northwards and into the existing township, the industrial area north of Two Wells and into the 30 Year Growth Area south of Temby Road. In fact, the highway creates a significant impediment to flow and a substantial flow rate is to be expected to the north (approximately 90 m^3s^{-1}) at its peak.

The same flooding mechanism is to be expected for the 1 in 50 ARI event but to a lesser extent with overtopping of the railway line less likely but still possible. Flood waters are still expected to push northwards along Port Wakefield Road into the industrial area but are less likely to impact on the 30 Year Growth Area south of Temby Road. The impacts on the existing township are also less severe.

A 1 in 100 ARI flood map for the Gawler River in the vicinity of Two Wells is provided in Appendix A (Figure A1).

4.5.2 Light River

Floodplain mapping has also been completed for the Light Right (AWE, 2011 (a,b)). This mapping indicates that flood events of magnitude greater than the 1 in 20 (5%) AEP event may cause floodwaters to enter the Two Wells residential areas as well as the areas proposed for urban expansion. These flood waters would emanate from a series of breakouts from the Light River near the Mallala to Gawler Road, downstream of the bridge crossing near Redbanks.

The Light River is perched along much of its length across the northern Adelaide Plains and its conveyancing capacity diminishes as the river travels from east to west. As a consequence, by the time the peak flow in the main channel arrives at Port Wakefield Road, a large proportion of flow will have surcharged out of the main channel and spilt out onto the floodplain. These floodwaters flow in a south to south westerly direction away from the main river channel and across the floodplain.

The passage of floodwaters is influenced by the railway line that traverses the Light River floodplain in a north-south orientation. The railway is raised above the surrounding floodplain and it is known from previous flood events that this embankment acts as a significant obstruction to flows. Along several localised drainage paths, floodwaters pond upstream of the railway embankment. At these locations floodwaters either pass through culverts under the railway line or continue southwards towards Two Wells.

Water that passes through the railway line culverts then flows to the south west towards Two Wells. Some of these waters would cross Temby Road and flood portions of the 30 Year Growth Area eventually passing through the industrial area north of Two Wells via the culverts under the Port Wakefield Road. Over topping of Port Wakefield Road is also to be expected at that location.

The water that does not pass through the railway line stays to the east and joins other floodwaters flowing southwards towards Two Wells (but not influenced by the railway line) ending up in Salt Creek. This water would pass through the 30 Year Growth Area north of Sharpe Road and East of the railway line. This water then flows along Salt Creek (via the existing Secomb Road alignment) continuing around to the south of the township where it behaves in similar fashion to floodwaters of the Gawler River with its passage being impeded by both the railway line and Port Wakefield Road crossings.

Over topping of the railway embankment is not expected but overtopping of the Port Wakefield Road is likely. Again flood waters are expected to push northwards along Port Wakefield Road to flood the industrial area to the north of Two Wells. The industrial area is expected to be flooded from both the north (directly from the Light River) and the south (via Light River flows that enter Salt Creek). The 30 Year Growth Area between Temby Road and Two Wells is not expected to be significantly impacted by flood waters from Salt Creek that originate from the Light River.

A set of culverts under the railway line at Sharpe Road allows a small volume of flood water to pass through the railway line at this point causing minor flooding in the 30 Year Growth Area west of the railway line.

A 1 in 100 ARI flood map for the Light River in the vicinity of Two Wells is provided in Appendix A (Figure A2).

4.6 Private and Public Assets at Risk

1 in 50 ARI event from either the Gawler or Light River

There are approximately 135 properties directly affected by a 1 in 50 ARI flood event from either the Light or Gawler River. This figure includes council buildings and infrastructure, such as pump stations and park facilities (eg playgrounds, toilets etc). Approximately 8 km of Council roads could be expected to be impacted including 3 km with kerbing and 1 km of formal footpaths.

The railway bridge crossing at Salt Creek would be impacted by flood waters and unlikely to be able to be used, whilst both the Old and main Port Wakefield Road crossing would be overtopped and both these roads would also be impassable. The Main Port Wakefield Road and railway line both form part of the national transport network. Hence the national transport network's serviceability requirements are compromised by flooding from the Light River and Gawler River.

1 in 100 ARI event from either the Gawler or Light River

There are approximately 370 properties directly affected by a 1 in 100 ARI flood event from either the Gawler or Light River. This figure includes council buildings and infrastructure, such as pump stations and park facilities (eg playgrounds, toilets etc). Approximately 21 km of council roads could be expected to be impacted including 7.5 km with kerbing and 2.5 km of formal footpaths. The railway bridge and bridge crossings of Old and main Port Wakefield Road would be overtopped and impassable.

4.7 Conjunctive Probability Implications

The design standard for communities and major public infrastructure such as that associated with the railway and Main Port Wakefield Road (both of which form part of the national transport network) is normally a 300mm of free board above the estimated flood level for the 1 in 100 ARI flood event. These key infrastructure and the township of Two Wells are at risk of inundation from a 1 in 50 ARI event from either the Gawler River or Light River. However, given that there is a flooding threat from two separate (and assumed to be independent) rivers the effective standard for these key infrastructure and the community of Two Wells is likely to be closer to 1 in 25 ARI than 1 in 50 ARI because they can be overtopped twice at that frequency, once from each river. The level of protection and standard of service provided is hence very low and in most instances elsewhere would be considered unacceptable.

Whilst a comprehensive conjunctive probability assessment was well beyond the scope of the project budget, it was considered important for the implications of there being two separate flooding mechanisms causing an elevated risk exposure at the 1 in 100 ARI flood level to be considered. This was done by reviewing the flood extents from both rivers at the 1 in 200 ARI flood level. The process involved interpolating between the flood extents of the 1 in 200 ARI flood to estimate the joint probability at the 1 in 100 ARI flood event. An interpolation process was adopted because simply adopting one flood extent or the other at the 1 in 200 ARI level would either over or under estimate the true joint probability. Simply adopting the larger of the two values was also considered to be overly simplistic and conservative. Hence a weighted average of the 1 in 200 ARI flood extents of the two river systems was calculated. The weighting (62% : 38%) was biased towards the higher of the two values.

The resultant weighted composite map is presented in Appendix A (Figure A3), along with the individual maps for flooding from the Gawler River and the Light River (Figures A1 and A2).

5 Local and Regional Stormwater Management Strategies

This SMP has been developed utilising a combination of new investigations and a compilation of existing data from previous reports and investigations.

Local flooding issues within the existing township were investigated in detail in the original SMP. Some works but not all have been undertaken since that plan was developed. Hence this updated SMP carries forward the original recommendations where the works have yet to be undertaken and acknowledges areas where works have been completed.

Furthermore, since that initial SMP work there have been a number of significant developments approved. The drainage designs associated with these have been reviewed as part of this more recent SMP and where appropriate this information has been included.

The Gawler River Floodplain Management Authority and Adelaide Plains Council have also undertaken major flood investigations for the Gawler River and Light River since the original SMP. These regional flood studies assessed a wide range of potential flood mitigation measures for Two Wells.

Those measures recommended in their previous reports as having highest priority for implementation at Two Wells have been carried forward into this updated SMP. An outline of these measures follows.

5.1 Regional Flood Management

5.1.1 Introduction

Council's Development Plan (updated in April 2106) includes principles of development control in relation to flood protection, such as:

> *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*
>
> *(b) buildings are designed and constructed to prevent the entry of floodwaters in a 1-in-100 year average return interval flood event.*

A number of alternative flood mitigation measures were investigated and documented in AWE 2011 (c). Those investigations identified three primary strategies that collectively would provide protection from flooding for the existing township as well as for the 30 Year Growth Area. These are:

- A flood protection levee around the east and south of Two Wells to protect the town from flood flows approaching the township along Salt Creek from either the Gawler River or Light River;
- The construction of a diversion channel north of Two Wells to protect the town (and growth area) from flood flows from the Light River approaching the township from the north; and

- The implementation of non-structural measures such as flood warning, flood preparedness and planning controls.

Of these measures the non structural ones are considered to have highest priority and should be implemented as soon as practicable. Whilst not preventing flooding, they provide effective mechanisms to ensure the consequences from flooding do not worsen and also provide existing landholders with the capacity to minimise the impacts to them in the event of a flood. They are also relatively inexpensive and are likely to have the highest benefit cost ratio of all measures assessed.

A description of the preferred strategy elements is provided in the sections that follow.

5.1.2 Regional Flood Management Recommendations

The regional flood management recommendations have been assigned a reference name (RFM#) to assist with identifying references to the actions in the following sections of the report.

5.1.2.1 RFM1: Flood Protection Levee East and South of Two Wells

The construction of a flood protection levee around the eastern and southern extent of Two Wells would prevent floodwaters passing through the urbanised areas of Two Wells Township. The levee would prevent flows from the design flood event passing through the railway culvert adjacent to Gawler Road and similarly would eliminate floodwaters that would otherwise move north along Port Wakefield Road.

The function of the levee is to provide flood protection for the township and existing flood prone areas situated to the north of Two Wells. The levee is not intended to protect new (yet to be approved) development as protection for new development should be established by setting minimum finished floor levels above the 1 in 100 ARI flood level (without the levee).

Alternative Strategies to Levees Considered

Alternative flood mitigation options for protection of the Two Wells township have been considered during the preparation of this SMP. Most recently the GRFMA have reviewed options to construct a new larger flood control dam upstream of Gawler, or to enlarge the existing Bruce Eastick North Para Flood Control Dam. Enlarging the existing dam was the preferred alternative of these two options. However, both options were found to be very expensive and to have long time frames for implementation.

Furthermore, at present there are no regional proposals to address flooding of the Light River other that flood preparedness measures. Hence the levee system proposed for Two Wells was considered to be the most cost effective structural solution for the prevention of damage in the existing township of Two Wells. It is the only measure within the Adelaide Plains Council area considered capable of addressing flooding from both the Light and Gawler Rivers.

The Limitations of Levees as a Flood Management Approach

It is important to recognise that flood mitigation approaches that rely on levees are sub-optimal. Levees require ongoing, regular maintenance and there integrity can be threatened if maintenance activities are compromised. Furthermore, they can actually exacerbate flooding once overtopped if allowance and management strategies are not in place to deal with this outcome. It is important to recognise that levees, as with any other structure mitigation strategy, are designed for a specific level of service. When this design standard is exceeded the protection measure will fail and hence strategies must be developed that consider the implications of such a situation.

A further drawback with a levee system as opposed to some other mitigation strategies is that there can be rapid change in flood behaviour from when before and after a levee is overtopped. Thus they can create a rapidly changing emergency situation if their deign standard is exceeded.

Nevertheless, in some situations they remain the most viable and practical solution to improve the level of flood protection for existing developed areas. This is the case for Two Wells.

Preliminary Levee Alignment and Height

A preliminary levee alignment was defined based on recent aerial photography and cadastral boundaries to provide a solution that would maximise the benefit and minimise the impact on existing landholders. The alignment follows an existing road reserve to the south of Two Wells and also to the east.

It was determined that the location of the flood protection levee around Two Wells would need to extend from Gawler Road through to Port Wakefield Road via the northern bank alignment of Salt Creek. To avoid floodwaters travelling northwards along Port Wakefield Road, the levee would need to extend a short distance north, parallel with Port Wakefield Road. A potential alignment for the flood protection levee around Two Wells is shown in Figure 5-1 along with approximate top of levee elevations for either a 1 in 100 or 1 in 200 ARI level of protection. (The final choice in level of protection should be finalised through the detailed design process).

The outcomes indicate a significant variance in the required height of the proposed levee due to the difference in ground elevation. It has been assumed that a freeboard of 300 mm would be required to prevent overtopping due to wave action.

The levee would need to extend a short distance north of Gawler Road and Gawler Road would need to be raised at the cross over point (or a removable levee system installed) to a level of 12.9 mAHD to provide protection from the 1 in 100 ARI flood with allowance for 300 mm freeboard. This level is approximately 0.75 m above the natural ground level at present.

Further along the levee, adjacent to the termination of Wilson Street, the levee would be approximately 2.6 m above the natural ground level. The length of levee exceeding 2 m above the natural surface would be approximately 600 m. At the railway line, the levee will be slightly higher than the top of the sleeper level and be approximately 2.0 m above the natural ground level. An impermeable barrier would need to be installed within the railway embankment to prevent flood waters from flowing through the ballast and thereby tunnelling through the levee.

The railway would need to be closed during a 1 in 100 ARI or larger flood event.

The levee height would be approximately 1.7 m above the natural ground level at Port Wakefield Road and between this location and the railway the levee height would need to range from 1.5 m to 2.4 m above the natural ground surface.

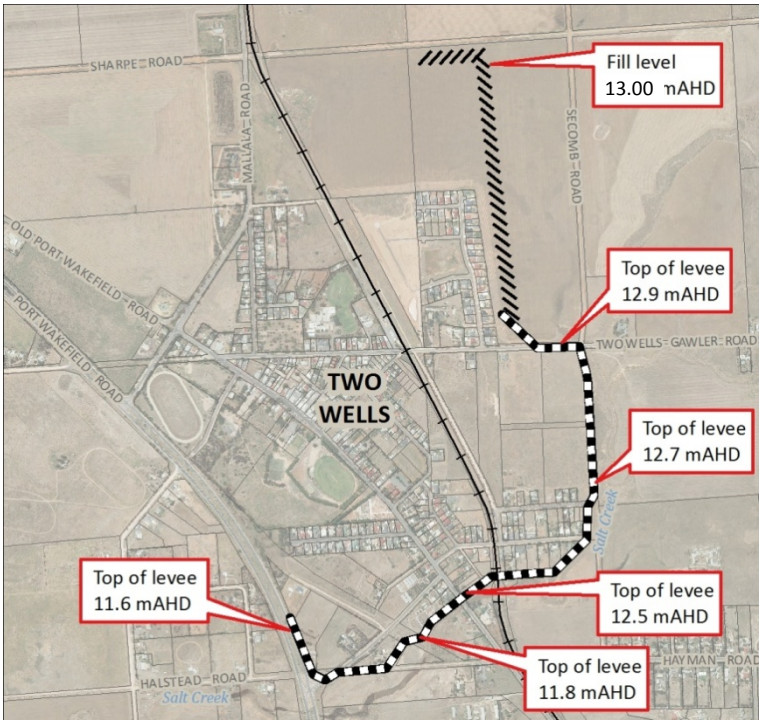


FIGURE 5-1 : TWO WELLS SOUTHERN LEVEE ALIGNMENT AND APPROXIMATE ELEVATIONS TO PROVIDE 1 IN 100 ARI LEVEL OF FLOOD PROTECTION (INCORPORATING ALLOWANCE FOR CONJUNCTIVE PROBABILITY OF FLOODING)

Potential Adverse Impacts of a Levee Implementation

As a consequence of providing improved flood protection to Two Wells there may be some minor increase in flood depth outside of the levee and small areas of new flooding may develop. These new areas of flooding will only be on the fringe of the existing flood extent and field assessment indicated that there is unlikely to be any significant impact on existing dwellings (that are not otherwise protected by the levee). No new properties would be subjected to flooding as a result of the levee.

