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Shepparton North East Growth Area Physical Services Assessment Report

Commercial-in-Confidence
Nordic Pty Ltd

21 November 2008

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Physical Services Assessment Report

Prepared for

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Executive Summary

The Shepparton North-East Growth Area requires the preparation of an Outline Development Plan (ODP) and Development Contributions Plan (DCP) to support the development of the site. This report contains justification for physical infrastructure requirements in the Shepparton North-East Growth Area.

The provision of the physical services was examined to determine how best to provide the required services to the development area.

Electricity, gas, water, sewer, drainage and telecommunications can be provided to the development area. The existing gas, telecommunication and water assets with sufficient capacity to supply the new development are along Verney Road on the western side of the site. The electricity can be supplied from the east, north or the west and sewerage may need to be pumped along Grahamvale Road. There may be some capacity in the existing Verney Road sewer.

It would make the provision of services to the development more cost effective if the development was to be staged starting in the west rather than starting in the east along Grahamvale Road. This will allow for most of the services to be built from their current location, rather than having to construct assets in advance for an out of sequence development.

A detailed investigation into the drainage requirements of the development was carried out and it was determined that a north-south running swale could be used as the main collector drain for the minor drainage system. This will provide the advantage of removing pollutants and nutrients from the runoff improving the quality of the discharge water. The swale should be located in the middle of any north-south collector road, to enable a few culvert crossings along the route rather many crossings for individual driveways if the swale was located on one side or the other of the collector road. The major drainage for large flow events will be along roads with a maximum depth of 0.35 m and a maximum velocity of 1.5 m/s.

A wetland and sedimentation pond at the southern boundary of the site will also be used to improve the quality of the discharge into the receiving waters and can provide a buffer between the site and industrial land uses further south. Goulburn-Murray Water has set a discharge limit of 1.2 L/s/ha for the development. In order to accommodate this target a retarding basin of approximately 4.2 hectares is required.

1.0 Introduction

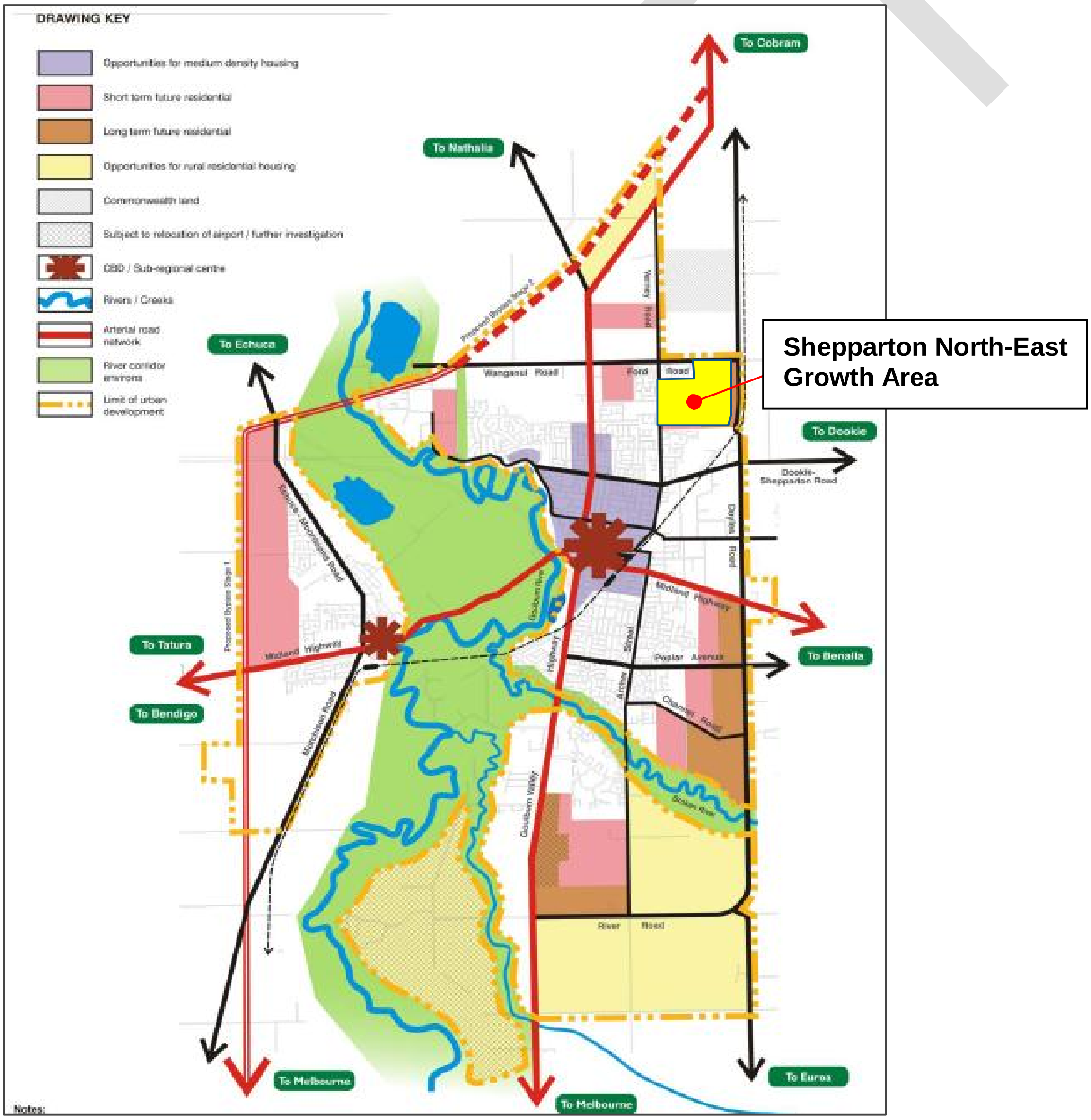
1.1 Project Background

Maunsell AECOM is undertaking numerous specialist studies required to support the preparation of an Outline Development Plan (ODP) and Development Contributions Plan (DCP) reports for Shepparton North-East Growth Corridor.