Maintenance Requirements

Should the works proceed, it will be important that Council maintains the levee in good working order and establishes a regular maintenance program. Such a program should include an annual visual inspection with a check survey conducted every five years (for example).

Further Design Considerations

Arrangements would need to be made to ensure that stormwater runoff from Two Wells itself would not be impeded in an adverse way by the levee (e.g. pipes through the levee with non return systems such as flap gates). An assessment of the likely outlet points for the existing drainage system through the levee has been undertaken. These locations are identified in Figure 5-2, along with culvert sizes and flood detention volumes and areas based on a 1 in 5 ARI flood event on the Township coinciding with a 1 in 100 ARI flood event on the Gawler River (or Light River).

Provision would therefore be made for the temporary storage of stormwater runoff from the township in the unlikely event that local runoff becomes trapped behind the levee when the Gawler River, and as a consequence Salt Creek, is in flood. The times of concentration for these two scenarios are vastly different and hence it is extremely unlikely that there would be a coincidence of peak flows. Nevertheless provision needs to be made for managing local stormwater runoff during a

major regional flood event. The design criteria considered appropriate for this scenario was the coincidence of a 1 in 5 ARI local runoff event and a 1 in 100 ARI flood of the Gawler River.

Consideration of a Greater then 1 in 100 ARI Design Standard

Typically it is considered best practice to ensure that development within a floodplain is managed to achieve a flood immunity of 1 in 100 ARI flood event or greater, which is the basis used for the flood protection levee. However, it was considered appropriate to also investigate the works necessary to increase the standard of flood protection to the 1 in 200 ARI flood event which would provide greater protection against unexpected events, such as a possible breach in the railway embankment, and provide an additional factor of safety against levee failure.

To retain the existing 300 mm of freeboard above the design flood level the height of the levee around Two Wells would need to be raised by between 100 – 200 mm. The larger increases of around 200 mm would need to occur along the northern end of the levee. The levee would also need to extend a very short distance further north to prevent floodwaters spilling around the northern end. Towards Port Wakefield Road the levee height would only need an increase in the order of 100 mm to achieve the 200 year ARI flood immunity standard.

A plan showing the water surface elevation comparing the 100 ARI and 200 ARI events with the proposed levee is provided in Appendix B.

A levee designed for the 1 in 100 ARI with a freeboard allowance of 300mm would therefore also provide protection against a 1 in 200 ARI event, but with a smaller freeboard and hence lower factor of safety.

A final decision on any additional works to raise the levee to achieve the a full 300 mm freeboard allowance and minor additional works to extend the levee along Port Wakefield Road for the 1 in 200 ARI level of protection should be made during the final design phase based on a detailed cost benefit assessment for the works. This is considered a reasonable way forward given that the footprint of the levee is essentially the same for the 1 in 100 or 1 in 200 ARI events.

A further consideration is the impact of the levee on properties that are not afforded protection by it. When changes are made to the flow of water across a flood plan there are invariably those who benefit and those who do not. In some cases some properties can be worse off. A critical design consideration is ensuring that the number of properties adversely affected is minimised and also that the scale of any individual adverse impacts are minimised.

There are a small number of properties (up to 10) where flood depths could be increased by between 150 to 200 mm. Whilst this is considered to be a significant increase in depth for these properties, site inspections indicate that there are no additional properties are likely to suffer over floor flooding, than otherwise would be the case (without a levee).

A plan showing the flood depth difference as a result of the levee is provided in Appendix B.

Benefits of Implementation

The positive outcomes of this mitigation approach are that it will effectively prevent floodwaters passing through the existing urbanised areas of the Two Wells township. Protection would be provided for up to the 1 in 100 ARI flood event from either the Gawler River or Light River. It would prevent flows through the railway culvert adjacent to Gawler Road and similarly could prevent floodwaters that would otherwise move north along Port Wakefield Road.

Flooding of approximately 182 allotments would be prevented in a 1 in 100 ARI event due to the implementation of levee system. The direct tangible flood damage cost of over floor flooding of a

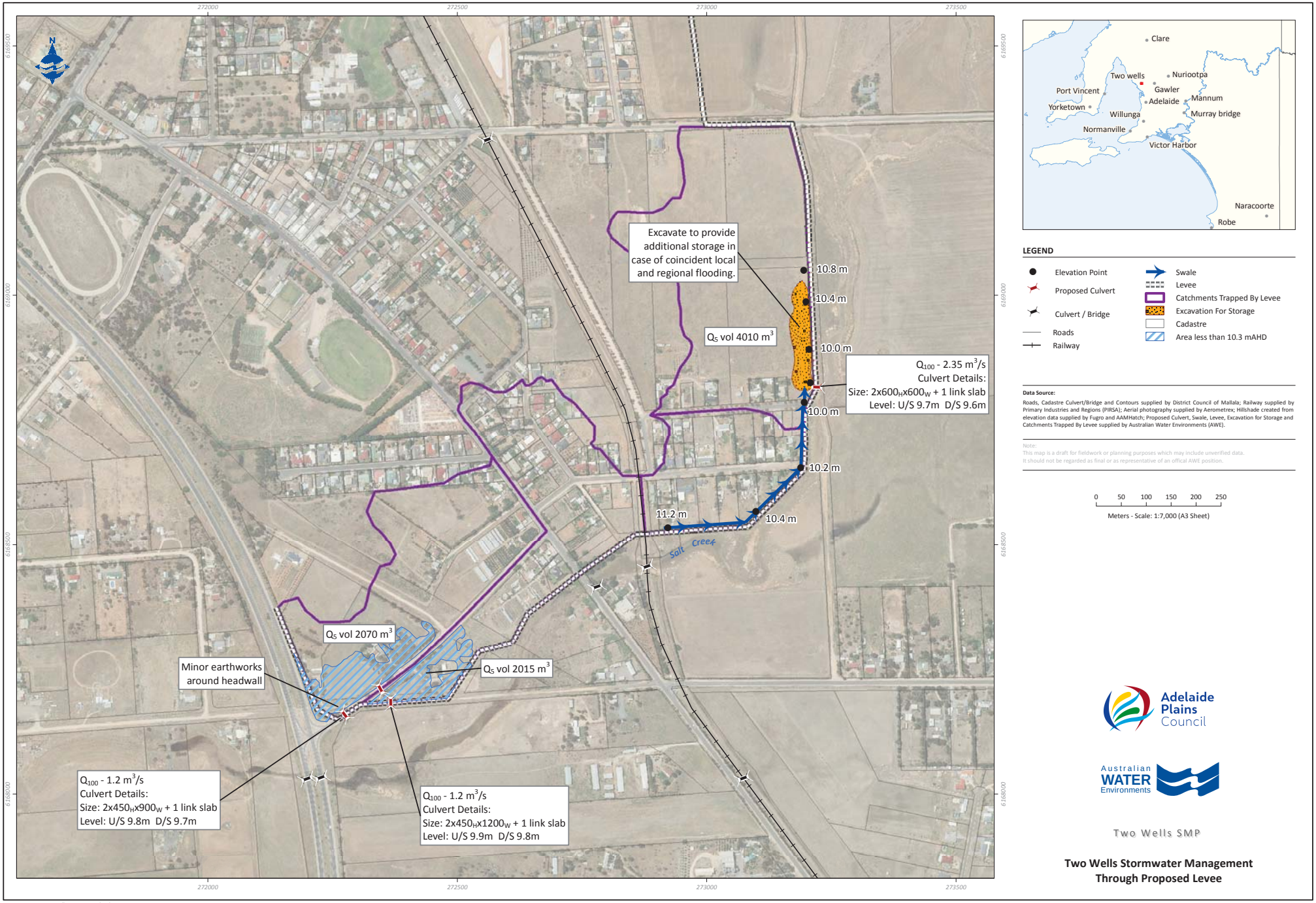
residential property is estimated to be $33,212 (Bureau of Transport Economics (2001), escalated to 2016)).

The potential benefit of reducing flood inundation through the construction of the levee proposed would there be approximately $6 million of direct tangible flood damage costs. In addition to these direct costs there are also the indirect tangible costs such as emergency response, clean up and emergency accommodation as well as intangible costs such as household disruption and trauma.

Open Space and Watercourse Improvement

The proposed levee system alignment follows the Salt Creek channel from the eastern end of Wilson Street through to Port Wakefield Road. The construction along this alignment provides opportunity for the levee to be formed such that, areas of open space for public recreation can be provided. Landscaping of the levee will provide opportunities for local revegetation of the Salt Creek channel. The provision of public open space centred around the Salt Creek channel has the potential to raise the profile of Salt Creek as a watercourse with the local community.

Making a community feature of areas of the levee system may aid the Council in maintaining flood awareness in the community and provide additional impetuous to sustain investment in maintenance in the future.



LEGEND

- Elevation Point
- Proposed Culvert
- Culvert / Bridge
- Roads
- Railway
- Swale
- Levee
- Catchments Trapped By Levee
- Excavation For Storage
- Cadastre
- Area less than 10.3 mAHD

Data Source:

Roads, Cadastre Culvert/Bridge and Contours supplied by District Council of Mallala; Railway supplied by Primary Industries and Regions (PIRSA); Aerial photography supplied by Aerometrex; Hillshade created from elevation data supplied by Fugro and AAMHatch; Proposed Culvert, Swale, Levee, Excavation for Storage and Catchments Trapped By Levee supplied by Australian Water Environments (AWE).

Note:
This map is a draft for fieldwork or planning purposes which may include unverified data.
It should not be regarded as final or as representative of an offical AWE position.

0 50 100 150 200 250
Meters - Scale: 1:7,000 (A3 Sheet)

Adelaide Plains Council

Australian WATER Environments

Two Wells SMP

Two Wells Stormwater Management Through Proposed Levee

12197 D022 v2 Two Wells SMP Levee Flood Mitigation 131204
Last Updated: 4/12/2013

Figure 5.2

5.1.2.2 RFM2: Flood Diversion Channels North of Two Wells

Floodwaters associated with breakouts from the Light River main channel currently have the potential to result in widespread, but shallow, flooding to the area immediately north of Two Wells. Much of this area has been identified for future urban development in the 30 Year Plan for Greater Adelaide. AWE 2011(c) considered a number of mitigation options. The most cost effective alternative, and the one with the least impacts of those assessed, was the construction of a swale collection system along the alignment of Temby Road.

Proposed Alignment

The proposed alignment for the main diversion swale is immediately to the south of Temby Road. Flood waters from the north would be collected by the diversion channel and directed to the west. The flow is split midway along Temby Road with a "central" north south orientated channel/swale transferring a portion of these flood waters directly to existing sets of culverts under Port Wakefield Road. The central north south swale would be approximately 30 m wide and carry a peak flow of approximately 10 m^3/s. The alignment of this swale is to the east of the Warren Road reserve. This central swale serves the purpose of keeping water levels adjacent the main Port Wakefield Road below the level of the road seal. The balance of flows (11 m^3/s) continues along to the west just south of the Temby Road in a 60 m wide swale before being directed along the edge of Port Wakefield Road to also meet up with existing culverts under the highway. The swale widens in the west to accommodate an inflow of additional flood waters from the north.

Floodwaters, also from the Light River to the north, flow along the eastern side of the railway line to a set of culverts near Sharpe Road. Flood waters pool at this point and flow through the culverts to the west. A small swale (10 m wide) is required to carry these flows (peak of 5 m^3/s) across to the west to the culverts under Port Wakefield Road. The time of travel of these flows is much longer than the flows that are collected via the Temby Road system and hence these flow peaks are not expected to coincide.

Floodwaters are effectively transferred across the floodplain to existing culverts through Port Wakefield Road and thereby into existing flow paths downstream of the highway. A schematic of the Temby Road diversion system is provided in Figure 5-3.

The diversion channel system also reduces the extent of over topping of the Port Wakefield Road.

FIGURE 5-3 : TEMBY ROAD DIVERSION SYSTEM SCHEMATIC

5.1.3 Combined Regional Flood Management Measure Benefits

If both the levee arrangement south of Two Wells (RFM1) and the flood diversion channels north of Two Wells (RFM2) were implemented the extent of overtopping of Port Wakefield Road between Salt Creek and Temby Road would be reduced from 2100 m down to 800m. The remaining 800m would be confined to the immediate area associated with overtopping of the Salt Creek crossing. The bulk of the reduction in overtopping is achieved by the levee preventing flow pushing north along Port Wakefield Road and causing overtopping of the road.

5.2 Local Drainage Management

5.2.1 Existing Township

Strategies for managing the stormwater deficiencies identified for the existing township are discussed in the following sections. The list has been ordered in rank of priority for completion of the works. The local drainage management actions have been assigned a reference name (eg. LDM#).

5.2.2 LDM1: Chapman Street Spoon Drain

Further investigation should be undertaken by Council to develop an understanding of the drainage infrastructure connected to the Chapman Street spoon drain.

It is possible that the deficiencies noted at this location could be the result of the poor condition of the infrastructure (vegetation growth and sediment build up). Council has removed debris and silt in the past from this drainage system. The ongoing strategy required to deal with this deficiency may be as simple as continuing with the sediment removal and making sure that any vegetation growth and/or sediment around the infrastructure is minimised using standard Council methods.

The benefit of undertaking further investigations and potentially maintenance actions at this location include reduced frequency and extent of inundation of the road verge. Conducting regular maintenance in this area may also reduce the expected negative impacts of increasing impervious area due to development pressure in the catchment.

5.2.3 LDM2: Potential Drainage Deficiencies Identified by the Model that Require Verification

A number of potential drainage deficiencies within the existing township were identified through the modelling process. It is possible that the deficiencies identified may be as a result of overestimates of inundation due to inherent limitations in the modelling approach.

It is proposed that Council monitor these areas during storm events to gather more anecdotal information on the performance of drainage infrastructure in these areas.

The locations that fall into this category are listed below (along with their model reference code):

- Old Port Wakefield Road (optwkfld70);
- Old Port Wakefield Road (optwkfld58);
- Old Port Wakefield Road (optwkfld64); and
- Chapman Street (chapman21).

Through actively collecting anecdotal information on these areas identified as potentially deficient Council may be able to take corrective action before these areas become issues for the community.

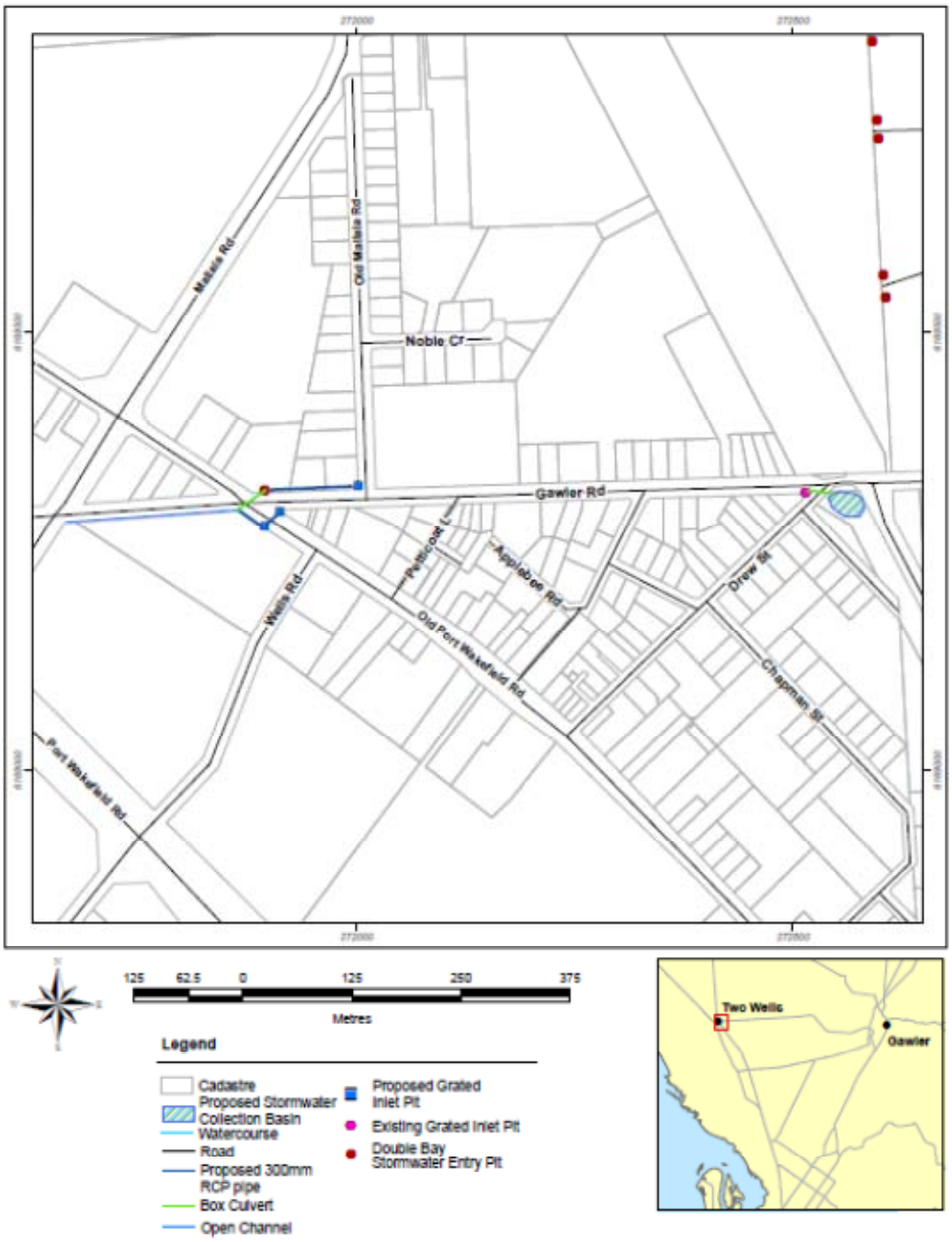


FIGURE 5-4 : CONCEPT DESIGN FOR STORMWATER MANAGEMENT IN EXISTING TWO WELLS TOWNSHIP

5.2.4 LDM3: Infill Development

The findings presented in Section 4.3 indicate that infill development within the existing township areas could have a significant impact on the Two Wells drainage system if not well managed. The introduction of best practice WSUD procedures as standard across the region can provide comprehensive solutions for the reduction of runoff generation and the attenuation of peak flows.

The degree to which future development will impact runoff rates and volumes, and hence the capacity of the current stormwater conveyance devices also depends on the development, introduction and successful implementation of policies that deal with the detention or retention of stormwater from properties.

The benefits of successfully managing infill development of Two Wells include:

- Preserve the historical, "rural" character of the town;
- Ensure public safety by preventing dangerous stormwater flows through the township that may result in limited road access and inundation of private property;
- Reduce the cost of infrastructure development required to cope with increased stormwater loads, e.g. piped stormwater network may be necessary to ensure public safety under increased infill development scenario; and
- Through the use of WSUD techniques multi benefits are often achieved including increased quality of public spaces and improvement in runoff quality.

Recommendation for Implementation of Policies for Onsite Stormwater Detention

Where infill development is undertaken, it is proposed Council enforce a requirement for the developed site to retain the stormwater leaving the site at the pre-developed level using on-site management techniques. Rainwater tanks and rain saver gutters that are plumbed into in-house demand, such as toilet flushing, are likely suitable measures for residential development. Assessment of stormwater flows off-site should be investigated during the planning application stage.

Recommendation for Council to use WSUD techniques for its own Works and Measures.

Council can then also contribute to the management of infill development impacts by utilising WSUD techniques for its own works and measures, in a similar fashion to that suggested below for the 30 Year Growth Area.

5.2.5 30 Year Growth Area- Options for Distributed Stormwater Management System Elements to Meet WSUD Principles of Development Control

The drainage systems for the new urban growth areas should be designed with the aim of achieving the stormwater management objectives of Council, which include principles of development control through WSUD.

There are a range of distributed measures that can be used within new developments to assist with this process. Distributed water management systems create more localised smaller scale systems that can be equally effective as an end of system approach but possibly at a higher cost. Localised WSUD features are also an effective means of visually highlighting the ability to achieve sustainable stormwater management within the urban setting. However, they can be more challenging to maintain and less space efficient in achieving the desired treatment outcomes. This is mostly due to difficulties in locating the system to capture the majority of runoff.

It is envisaged that the stormwater management system would incorporate some distributed elements and that the number and nature of these will evolve through the design process to optimise the landscape and systems benefits along with implementation costs.

Some systems that may be considered as part of the WSUD drainage approach include buffer strips, swales, rain gardens and bioretention systems. Propriety products such as gross pollutant traps may be adopted in some instances while rainwater tanks are assumed to be installed to meet the current legislative requirements and Council's existing Development Plan.

A brief description of the key landscape related elements of a distributed stormwater management system that could expect to be incorporated within the final detailed system designs on an opportunistic basis follows.

5.2.5.1 Buffer Strips

Buffer strips are usually provided in areas adjacent to impervious surfaces such as roads. The intent is that runoff traverses these areas and the grassed finish provides a higher resistance which allows for course sediment to be deposited and for infiltration losses to occur. These are only suitable for sheet flow as opposed to along a concentrated flow path.

FIGURE 5-5 : BUFFER STRIP ADJACENT TO ROAD

5.2.5.2 Swales

A swale is an earthen channel generally planted out with vegetation or protected with a stabilised base. These are designed to convey concentrated flow while still providing for infiltration and deposition of course sediment. These are often utilised along roads but less so in high density developments where there may be numerous driveway crossovers required. Swales are also limited to sites with gentle longitudinal grades (<4%) to prevent scouring velocities from occurring.

Swales are ideally suited to the Two Wells area given the flat topography of the region. It is envisaged that the bulk of the floodways will be of the swale form, and the internal drainage lines will also be of this form.

FIGURE 5-6 : SWALE AT PINE LAKES, CITY OF SALISBURY (SOURCE: CITY OF SALISBURY)

5.2.5.3 Rain Gardens and Bioretention Systems

Rain gardens and bioretention systems are essentially similar systems with the exception that bioretention systems include subsurface drainage which collects water towards the base of the system and conveys to the stormwater drainage network. Meanwhile, rain gardens are reliant on infiltration to the groundwater system and uptake by vegetation. Rain gardens may also be planted with larger shrubs and trees which are inappropriate for a bioretention system due to potential damage to the drainage system.

Bioretention systems usually require the importation of a suitable filtration media which is typically a sandy loam with moderate hydraulic conductivity. These are appropriate for installation in parks and may even be installed directly adjacent to roads and car parks. Examples of bioretention systems are shown in the figures below. Both rain gardens and bioretention systems can be prone to clogging with fine sediment if there are not suitable protection measures upstream. This can ultimately result in more frequent maintenance and reinstatement of the system.

FIGURE 5-7 : KERB INLET DESIGN WITH BIORETENTION SWALE (SOURCE: GOLD COAST CITY COUNCIL)

FIGURE 5-8 : KERB INLETS TO SMALL SCALE BIORETENTION SYSTEM (SOURCE: CITY OF KINGSTON)

5.3 Non-Structural Flood Mitigation Measures

Whilst this SMP promotes the establishment of structural measures to protect the township, this should not diminish the importance of non-structural measures such as flood warning, flood preparedness and planning controls. These measures are low cost and typically can be implemented over much shorter timeframes. They could be initiated almost immediately and thereby provide the people of Two Wells with an improved risk profile in the interim period whilst the structural measures are being developed and arrangements being made for funding.

Opportunities for better managing flood risk using non-structural flood mitigation measures are described below.

5.3.1 NSFM1: Flood Preparedness

Flood preparedness is a cost effective non-structural means of reducing damages as a result of a flood. Flood preparedness programs in this context are considered in four phases: flood awareness, warning, response (including access) and recovery.

Flood Awareness

A flood awareness program for people in Two Wells is an important aspect of reducing the risk of flood damage. A community awareness program, such as the SA State Emergency Service's (SES) highly successful community education and awareness raising 'Floodsafe' program which assists the community in being better prepared and able to respond to flood risks and events is recommended. 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).

A sophisticated and effective flood warning service is provided by BOM for the Gawler River. However, real time rainfall and flow data is only available for the Light River well upstream of its junction with Gilbert River. No flow information on the Gilbert River is currently collected. An additional gauging station on the Gilbert River and/or downstream of the junction with Light River would significantly improve the ability to warn the people of Two Wells of an impending flood. As such, another flow gauge station at Red Banks is recommended to extend the Gilbert River warning system. Additional rain gauges further upstream would also improve flood warning.

Flood Response

The 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. 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.

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.

Access

Providing safe effective access to flood prone areas is important to reduce the risk to residents and emergency workers. Effective access means a high level exit route that remains trafficable for sufficient time to evacuate the population at risk (i.e. evacuation can be undertaken solely by motor vehicle) (SCARM, 2000).

The levels of damage and disruption caused by a flood are also influenced by the difficulty of evacuating flood-affected people and property. Evacuation may be difficult due to a number of factors, such as the following (SCARM, 2000):

- Number of people requiring assistance;
- Depth and velocity of floodwaters;
- Wading problems, which can be exacerbated by, for example, uneven ground, fences, debris, localised high velocities;
- Distance to flood-free ground;
- Loss of traffic ability on evacuation routes because of rising floodwaters;
- Bottlenecks on evacuation routes (i.e. roads cannot cope with the increased volume of traffic, the large number of people and great volume of goods that have to be moved);
- Inability to contact evacuation services; and
- Unavailability of suitable evacuation equipment such as boats, heavy trucks and helicopters.

In assessing the safety of wading, factors other than depth and velocity need to be taken into account such as evenness of the ground surface or presence of depressions, potholes, fences or deep major stormwater drains (SCARM, 2000).

The suitability of access should be investigated for a range of flood events. Initial analysis usually focuses on the 1% AEP (1 in 100 ARI) flood event but the 0.5% or 0.2 % AEP events should also be considered to ensure that in larger events the flood conditions do not deteriorate significantly.

To determine the safety of access the criteria for which flood conditions are considered safe to traverse for both people and vehicles needs to be considered.

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.

Summary of Recommended Flood Preparedness Actions

It is recommended that a Total Flood Warning System be developed for Two Wells. This would involve implementing a Flood Preparedness Program including community education and awareness raising, and consideration of installing additional gauging stations, e.g. river gauges on the Gilbert River and/or downstream of the junction with Light River, and rain gauges further upstream.

5.3.2 NSFM2: Development/planning controls

The Development Plan is a statutory document that controls and manages all forms of development within the Council area. It sets out a range of development zones, maps and rules to guide development in a well managed way and to take into account relevant environmental, infrastructure, urban design, heritage and community issues.

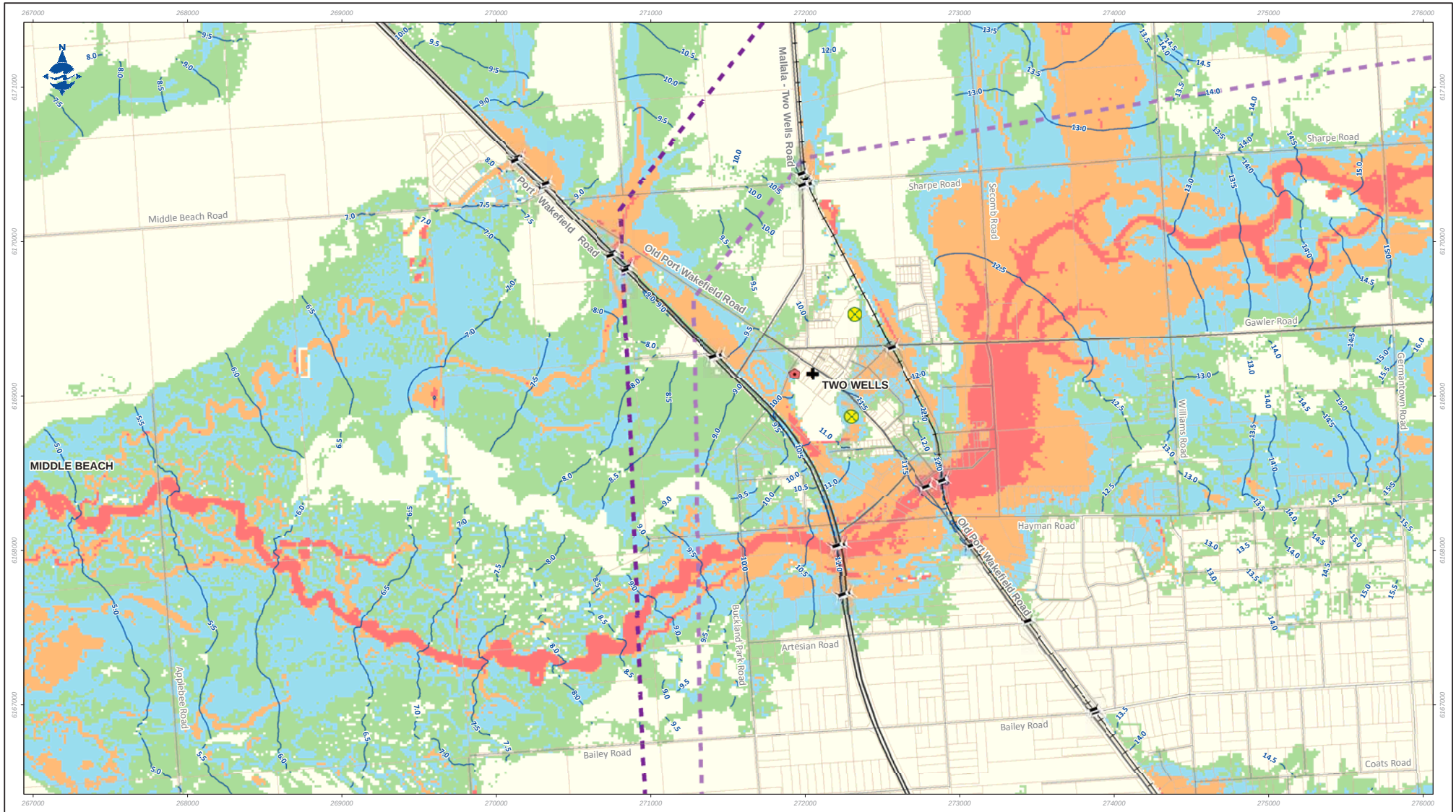
Planning controls within Council's Development Plan provide a framework to plan and build in a manner that incorporates stormwater management.

Council's Development Plan currently does not include specific water quality treatment objectives however it does include principles of development controls that aim to manage the quality of stormwater runoff, which are described in section 6.1 of this report.

Recommended Changes to Development Plan

To improve the effectiveness of the Development Plan, Council should consider including specific water quality and reuse targets identified in the State Government's targets and the NRM Board's resource condition targets.

The Development Plan should also provide information on the required finished floor levels for development in flood prone areas. This SMP provides direction on finished floor levels by providing a 300 mm freeboard above the expected water surface elevation for a 1 in 100 ARI flood. A flood inundation map is provided in Appendix A. A flood hazard map is provided in Figure 5-9.

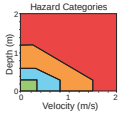


LEGEND

- Culvert / Bridge
- CFS / MFS
- Hospital / Ambulance
- Police Station
- Sports Facility (tennis courts, oval, golf course, etc)
- ETSA Substations
- Railway
- Road - Major
- Road - Intermediate
- Road - Minor
- Water Surface Elevation Contours (mAHD) (9.5)
- Light River DTM Extent
- Gawler River DTM Extent
- Local Government Area
- Cadastre

Hazard Category:

- *Low*
- *Medium*
- *High*
- *Extreme*



0 200 400 600 800 1,000

Metres Scale 1:25,000 on A3 Sheet

Data Source:

Light River and Gawler River study extent, CFS, Hospital, Police and Sporting Facility locations developed by AWE. Railway, Roads and Suburbs from Geoscience Australia, District Council of Mallala, Light Regional Council and City of Playford. Culverts and Bridges from DTEI and ARTC. Port Wakefield Road, Railway, Culverts and Bridges -spatially edited at AWE. Cadastre from District Council of Mallala. Substations from ETSA Utilities. Watercourses from DWLBC. Local Government boundaries from Planning SA. Locality or Place Name data from Geoscience Australia. Contours from Fugro Spatial Solutions (Light River region) and AAMHatch (Gawler River region). Flood data (received 24th June, 2011) from Water Technology.

Australian WATER Environments

Adelaide Plains Council

WATER TECHNOLOGY

Two Wells SMP

1 in 100 ARI Flood Hazard and Water Surface Elevations

12197 D035 v1 1 in 100 ARI Surface Water Elevations 140710
Last Updated: 18/07/2014

Figure 5-9

6 Water Quality Assessment

6.1 Overview

The SMA's multi-objective planning approach to preparing stormwater management plans includes seeking opportunities to improve stormwater quality. The aim of improving stormwater quality is also supported by Council and state government, as described below.

Council's Development Plan does not include specific water quality treatment objectives however it does include principles of development controls that aim to manage the quality of stormwater runoff, such as:

> *Principle 9: Water discharged from a development site should:*
>
> *(a) be of a physical, chemical and biological condition equivalent to or better than its pre-developed state;*
>
> *(b) not exceed the rate of discharge from the site as it existed in pre-development conditions.*
>
> *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.*

6.2 Water Quality Targets for this SMP

As described in section 3.3 the overarching aim of this SMP with respect to water quality is that stormwater runoff from new development should meet state government pollutant removal targets and where possible runoff from existing development should be managed to improve the condition of downstream receiving environments.

The South Australian Government (Water Sensitive Urban Design, 2013) reduction targets are provided below:

- 80% reduction in Total Suspended Solids;
- 60% reduction in Total Phosphorous; and
- 45% reduction in Total Nitrogen.

6.2.1 New Development: 30 Year Growth Area

The stormwater generated as result of the 30 Year Growth Area will require a treatment system to improve water quality and to ensure that the above water quality targets can be achieved and the water quality objectives of the plan can be supported.

There are a number of areas that have been designated as future development areas. Based on the 30 year growth boundary, the anticipated urban growth potential in the region equates to approximately 418 ha for potential future development (Connor Holmes 2011), with an estimated dwelling yield of 7.1 and 9.5 dwellings per hectare for low and medium density predictions respectively.

Council requires that future development reflects best practice to minimise impacts on the receiving environments, both during the course of development; and into the future (e.g. in order to ensure adverse impacts on the environment are minimized during new land development, a range of

measures and strategies could be implemented, including the provision of specific soil, erosion and sediment management strategies that would need to be evaluated and approved by Council).

6.3 Water Quality Modelling

Water quality modelling was undertaken in 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.

Preliminary modelling was undertaken in MUSIC to determine the treatment area required to meet the water quality objectives. This assessment process assumed that all treatment would be carried out in "end-of-line" treatment systems such as in wetlands or biofiltration systems. The relevance of this is that no provision has been made for any treatment that may occur as water is conveyed via a swale or other system mechanism which in reality would provide additional treatment. In some cases, sufficient treatment may be able to be provided within the conveyance system itself and in such cases there would be no need for any further end-of-line treatment. Therefore it is likely that the areas required for treatment identified in this analysis will be conservative.

6.3.1 Catchment Delineation

The catchment for Two Wells SMP water quality assessment was divided into eight sub catchment areas (See Figure 6-1 on the following page).

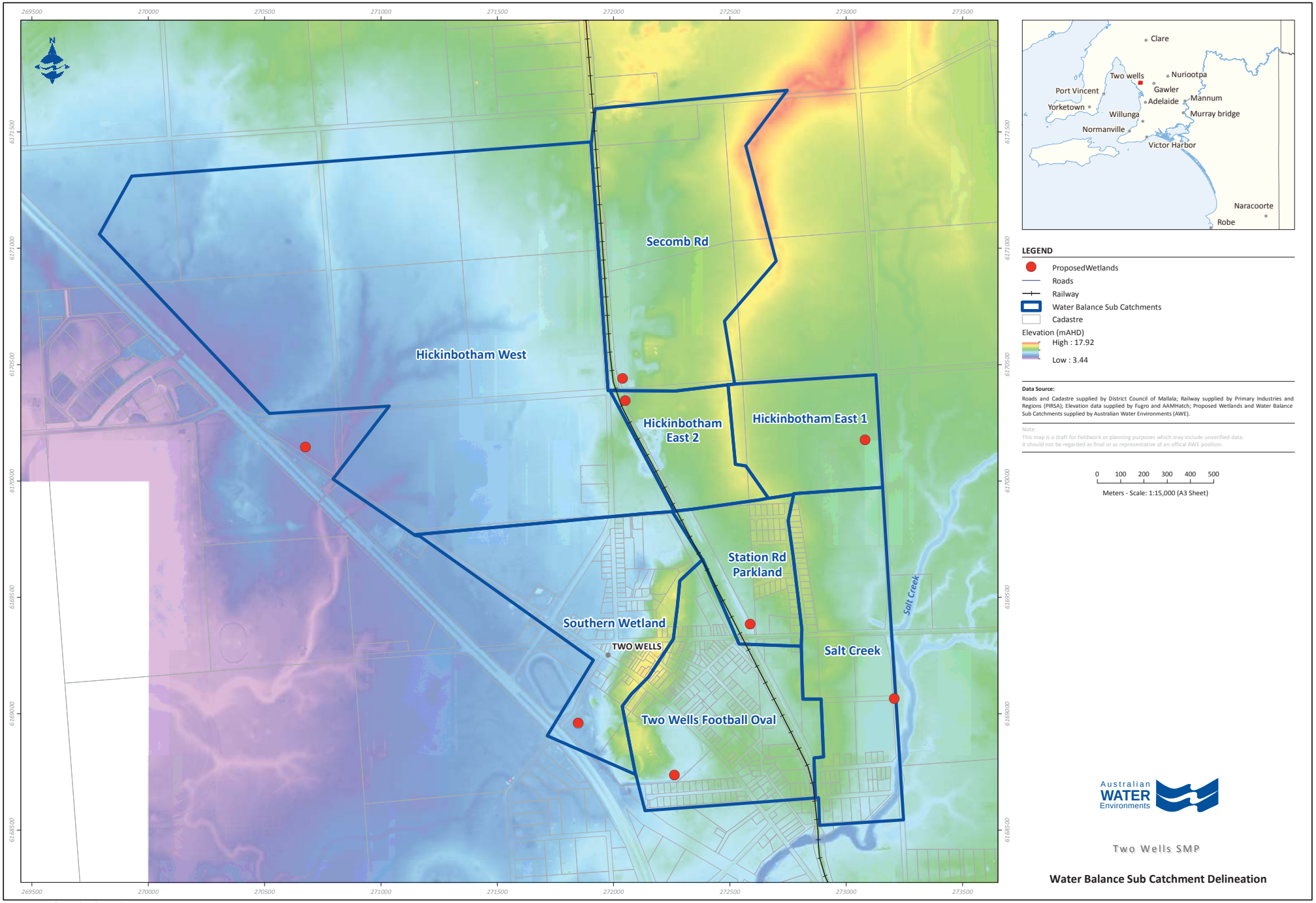
6.3.2 MUSIC Parameters

A daily time series for rainfall and evaporation data for Two Wells Rainfall Station (023028) (BOM) was used as the primary input parameters of the model. Each catchment was assigned an impervious percentage factor, as shown in the table below.

TABLE 6-1 : INITIAL CATCHMENT PARAMETERS

Catchment	Catchment Area (ha)	Impervious (%)	Pervious (%)
Hickinbotham West	260	60	40
Hickinbotham East 1	36	60	40
Hickinbotham East 2	14	60	40
Station Rd Parkland	22	60	40
Salt Creek	53	57	43
Secomb Rd	34	57	43
Southern Catchment	58	60	40
Two Wells Football Oval	61	57	43

The MUSIC model was run over a 50 year time sequence to understand the seasonal variability of the wetland and how long sequences of dry or wet periods could affect water yields, aesthetics and water quality treatment performance of the wetland.



12197 D001 Two Wells SMP Sub Catchment Delineation 131105
Last Updated: 5/11/2013

Figure 6.1

6.4 Water Quality Improvement Options Investigated

A range of alternative approaches and configurations were considered to identify and investigate water quality improvement strategies. Two approaches were considered most appropriate for either retrofitting water treatment systems for the existing township or for adoption in newly developed areas. The two approaches presented involve either an end of pipe approach using wetland systems or by utilising biofiltration systems.

Council may elect to evaluate a wider range of potential approaches during further detailed design phases but either a biofiltration system or wetland treatment system at the end of each sub-catchment was considered to be the options that would most easily be installed and be the most cost effective.

Both approaches should provide Council with multiple benefits in the following areas:

- Improved water quality (and thus beneficial outcomes for receiving environments);
- Opportunities for water harvesting;
- Flood mitigation; and
- Parklands for aesthetical and recreational purposes.

The biofiltration approach offers an opportunity to adopt a more distributed approach, where treatment systems can be distributed throughout the catchment.

6.5 Indicative Areas Required for Treatment

6.5.1 30 Year Growth Area

The final selection of treatment system configuration within the 30 Year Growth Area will need to be resolved during the detailed design phases of the project but the information presented below should assist Council in reviewing the detailed design proposals being put forward for approval.

6.5.2 Existing Township

Consideration was given to constructing a single or a series of consolidated treatment systems in Salt Creek. Salt Creek is the main receiving water body in the immediate vicinity to Two Wells and a single treatment system downstream of the Port Wakefield Road or a series of treatment systems east and west of the railway line could conceivably perform a similar function. However, the proposed sub-catchment by sub-catchment approach was considered to be a superior option because that approach would enable staging of works.

6.5.3 Treatment Area Estimates

The treatment systems (wetlands and biofiltration areas) were adjusted iteratively in MUSIC until they achieved the % reduction objectives for Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN).

Modelling for the biofiltration system approach was based on a standard vegetated biofilter with effective nutrient removal plants, extended detention depth equivalent to 0.3 m and a filter depth of approximately 0.7 m.

The analysis considered further development to the east of Two Wells which would ultimately drain into Salt Creek and the future development east of Secomb Road and north of Sharpe Road.

The indicative treatment areas for each of the catchments modelled are presented in Table 6-2.

TABLE 6-2 : INITIAL CATCHMENT TREATMENT AREA ESTIMATES

Catchment	Catchment Area (ha)	Wetland Treatment Area (ha)	Biofiltration Treatment Area (ha)
Hickinbotham West	260	4.5	5.0
Hickinbotham East 1	36	1.0	0.9
Hickinbotham East 2	14	0.2	0.5
Station Rd Parkland	22	0.9	1.0
Salt Creek	53	0.9	1.0
Secomb Rd	34	0.9	1.0
Southern Catchment	58	0.9	1.5
Two Wells Football Oval	61	0.9	1.0

A comparison of the expected pollutant reductions against the State Government targets is provided in Table 6-3.

TABLE 6-3 : EXPECTED STORMWATER TREATMENT PERFORMANCE FOR ESTIMATED TREATMENT AREAS

Catchment	Analyte	State Govt target (% reduction)	Wetland – Expected treatment performance (% reduction)	Biofiltration - Expected treatment performance (% reduction)
Hickinbotham West	Total Suspended Solids	80%	97	99
	Total Phosphorous	60%	90	63
	Total Nitrogen	45%	75	84
Hickinbotham East 1	Total Suspended Solids	80%	98	99
	Total Phosphorous	60%	89	66
	Total Nitrogen	45%	72	86
Hickinbotham East 2	Total Suspended Solids	80%	98	99
	Total Phosphorous	60%	89	70
	Total Nitrogen	45%	64	87
Station Rd Parkland	Total Suspended Solids	80%	98	99
	Total Phosphorous	60%	89	74
	Total Nitrogen	45%	72	89
Salt Creek	Total Suspended Solids	80%	98	99
	Total Phosphorous	60%	90	62
	Total Nitrogen	45%	73	84
Secomb Rd	Total Suspended Solids	80%	98	99
	Total Phosphorous	60%	89	73
	Total Nitrogen	45%	71	89
Southern Catchment	Total Suspended Solids	80%	98	99
	Total Phosphorous	60%	89	78
	Total Nitrogen	45%	70	81
Two Wells Football Oval	Total Suspended Solids	80%	98	99
	Total Phosphorous	60%	89	59
	Total Nitrogen	45%	70	83

6.6 Generalised Guidelines for Required Water Quality Improvement Treatment Area Size by Catchment Area

The analysis presented above was used to develop a look up table (Table 6-4) of catchment areas and treatment areas. The purpose of the look up table is to assist council in assessing development proposals by providing general guidance on the areas of treatment that might be required.

TABLE 6-4 GENERAL GUIDANCE ON WATER QUALITY TREATMENT AREA REQUIRED TO MEET POLLUTANT REMOVAL TARGETS (BY CATCHMENT AREA)

Catchment Area (ha)	Indicative Treatment Area Required (ha)
5	0.1
15	0.3
40	0.8
100	2.0

The information is not intended (nor is it appropriate) to be used to replace specific designs that must still be requested from proponents through the development application processes.

6.7 Quality Management Recommendations

6.7.1 WQ1 and WQ2: 30 Year Growth Area Wetlands

The focus for Council for the growth areas at this time is to ensure quality of runoff from the significant new development proposed is managed effectively and in a way which provides multi benefits to the community whilst minimising the ongoing costs of maintenance.

The recommendations for direct capital investment in stormwater quality improvement infrastructure in these areas within the life time of this plan are therefore restricted to the wetlands in the Hickinbotham East catchments and in the Hickinbotham West catchments.

These two wetlands are expected to exceed the South Australian Government WSUD targets (Water Sensitive Urban Design, 2013). They will also provide opportunities to enhance public open space, raise the profile of stormwater quality within the community and increase local biodiversity.

Other treatment strategies could also be employed to achieve the desired treatment outcomes. Consideration should be given to integrating principles of WSUD such as swales, biofiltration systems, and buffer strips (as described in section 5.2.5) as part of future residential development planning to maximise the potential for water quality improvement. Implementation of such measures would reduce the need for end of system treatment, i.e. wetlands.

6.7.2 WQ3: Opportunistic Water Quality Improvement in Existing Catchments

Pursuing large scale water quality improvement capital investment for the existing township area is not currently within Council's resources. Also, at this point in time managing flooding is considered to be a higher priority for Council.

Whilst this may be the case for large scale investments, there will be opportunities for smaller scale systems as part of normal infrastructure upgrade and renewal programs. Council should give high priority to retrofitting small scale localised measures such as rain gardens, street tree pits, kerb side protuberance gardens as part of road and /or street scape upgrades within existing developed catchments.

Implementing small scale works will improve the quality of public space within the township, provide localised improvement in the quality of runoff, and provide opportunities for increased awareness of stormwater quality issues within the community.

These small scale works may also provide a soft entry for Council design and maintenance staff as well as the local community into the design and use of water sensitive urban design infrastructure.

6.7.3 WQ4: Retrofit Biofilteration or Wetlands in Existing Developed Catchments

Five other subcatchments (Station Rd Parkland, Salt Creek, Secomb Rd, Southern Catchment and Two Wells Football Oval) which receive water from the developed areas of Two Wells have also been investigated. The quality of runoff from these catchments would be improved to meet South Australian Government WSUD targets if distributed biofiltration basins or swales were installed or end of pipe wetlands were constructed.

Many of these catchments contribute directly or indirectly to Salt Creek. Improving the quality of runoff into Salt Creek would contribute to the improvement of the condition of Salt Creek. Both wetland and biofiltration devices have the potential to improvement quality of public space and provide opportunities for increased awareness of stormwater quality issues within the community.

Construction of treatment infrastructure of the form and type described here is expected to realise pollutant reduction performance exceeding the SA Government WSUD targets.

These systems have been assessed at a high level to provide Council with guidance on the required scale of investment that would be required to achieve the aspirational water quality goals. This then places Council in a position where it can pursue these measures over a longer timeframe being mindful that any shorter term actions undertaken in good faith do not foreclose on a future opportunity.

7 Stormwater Harvesting and Reuse Assessment

7.1 Overview

The SMA's multi-objective planning approach to preparing stormwater management plans includes maximising the reuse of stormwater. This is also an aim of Council, as described below.

One of the objectives in Council's Development Plan (21 April 2016) is to maximise the harvest and use of stormwater. In line with this objective are principles of development control, including the following:

> *Principle 15: Stormwater management systems should:*
>
> *(a) maximise the potential for stormwater harvesting and reuse, either on-site or as close as practicable to the source*
>
> *(b) utilise, but not be limited to, one or more of the following harvesting methods:*
>
> *(i) the collection of roof water in tanks*
>
> *(ii) the discharge to open space, landscaping or garden areas, including strips adjacent to car parks*
>
> *(iii) the incorporation of detention and retention facilities*
>
> *(iv) aquifer recharge.*

7.2 Runoff Assessment

This SMP has explored options for harvesting and reuse. A water balance assessment was undertaken to assess the potential for stormwater reuse. The area for consideration in the water balance is approximately 538 ha and corresponds to the same catchment areas used for the water quality assessments (refer to Figure 6-1).

The stormwater volumes generated as part of the MUSIC modelling process were used for the water balance assessment. In the first instance it was envisaged that water would be used for irrigation of public open space. It was further assumed for the analysis that the reuse system would comprise a wetland treatment system along with Managed Aquifer Recharge (MAR) to provide storage capacity.

An assessment of irrigation opportunities within Two Wells was undertaken to determine potential uses for the treated stormwater. This assessment considered irrigation of parklands (for passive recreation and open spaces), gardens and reserves in Two Wells and the indicative areas identified in the earlier section.

7.3 Stormwater Runoff Volumes

The resultant stormwater runoff volumes were calculated using the initial catchment parameters to define the sub catchments characteristics and defining the infiltration component (0.03 mm/hr).

The total runoff volumes from each sub catchments were added to give an overall estimated average runoff volume of 1016 ML/year. The estimated volumes for each sub-catchment are provided in Table 7-1.

TABLE 7-1 : CATCHMENT YIELD ESTIMATES

Catchment	Catchment Area (ha)	Catchment Yield ML/year
Hickinbotham West	260	499
Hickinbotham East 1	36	68.5
Hickinbotham East 2	14	40.1
Station Rd Parkland	22	41.6
Salt Creek	53	96.5
Seacomb Rd	34	61.2
Southern Catchment	58	111
Two Wells Football Oval	61	111

7.4 Irrigation Opportunities

An opportunity for reusing stormwater is irrigating public open space which would benefit recreational pursuits and local amenity values. This assessment involved identifying areas in Two Wells for regular weekly and/or daily watering of turf, (such as reserves, public gardens and parklands), particularly during the dryer months of the year. The areas identified for potential irrigation are provided in the table below. These areas are consistent with Council's Open Space Management Plan.

TABLE 7-2 : POTENTIAL PUBLIC OPEN SPACE OPPORTUNITIES

Potential Irrigation Opportunity	Area (ha)
Two Wells Football Oval and Surrounds	8.6
*Parklands for development west of Secomb Road and south of Sharpe Road.	3.4
Hickinbotham Development (including Reception to Year 12 private school)	116
Two Wells Primary School	6.5
Parklands in Tangari Estate	1.8
Gardens around the Station Road parklands	2.6
Windmill Road (Two Wells Trotting Track)	4.0

**It was assumed 10% of the total area for future development south of Sharpe Road and west of Secomb Road would be assigned to parklands.*

Once an assessment of areas identified for irrigation was completed a further analysis was undertaken to determine the minimum seasonal irrigation volumes that would be required to maintain the parklands area. An irrigation of public open space (IPOS) model was utilised (using monthly rainfall and evapotranspiration data) to calculate the monthly irrigation requirement. It is assumed that the irrigation season would occur from October to March. The average monthly irrigation volumes are summarised in Table 7-3.

TABLE 7-3 : IRRIGATION REQUIREMENTS

Month	Irrigation Requirement (ML)
January	108
February	86
March	64
April	19
May	0
June	0
July	0
August	0
September	19
October	52
November	82
December	90

7.5 Managed Aquifer Recharge

MAR is the process of adding stormwater and/or treated wastewater to aquifers in a controlled environment. The purpose of MAR is to allow for the extraction and storage of reuse water for irrigation and providing alternative water resources particularly in extended dry periods. The MAR option has been considered to be integrated as part of the stormwater reuse scenario.

The aquifer (which will be considered for further investigations) is the T2 limestone aquifer (beneath the Adelaide and Northern Adelaide Plains) that typically generates bore yields of around 10L/s. This aquifer is currently being used to support the City of Salisbury MAR projects.

The water quality for the T2 Aquifer typically tends to be more saline as it moves north. It would be anticipated that the injection of treated stormwater would actually improve the overall water quality of the groundwater.

Whilst the T2 aquifer would be conducive for MAR, experiences at Salisbury Council have indicated that to be a financially viable scheme, an MAR scheme needs to harvest at least 200ML/year. The local catchments at Two Wells outside of the 30 year growth areas are not sufficient to provide harvestable yields of that quantity. However, the capture and reuse of stormwater provides a wider array of benefits to the community through improved amenity, social connection and would reduce the impact of the existing township and any new development within it on receiving waters. When these wider array of benefits are considered smaller localised schemes can provide an attractive proposition for communities.

Similarly, whilst there would be greater potential to consider the development of a MAR as part of the 30 year growth area development, it is likely though that the development of such a scheme would need the bulk of the 30 year growth area to have been developed to generate the required volumes of water to be cost effective.

Hence, Council should continue to pursue smaller scale WSUD elements (such as street verge watering, rain water tanks, rain gardens etc) and encourage developers to do the same in the absence of a large scale MAR Scheme. Collectively these smaller scale distributed systems should be able to achieve significant levels of reuse.

In areas where the MAR scheme can support a wider array of benefits and does not need to be justified as a cost effective water supply then the local aquifer system should be able to support MAR development.

7.6 Stormwater Reuse Using MAR (Harvesting Water Balance)

The high level water balance assessment provides information in relation to the following key issues:

- The daily natural variability of rainfall and runoff in the wetland system;
- Spillage from the wetland system;
- Assessment of storages and ensuring that these are meeting minimum requirements for aesthetical purposes;
- Assessing the need for groundwater to supplement the stormwater reuse and the associated limitations; and
- If additional storage is required for surplus water in system on the provision that aquifer storage is available.

The water balance was modelled over a 50 year time sequence and the daily stormwater yields derived from the MUSIC model were incorporated in the water balance.

Daily time series for rainfall and evaporation were sourced from BOM and the irrigation volumes generated in IPOS were used as an input parameter to the model. Given the soil type it was anticipated that seepage would be low; approximately 0.03 mm/hr.

For the MAR system it was assumed that one bore would be used for the dual purposes of extraction and injection. However increasing the number of bores would improve system efficiency and capture rates. There would need to be monitoring bores to assess/report on system effectiveness and operations.

The operating conditions assumed for the bore in the water balance are summarised below:

- Maximum Injection Rate: 1296 m3/day; and
- Maximum Withdrawal Rate Injection Rate: 864 m3/day.

The lower extraction rate was to ensure that the system would comply with the MAR licensing requirements for the Adelaide Plains.

The key water supply requirements and operating rules assumed for the water balance were as follows:

- If the storage of the wetland exceeds the maximum (allowable) design volume then the wetland spills;
- Stormwater from the wetland will be provided for irrigation purposes on the condition that there is a minimum volume of water in the wetland for aesthetical and recreational purposes;

- If irrigation water cannot be supplied due to the wetland not having sufficient sources then providing there is groundwater available, groundwater is extracted to 'top up' or provide the irrigation volume required;
- Upon water being accounted for reuse purposes and the minimum storage requirements being met, if there is surplus water remaining this is injected into the aquifer; and
- If water is required to top up the wetland this is provided by groundwater on the condition that the maximum ASR withdrawal rate has not been met and there are sufficient groundwater storages available.

This scenario investigates the potential to use stormwater for irrigation purposes whilst maintaining water levels in the wetland at a minimum for aesthetical and recreational requirements.

The modelling approach assumed that the wetlands were interconnected or at least that water could be transferred between to a centralised MAR bore. Similarly it was assumed that harvested water could be distributed to the irrigation demand areas.

The water balance demonstrates sufficient stormwater (when land is fully developed) can be provided to sustain the above open space areas whilst also ensuring that the wetlands are kept at or above the minimum volume requirements. The water balance indicates the critical periods for which the wetland will require topping up from the groundwater. These periods coincide with the peak irrigation application rates in the summer months.

A sensitivity assessment of the water balance was undertaken to determine if the wetland size could be reduced. This analysis indicated that the primary driver for wetland size was to achieve the water quality treatment objectives. Hence there was not scope to reduce the wetland size. Additionally, the amount of water which can be stored and extracted is limited by the extraction and withdrawal rates of the bores. This could be increased (as previously indicated) by increasing the number of bores.

7.7 Rainwater Tanks

An alternative approach to a centralised stormwater harvesting system utilising wetlands and MAR is to adopt a distributed approach utilising rainwater tanks.

The principles of development control in Council's Development Plan (21 April 2016) includes:

> *Principle 9 – Residential development should be designed in association with rain water tanks having a storage capacity of at least 10 000 litres in urban areas and 22 000 litres in rural and rural living areas, independent of fire fighting purposes.*

The extensive use of rainwater tanks is considered to be a practical at source alternative to larger centralised MAR schemes. Furthermore, the cost of the harvesting system is effectively passed on directly to the individual landholder who benefits from the scheme.

The amount of rainfall (or roof runoff) a property can capture, store and use annually is dependent on factors including:

- The annual rainfall;
- The roof area connected to the tank;
- How much rainwater is used and when it is used;
- The capacity to draw on a backup supply; and
- The capacity of the tank.

The key to this approach is to have a secure backup supply so that water in the rainwater tank can be used as a first option to supply household and garden needs in the winter and spring periods whilst over summer supplies can be sourced from the alternative supply (i.e. mains water).

Rainwater used in this way can significantly reduce the demand for mains water.

Water from the tanks can be used for toilet flushing, in the hot water system or other non-potable uses.

Rainwater tanks used in this way can also have an impact on minor flows (less than 5 year ARI) in the downstream drainage system. They will also reduce the total volume of stormwater discharged from allotments and as a result are likely to be of benefit in reducing the impact of stormwater on the downstream receiving environment. There is also the potential for Council to further encourage the installation and use of rainwater tanks by offering additional rebates to the rebates already available from SA Water.

7.8 Summary of Reuse Potential

The water balance considered an option of stormwater reuse using a combination of stormwater and MAR to supply an open space area of approximately 143 ha. This would have beneficial outcomes for recreational pursuits and enhance the local amenity values of the area.

The water balance anticipates that approximately 1016 ML/year will be generated as stormwater runoff with approximately 356 ML/yr spilling from the system.

Approximately 19 ML/yr would be used to top up the wetland and 132 ML/year of stored groundwater being used for irrigation.

Graphs demonstrating the wetland behaviour and the integration of the MAR system are provided in Appendix C.

The water harvesting and reuse approach modelled presents a scenario whereby 65% of runoff from the fully developed catchment would be retained within the township.

The water balance analysis highlighted that the sizing of the wetland is ultimately governed by the stormwater objectives and ensuring the area is sufficient to meet the required treatment for water quality. The extraction and injection limits on the bore in the water balance limit the amount of water which could be stored in the aquifer and groundwater which could be using for irrigation and/or topping up the wetland.

The creation of a MAR scheme for stormwater is considered an attractive option for ensuring that the wetland systems (which are required for water treatment purposes) will remain filled with water and retain a high level of amenity and habitat value. It also provides a mechanism for watering open space areas during the initial phases of the development.

The wetlands should retain water throughout the year and so would maintain their water treatment functionality, but a scheme utilising MAR would be able to maintain the wetland systems to a higher level of amenity.

Potential locations for harvesting and treatment areas are shown in Figure 7.1.

Consideration should be given to integrating principles of WSUD such as swales, biofiltration systems, rain gardens, rainwater tanks, and buffer strips as part of future residential development planning to maximise the potential for reuse and water quality improvement. For example, use of rainwater tanks alone for active use by households can provide a significant additional benefit in terms of water quality but also water harvesting. This scenario was modelled for a fully developed

Two Wells and the 30 year Growth Area. This scenario would reduce runoff volumes by 370 ML or approximately 37%.

Other opportunities for increasing reuse to meet the 75% post development runoff reuse target include:

- Providing a higher turf quality in the reserves;
- Maintaining areas of open water for amenity purposes in ornamental lakes;
- Increasing the size and uses of rainwater tanks on each allotment;
- Increasing the area of the school which is irrigated;
- Providing irrigation water for other local sites; or
- Contributing to a regional reuse scheme.

It appears that there are a number of options to reuse the runoff volume needed to meet the 75% post runoff volume reuse target, should Council consider this to be desirable.

If a conjunctive stormwater reuse approach is applied, utilising wetlands and MAR along with the active use of rainwater tanks, this could achieve a 85% capture and reuse rate of stormwater runoff – indicating that the proposed SMP reuse objective is achievable.

7.9 Reuse Recommendations

Recommendations for harvesting reuse in this SMP focus on options that have a higher level of community demand, as well as options that are more likely to attract funding. The reuse of stormwater has been explored. It was found that a range of techniques would be required to meet the SMP target of 75% of runoff reused. To meet this target a large scale MAR scheme would be necessary. These have significant capital and maintenance costs.

Given Council's limited resources within the scope of the current SMP time frame the recommendations focus on small scale works.

7.9.1 SWR1: MAR based reuse Scheme Hickinbotham West Wetland

It is recommend that a reuse scheme using MAR based around the Hickinbotham West catchment wetland be constructed as part of the new development associated with the 30 year growth area.

This scheme alone is expected to reduce runoff by 65%. In addition the use of large scale reuse scheme will enable the wetlands proposed to be maintained in higher aesthetic condition by being watered during drier months. A reuse scheme associated with the catchment draining to the west will reduce the volume of runoff discharged under Port Wakefield Road and into the agricultural land to the west. This reduction in runoff volume will reduce the nuisance flooding impact which could potentially be caused by the construction of the large areas of impervious areas associated with residential development.

7.9.2 SWR2: Promotion of Rainwater Tank Use and Incorporation of WSUD systems within Council scheduled works

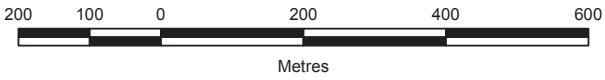
It is recommended that Council promote the use of rainwater tanks for each dwelling within the township. Plumbing of the tanks for automatic reuse within a dwelling will also increase the runoff reused.

Modelling of rainwater tank use, assuming the tanks were the sole source of water supply for households, was found to provide a significant benefit in terms harvesting. This scenario was modelled for a fully developed Two Wells and the 30 year Growth Area, and was found to reduce runoff volumes by 370 ML or approximately 37%.

Rainwater tanks used in this way can also have an impact on minor flows (less than 5 year ARI) in the downstream drainage system. They will also reduce the total volume of stormwater discharged from allotments and as a result are likely to be of benefit in reducing the impact of stormwater on the downstream receiving environment.

It is also recommended that Council should also give high priority to retrofitting small scale localised measures such as rain gardens, street tree pits, kerb side protuberance gardens as part of road and /or streetscape upgrades within existing developed catchments.

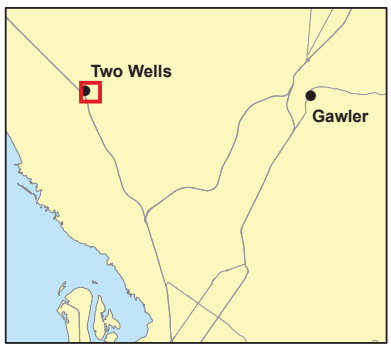
Implementing small scale works will improve the quality of public space within the township, provide localised improvement in the quality of runoff and provide opportunities for increased awareness of stormwater quality issues within the community.



Legend

- Cadastre
- Watercourse
- Road
- Potential stormwater harvesting and MAR sites

Data Source:
Road surveyed by AWE.
Major road of the location plan - Geoscience of Australia Series 3.
Cadastre - District Council of Mallala



Adelaide Plains Council

Australian WATER Environments

Two Wells SMP

Existing Township

Potential Stormwater Harvesting and MAR Sites

Job No. 12197 - 021
131204

Figure 7.1

8 Recommended Actions

8.1 Summary of Recommended Works

Key actions that are considered priority responses for improved stormwater management in Two Wells and corresponding objectives are summarised on the following page in Table 8-1.

Further information on the environmental, social and economic benefits of the proposed actions, responsibility for maintenance, as well as the recommended timeframes, suggested budget requirements and funding (implementation summary) are provided in the following sections.

TABLE 8-1 : OBJECTIVES AND ACTIONS

Actions	Primary SMP Objective	SMP Objective Criteria
RFM1: Temby Road Swale System. **RFM2 (a):** Raised land for flood protection north of Gawler Road. **RFM2 (b)**: Southern Levee between Gawler Road and Railway Line (Including short extension north of Gawler Road to avoid outflanking of levee). **RFM2 (c)** Southern Levee between Railway Line and Port Wakefield Road. **LDM1:** Chapman Street Spoon Drain. **LDM2:** Modelled drainage anomalies.	Manage flood waters.	Local Flooding: • All roads are required to be trafficable. (2.5 m wide lane width for 1 in 5 ARI, depth no greater than 300mm in 1 in 100 ARI event). • Stormwater flows should be contained in the road reserve. • No increase in peak flows as a result of development. Regional Flooding: • Existing and new properties to be protected from the 1 in 100 ARI event.
WQ1: Wetland water treatment Hickinbotham East catchments. **WQ2 and SWR1:** Wetland water treatment and water reuse Hickinbotham West catchments. **WQ3:** Incorporate WSUD systems within council infrastructure works (eg road upgrades) and streetscape upgrades.	Manage the catchment to improve the condition of receiving environments.	Water Quality: • Achieve the following reductions in pollutant loads from developed areas: o 80% reduction in SS o 60% reduction in TP o 45% Reduction in TN Biodiversity: Improve the condition of Salt Creek
WQ2 and SWR1: Wetland water treatment and water reuse Hickinbotham West catchments.	Manage water use to benefit the community.	As a minimum 75% of water generated by existing and new urban development is captured and reused.
LDM3: Review of planning controls in Development Plan to manage infill development and to incorporate water reuse and water treatment management objectives.	Council to lead and advocate the sustainable use of water, and the sustainable management of stormwater infrastructure, including maintenance.	Infrastructure to remain effective.
LDM3: Review of planning controls in Development Plan to manage infill development and to incorporate water reuse and water treatment management objectives. **SWR1:**Promote the effective use of rainwater tanks in the existing township as well as in the 30 Year Growth Areas.	Desirable planning outcomes associated with new development, open space, recreation and amenity. Minimise impact of new development on stormwater and receiving environments. Maximise the opportunity for private and partnership investment in and management of infrastructure and the natural systems.	Provide guidance to developers on appropriate finished floor levels to prevent flooding. Require developers to meet SMP targets for local drainage, water quality and reuse. Identify flood management strategies that Council should pursue in partnership with other beneficiaries and potential funding partners.

Actions	Primary SMP Objective	SMP Objective Criteria
NSFM1: Flood Preparedness. Develop a Total Flood Warning System for Two Wells. This would involve implementing a Flood Preparedness Program including community education and awareness raising, and installing flow monitoring gauging stations, on the Gilbert River and/or downstream of the junction with Light River, along with rain gauges further upstream.	Manage flood waters.	Regional Flooding: Existing and new properties to be protected from the 1 in 100 ARI event.
NSFM2: Development/planning controls. Include specific water quality and reuse objectives and targets in Council's Development Plan consistent with the State Government's targets and the NRM Board's resource condition targets.	Manage the catchment to improve the condition of receiving environments.	Biodiversity: Improve the condition of Salt Creek.

8.2 Environmental, Social and Economic Benefits

Each action proposed supports the achievement of the SMP objectives, as described earlier in Table 8-1. The specific links between the actions and objectives are highlighted in Table 8-2.

Environmental enhancement opportunities resulting from the proposed actions in this SMP are predominantly based on the improvements to water quality and better management of stormwater flows. These actions will help to protect the receiving environments of Salt Creek, samphire and mangrove vegetation at Middle Beach and Gulf St Vincent. Inclusion of water reuse and treatment objectives in Council's Development Plan will also help to ensure the protection of these downstream environments.

The improved infrastructure proposed in this SMP will provide opportunities for social benefits, including improved 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. This will alleviate community frustration and help maintain business trade in the town.

Other social benefits arise from the reuse of stormwater. In the township this could be the use of rainwater tanks for watering private allotments. In the 30 Year Growth Areas this could be the development of MAR systems to enable the reuse of stormwater for irrigating public open spaces, such as ovals and parks. The 'greening' of the township and future growth areas can engender a sense of community pride and belonging, as well as reducing the costs of using mains water. The local amenity will also be enhanced through the greening of public open spaces, as well as by improved stormwater systems that prevent the creation of stagnant, odorous pooling of stormwater.

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

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

8.3 Responsibility for Maintenance

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

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

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) Amendment Act 2007.

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.

8.4 Funding Opportunities - Potential Funding Contributions

Council will incorporate stormwater management strategies in its infrastructure/asset management plan for stormwater; however it will need to seek funding contributions from other sources, as described below.

The main stormwater related funding opportunity is the SMA. The SMA will potentially fund schemes that provide a wide range of benefits including flood risk, water quality and re use. It will not fund projects that only have water quality and reuse benefits. The SMA has limited funding each year and assesses projects with prime regard to the level of quantified benefits for the cost.

The SMA has in the past contributed up to 50% of the cost of certain works and may elect to contribute to the cost of works in a catchment of less than 40 hectares, provided that those works form part of an approved stormwater management plan. However, the works that the SMA typically funds are the main trunk drains or channels where the catchment area contributing is greater than 40 hectares. Where there are local catchments (with less than 40 hectares catchment areas) or even side entry pits on the trunk drains, these do not qualify for SMA funding. To assist in identifying funding opportunities with the SMA, the catchment sizes for the structural measures are provided in Table 8-2.

In addition, in order to gain SMA approval of the SMP, Council is required to take responsibility for undertaking watercourse maintenance in both public and private ownership within the area of the SMP. This issue was described in more detail in the previous section of this report.

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

There are also opportunities for developers of private land to fund works.

Potential funding partners for each recommendation are provided in Table 8-2.

8.4.1 Cost Sharing Arrangement

A cost sharing arrangement for Council and developers has been developed. In relation to new areas yet to be developed where the flood risk is known, the beneficiaries for each of the flood mitigation works have been identified for the purpose of apportioning costs of the flood mitigation works, e.g. the levee.

The benefits from the works and hence any cost sharing is based on the area of land that is flood prone that will be protected by the works irrespective of the current land use. In this way new development is treated equally with land that has already been developed.

The cost-sharing arrangement is reflected in the Implementation Table (refer to Table 8-2).

It is not anticipated that Council would contribute to any works that were solely for the benefit of developing the 30 Year Growth Areas.

TABLE 8-2 : IMPLEMENTATION SUMMARY TABLE

Project/ Activity Title and Location	Investigation Cost ($)	Capital Cost ($)	Recurrent Cost ($ pa)	Recommended timing (years)	Rating (H) - High (M) - Medium (L) - Low	Description of Benefit	Potential funding source
RFM1: Temby Road Swale System (catchment size greater than 40 ha)	Required for 30 Year Growth Area – Sharpe Land Parcel to be funded by developer	Required for 30 Year Growth Area – to be funded by developer	$10,000	0-15	M	• Required for protection of 30 Year Growth Area south of Temby Rd.	Developer
RFM2 (a): Raised land for flood protection north of Gawler Road (catchment size greater than 40 ha)	Required for 30 Year Growth Area – Gameau Land Parcel to be funded by developer	Required for 30 Year Growth Area – Gameau Land Parcel to be funded by developer	$2,000	0-2	M		Developer
RFM2 (b): Southern levee between Gawler Road and railway line (including short extension north of Gawler Road to avoid outflanking of levee). (catchment size greater than 40 ha)	$75,000	$750,000	$10,000	5-10	H	• Prevents floodwaters passing through the existing urbanised areas of the Two Wells township. Protection would be provided for up to the 1 in 100 ARI flood event from either the Gawler River or Light River. • Approximately 182 allotments would be prevented from flooding in a 1 in 100 ARI flood event. • Approximately $6 million of direct flood damage costs would be avoided in a 1 in 100 ARI flood. Cost associated with emergency response, clean up and community impacts would also be avoided. • Location of levee provides opportunity for the improvement of watercourse condition and the provision of public open space. • RFM2 in conjunction with RFM1 reduces the extent of over topping of Port Wakefield Road (Salt Creek to Temby Road) from 2100m to 800m. A reduction of 1300m. The majority of this reduction is as a consequence of the levee works (RFM2).	Stormwater Management Authority, Council
RFM2 (c): Southern levee between railway line and Port Wakefield Highway. (catchment size greater than 40 ha)	$50,000	$500,000	$10,000	10-15	H		Stormwater Management Authority, Council, Developer
LDM1: Chapman Street Spoon Drain. Further investigation of existing network condition. Possible rectification of blockage issues. (catchment size less than 40 ha)	$5,000	$5,000	$1,000	2-5	L	• Reduced frequency and extent of inundation of the road verge. • Regular maintenance may reduce the negative impacts of increasing development pressure in the catchment on drainage performance at this location.	Council
LDM2: Modelled drainage anomalies. Monitoring of identified areas to ground truth drainage network areas identified as potentially deficient. (catchment size less than 40 ha)	$2,000	TBA	TBA	5-10	L	• Ground truthing of hydraulic analysis. • May enable corrective action to be taken before these sections of network become issues for the community.	Council
LDM3:Review of planning controls in Development Plan to manage infill development and to incorporate water reuse and water treatment management objectives. (refer also NSFM2)	$25,000	-	-	0-5	H	• Ensures the Development Plan is kept up to date with WSUD and flood management principles. • Assist to preserve the historical, “rural” character of the town. • Ensure public safety by preventing dangerous stormwater flows through the township that may result in limited road access and inundation of private property. • Reduce the cost of infrastructure development required to cope with increased stormwater loads from infill development. • Through encouraging the use of WSUD techniques multi benefits are often achieved including increased quality of public spaces and improvement in runoff quality.	Council
WQ1: Wetland water treatment Hickinbotham East catchments. (catchment size less than 40 ha)	Required for 30 year Growth Area – Gameau Land Parcel to be funded by developer	Required for 30 year Growth Area – Gameau Land Parcel to be funded by developer	TBD	>10	H	• Water quality protection for Salt Creek and its coastal receiving environments. • Expected pollutant reduction performance: o TSS 98%, TP 89% and TN 64-72%. • Provide opportunities to enhance public open space, raise the profile of stormwater quality within the community and increase local biodiversity.	Developer

Project/ Activity Title and Location	Investigation Cost ($)	Capital Cost ($)	Recurrent Cost ($ pa)	Recommended timing (years)	Rating (H) - High (M) - Medium (L) - Low	Description of Benefit	Potential funding source
WQ2 and SWR1: Wetland water treatment Hickinbotham West catchments. (catchment size greater than 40 ha)	Required for 30 year Growth Area – Gameau Land Parcel to be funded by developer	Required for 30 year Growth Area – Gameau Land Parcel to be funded by developer	TBD	>10	H	• Water quality improvement and reduction in post development runoff volume for the receiving environments to the west of Port Wakefield Highway. • Expected pollutant reduction performance: o TSS 97%, TP 90% and TN 75%. • Provide opportunities to enhance public open space, raise the profile of stormwater quality within the community and increase local biodiversity. • Enable a 65% reuse of stormwater.	Developer
WQ3 and SWR2: Promote the effective use of rainwater tanks in the existing township as well as in the 30 Year Growth Areas and incorporate WSUD systems within council infrastructure works (eg road upgrades) and streetscape upgrades.	$20,000	-	-	0-15	M	• Reduces reliance on mains water supply. • For a fully developed Two Wells and the 30 year Growth Area and was found to reduce runoff volumes by 370 ML or approximately 37%. • Rainwater tanks used in this way can also have an impact on minor flows (less than 5 year ARI) in the downstream drainage system. • They will also reduce the total volume of stormwater discharged from allotments and as a result are likely to be of benefit in reducing the impact of stormwater on the downstream receiving environment. • Implementing small scale works will improve the quality of public space within the township, provide localised improvement in the quality of runoff and provide opportunities for increased awareness of stormwater quality issues within the community.	Council
NSFM1:Flood Preparedness (Total Flood Warning System) Implement a Flood Preparedness Program including community education and awareness raising, and consideration of installing additional gauging stations, e.g. river gauge on the Gilbert River and/or downstream of the junction with Light River, and rain gauges further upstream.	$30,000	$80,000	$10,000	0-2	H	• Community awareness raised. People are empowered to respond in an informed way – thereby significantly reducing flood damages. • Flood warning time and accuracy increased with additional monitoring. Flood damages reduced as the community has longer to respond to warnings.	Council, Bureau of Meteorology, Stormwater Management Authority, State Emergency Services
NSFM2: Development/planning controls. Include specific water quality and reuse objectives and targets in Council's Development Plan consistent with the State Government's targets and the NRM Board's resource condition targets.	Included in LDM3	-	-	0-5	H	• Ensures the Development Plan is kept up to date with the latest Natural Resource Management Plan for the region. • Provides protection for the environmental values and biodiversity of Salt Creek and contributes to the protection of the near shore marine environments and mangrove areas west of Two Wells.	Council

TABLE 8-3 PROJECTS FOR CONSIDERATION SHOULD FUNDING OPPORTUNITIES ARISE

Project/ Activity Title and Location	Description of Benefit	Potential funding source
WQ4: Retrofit Biofilteration or Wetlands in Existing Developed Catchments. (Station Road Parkland, Salt Creek, Secomb Road, Southern Catchment and Two Wells Football Oval	• The quality of runoff from these catchments would be improved to meet South Australian Government WSUD targets if distributed biofiltration basins or swales were installed or end of pipe wetlands were constructed. • Many of these catchments contribute directly or indirectly to Salt Creek. Improving the quality of runoff into Salt Creek would contribute to the improvement of the condition of Salt Creek. • Both wetland and biofiltration devices have the potential to improve quality of public space and provide opportunities for increased awareness of stormwater quality issues within the community. • Construction of treatment infrastructure of the form and type described here is expected to realise pollutant reduction performance exceeding the SA Government WSUD targets.	Council, AMLR NRMB, other grant schemes as they occur.

9 References

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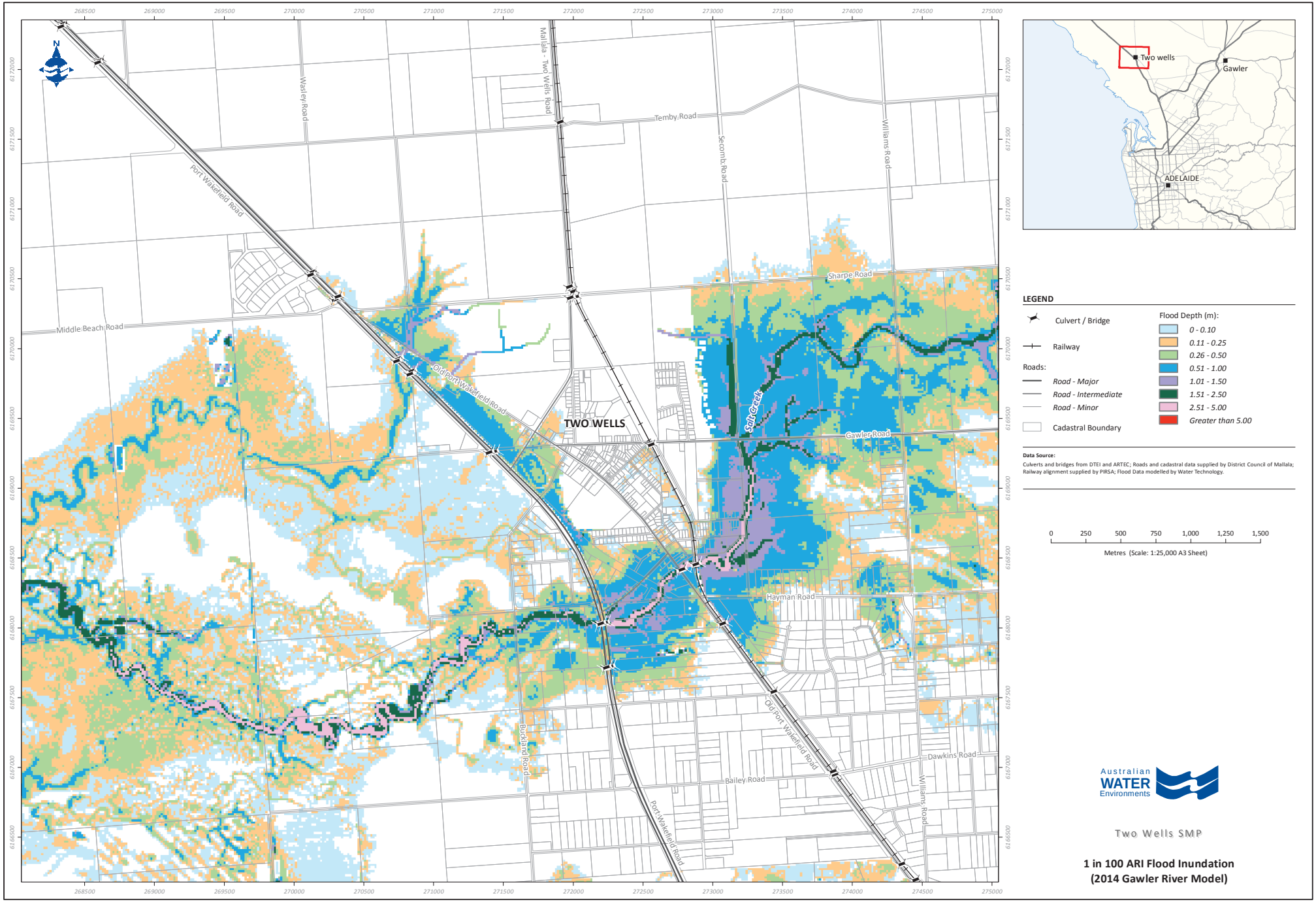
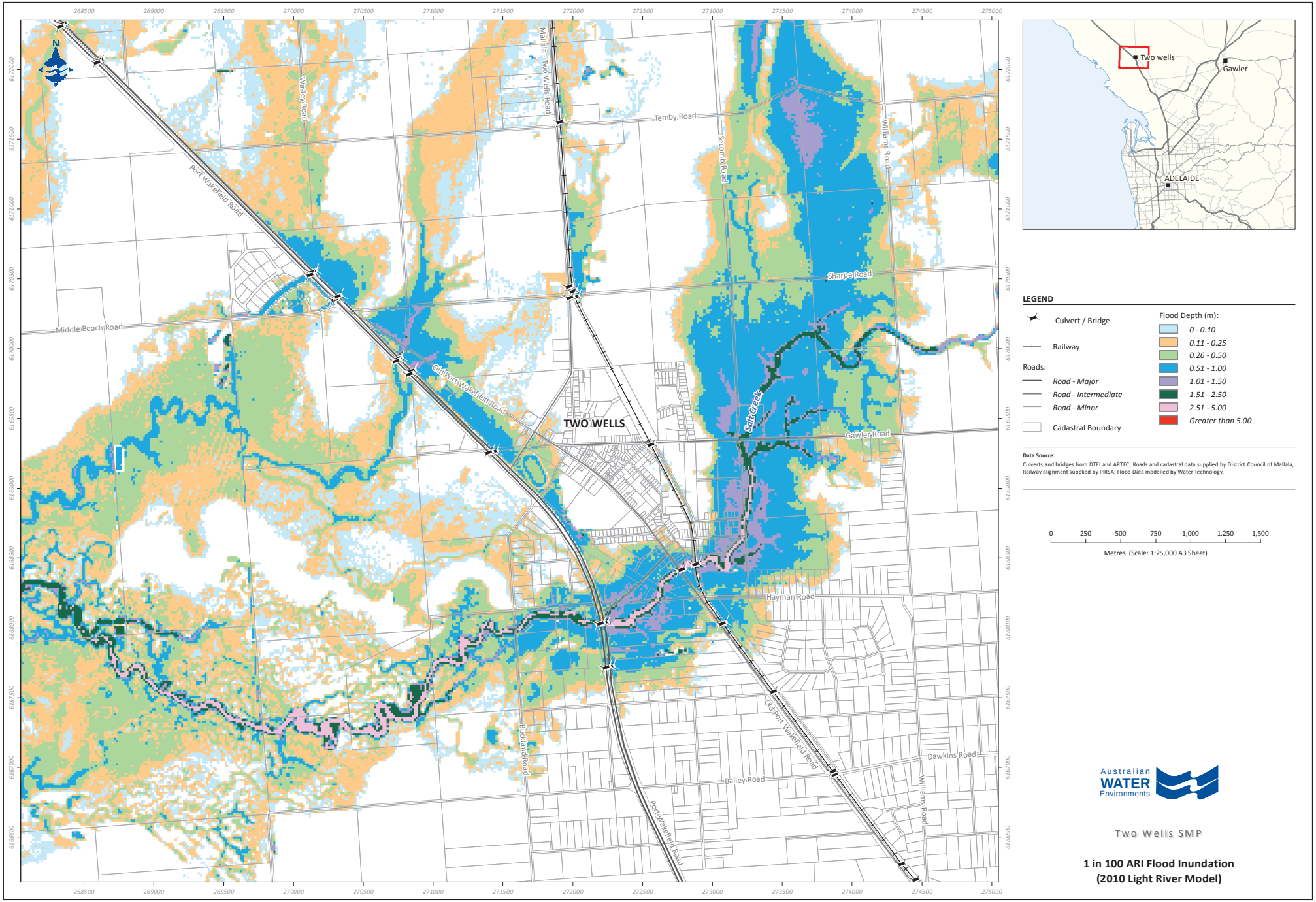
Appendix A: Flood Composite Maps



12197 D045 v1 Gawler River Only 100ARI Flood Depth 150612
Last Updated: 12/06/2015



LEGEND

- Culvert / Bridge
- Railway
- Roads:
  - *Road - Major*
  - *Road - Intermediate*
  - *Road - Minor*
- Cadastral Boundary

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:

Culverts and bridges from DTEI and ARTEC; Roads and cadastral data supplied by District Council of Mallala; Railway alignment supplied by PIRSA; Flood Data modelled by Water Technology.

0 250 500 750 1,000 1,250 1,500

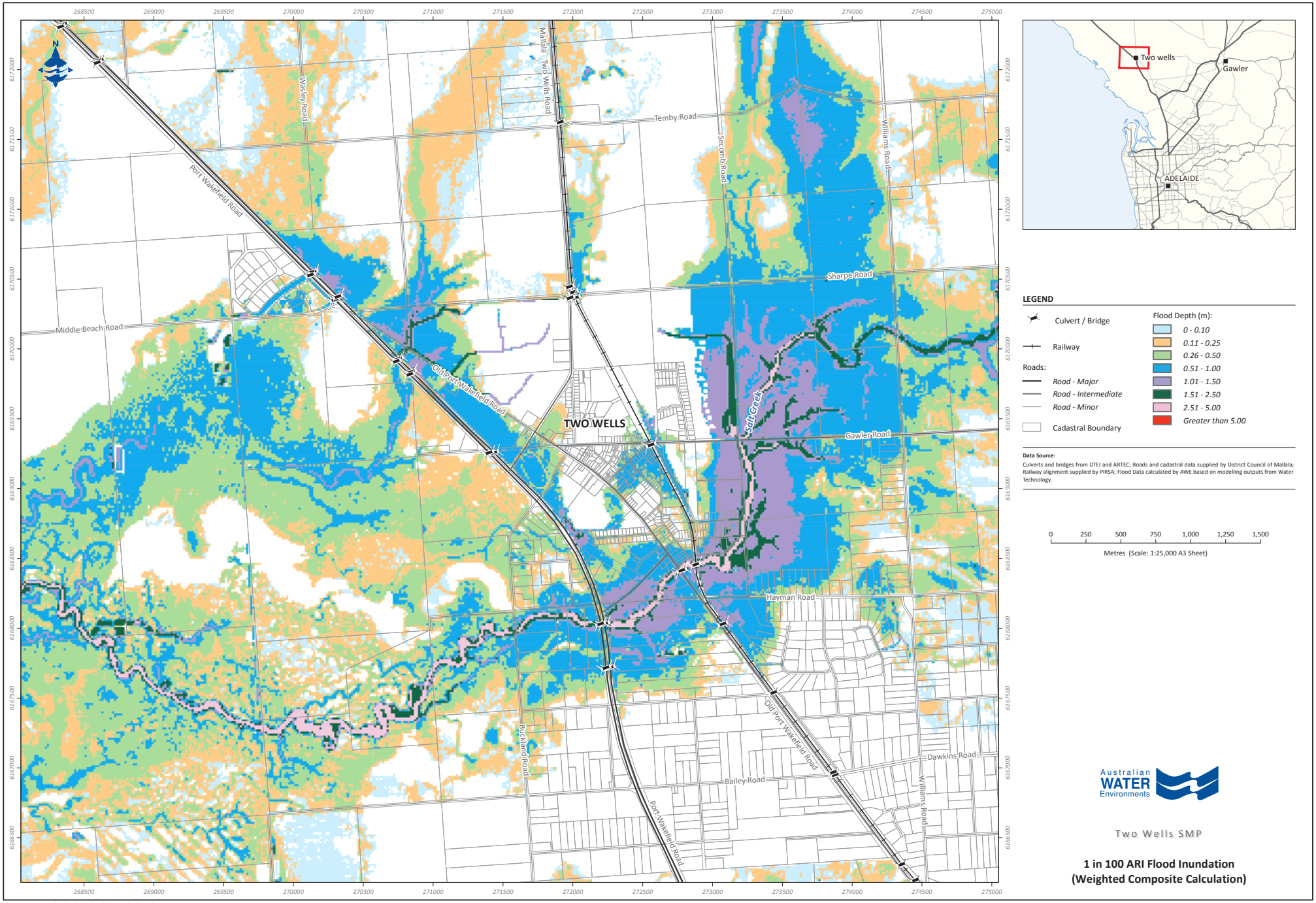
Metres (Scale: 1:25,000 A3 Sheet)

Australian WATER Environments

Two Wells SMP

1 in 100 ARI Flood Inundation (2010 Light River Model)

12197 D046 v1 Light River Only 100ARI Flood Depth 150612
Last Updated: 12/06/2015



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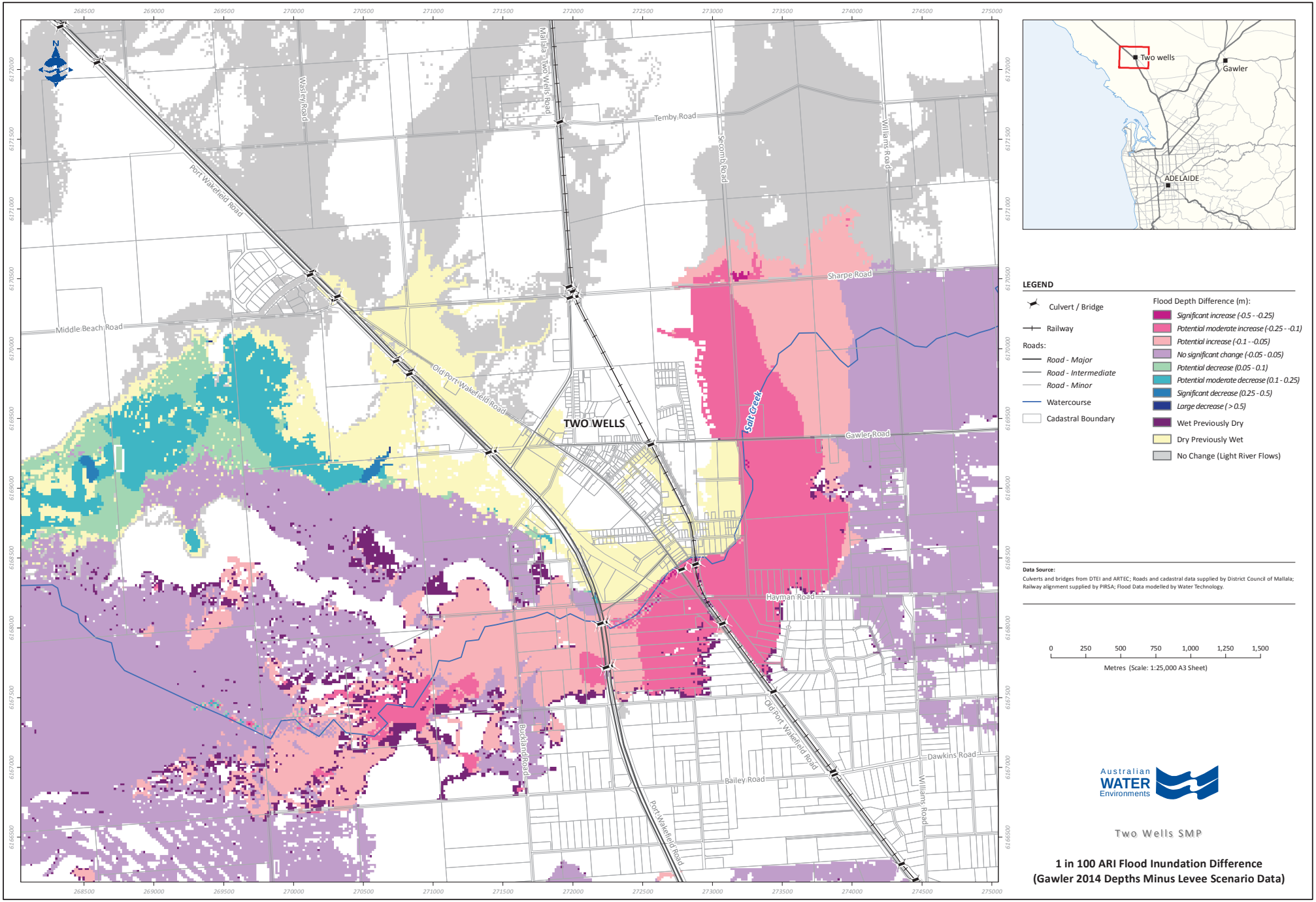
Last Updated: 26/06/2015

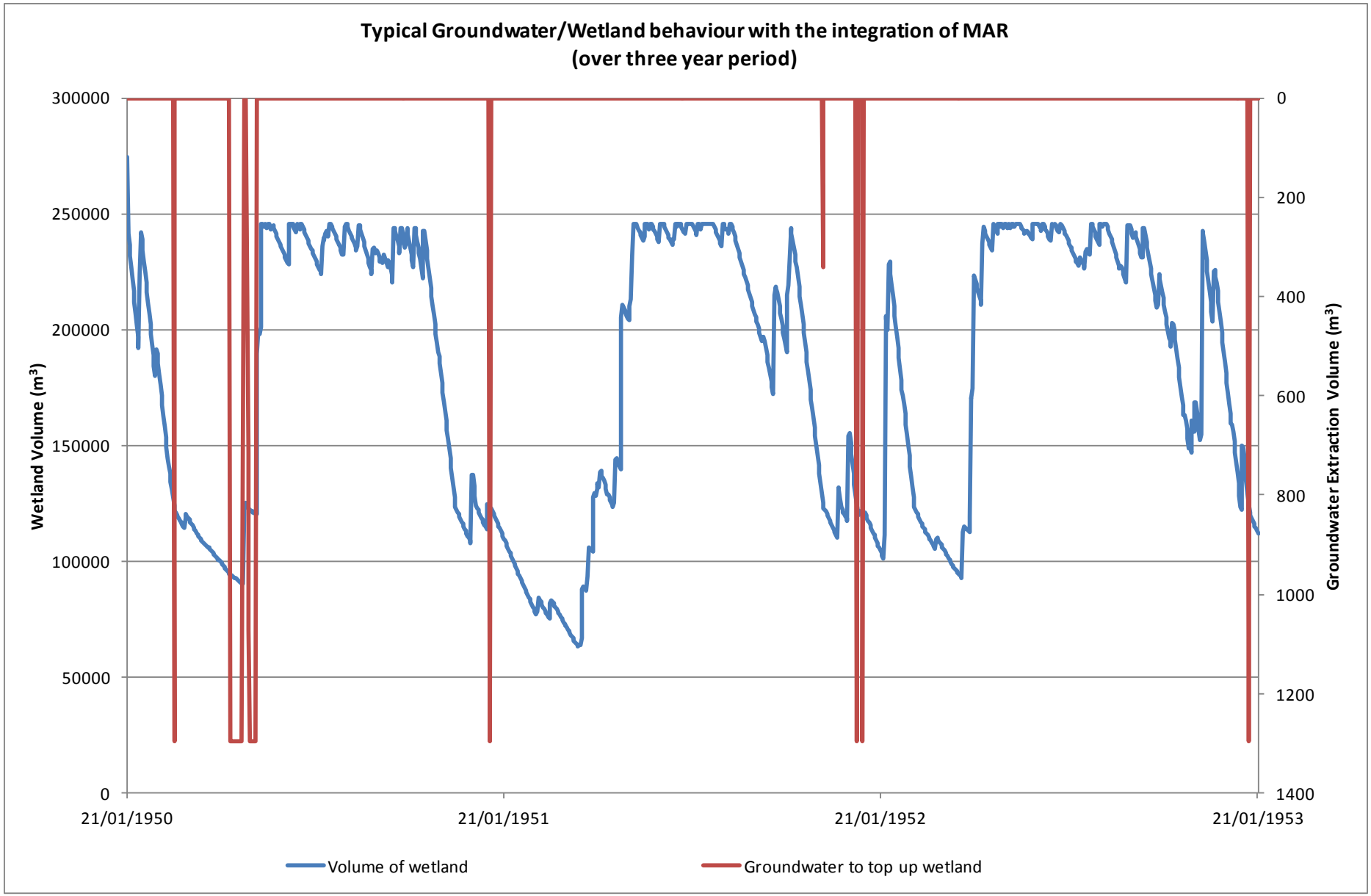
Appendix B: Flood Depth Difference

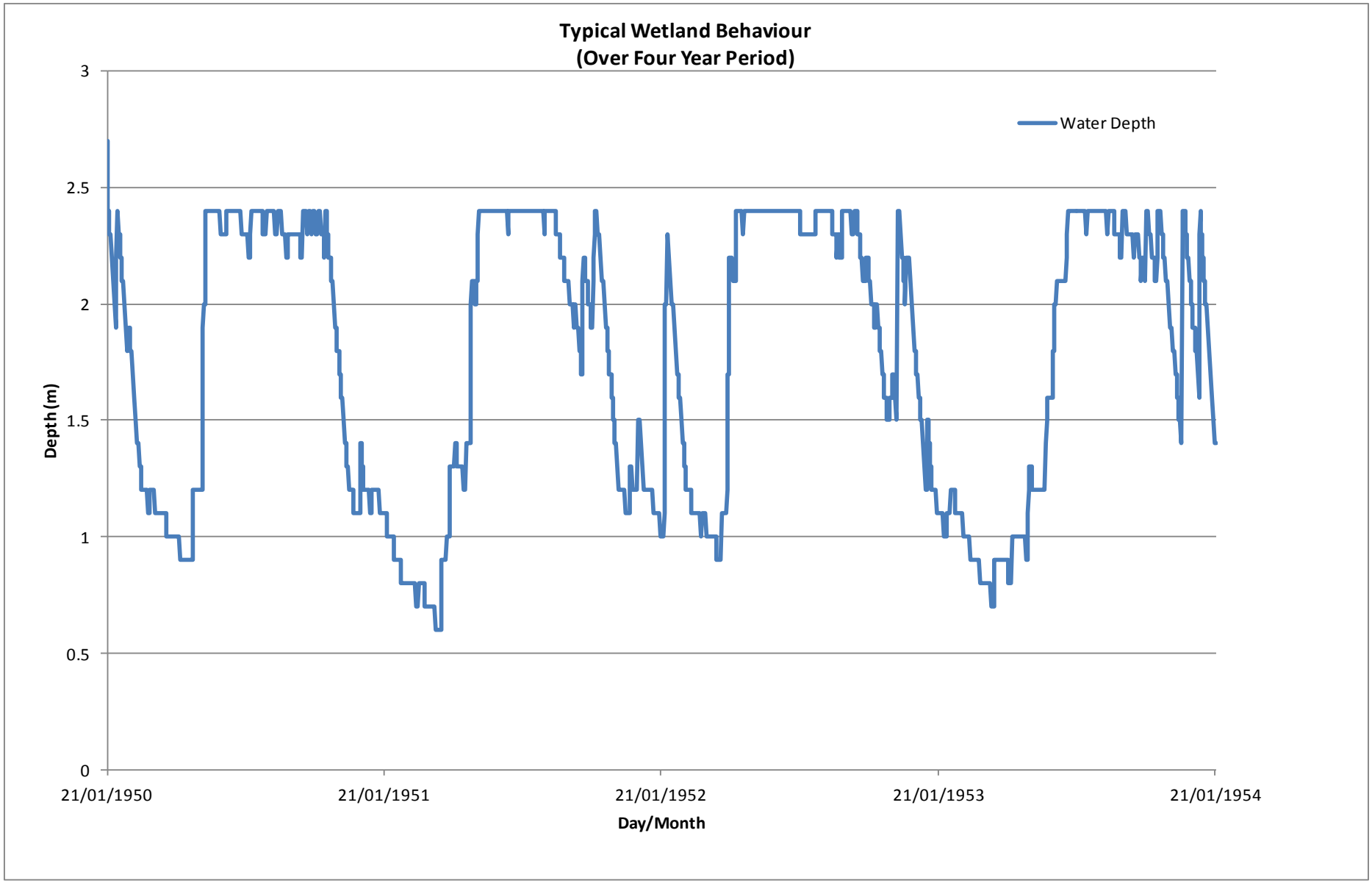


12197 D049 v1 100 ARI Inundation Difference 150619
Last Updated: 19/06/2015

Appendix B

Appendix C: Typical Wetland Behaviour and MAR


Typical Groundwater/Wetland behaviour with the integration of MAR
(over three year period)
Wetland Volume (m³)
Groundwater Extraction Volume (m³)
300000
250000
200000
150000
100000
50000
0
0
200
400
600
800
1000
1200
1400
21/01/1950
21/01/1951
21/01/1952
21/01/1953
Volume of wetland
Groundwater to top up wetland


Typical Wetland Behaviour
(Over Four Year Period)
Water Depth
Depth (m)
3
2.5
2
1.5
1
0.5
0
21/01/1950
21/01/1951
21/01/1952
21/01/1953
21/01/1954
Day/Month