The Shepparton North-East Growth Corridor has been earmarked by City of Greater Shepparton to be developed as a residential estate to support the growing town. The North-East Growth Corridor has a site area of 168.5 hectares which will be developed by a private developer. Figure 1 identifies the subject site which compromises the entire Shepparton North-East Growth Area.

In order to support the preparation of the ODP and DCP, a technical study assessing the demands for physical infrastructure is required.

Figure 1 Location of the Shepparton North-East Growth Area



1.2 Purpose

The following document guides the authority requirements for the development of the Shepparton North East Growth Area bounded by Ford Road, Grahamvale Road and Verney Road.

This document has been prepared through consultation with major stakeholders including:

- City of Greater Shepparton (Local Government)
- Department of Infrastructure (Public Transport)
- Goulburn Murray Water (Water and Wastewater)
- Goulburn Valley Water (Irrigation and Drainage)
- Powercor (Electricity)
- APA Group (Gas)
- Telstra (Telecommunications)
- VicRoads (Roads)

This document should be used in conjunction with the City of Greater Shepparton Urban Design Framework (1999).

This document has been prepared by Maunsell with available information and without detailed conditions of supply from the relevant authorities. The requirements and approvals of the relevant authorities and any applicable laws take precedence to any items set out in these guidelines.

The guidelines have been specifically collated for this development site and shall not be used for any other purpose including other development sites.

1.3 Project Methodology

The assessment of the Physical Services required for the development involved the following tasks:

- Use information from the relevant Service Authorities to investigate the availability and existing capacity of the following existing infrastructure to allow for future residential expansion and growth
  - Reticulated Water
  - Wastewater/sewerage
  - Drainage
  - Gas
  - Power
  - Telecommunications
  - Roads
  - Public Transport
- Develop a Concept Drainage Strategy, taking into account the existing stormwater and drainage infrastructure
- Determine the preliminary design requirements and siting of flow retardation areas within the landscaped environment.
- Ensure that any proposed wetlands and large drainage features have been considered as part of the overall open space network of the area
- Identify any land acquisitions or regional landscaping works that will form part of the DCP
- Establish a preliminary functional design of the Water Sensitive Urban Design stormwater treatment methods that will be used and ensure that they meet best practice standards.

This will include the development of a Model for Urban Stormwater Improvement Conceptualisation) MUSIC model.

- Consult and meet with Goulburn Murray Water and the Shepparton City Council's engineering department to discuss drainage plans.

2.0 General

The following tables guide the horizontal and vertical clearances required between services. All items in this table should be treated as a guide only and are subject to the approval and agreement of the relevant authorities. The clearances have been specifically collated for this development site and shall not be used for any other purpose including other development sites.

Please note that all clearances refer to the distance between the outer most surface (or nearest point) of the services/infrastructure.

2.1 Minimum Horizontal Clearance Guide (Subject to approval by the Relevant Authorities)

All distances in the table are shown in millimetres.

Service	Gas	Telstra	Water (≤200dn)	Water (>200dn)	Sewer (≤300dn)	Sewer (>300dn)	Electricity	Drainage	Kerb
Gas	300	500	300	600	300	600	1000	300	750
Telstra	500	500	300	600	300	600	300[1]	300	1200
Water (≤200dn)	300[0]	300	300[0]	600	1000[2]	1000[2]	500	300[0]	150
Water (>200dn)	600	600	600	600	1000[2]	1000[2]	1000	600	600
Sewer (≤300dn)	300[0]	300[0]	1000[2]	1000[2]	300	600	500	300[0]	150
Sewer (>300dn)	600	600	1000[2]	1000[2]	600	600	1000	600	600
Electricity	1000	300[1]	500	1000	500	1000	-	300	750
Drainage	300	300	300	600	300[0]	600	300	-	300
Kerb	750	1200	150	600[0]	150	600	750	300	-

[0] Allowances may be made for lower clearances under particular conditions, contact relevant authorities for details.
[1] Allowances may be made for lower clearances if electricity is low voltage, contact relevant authorities for details.
[2] Minimum horizontal clearance may be reduced progressively to 600mm as the vertical clearance increase to 750mm (*WSA 02-2002).*

2.2 Minimum Vertical Clearance Guide (Subject to approval by the Relevant Authorities)

All distances in the table are shown in millimetres.

Service	Surface Level	Gas	Telstra	Water (<200dn)	Water (>200dn)	Sewer (<300dn)	Sewer (>300dn)	Electricity	Drainage	Kerb
Gas	600	-	150/ 300[3]	150	150/ 300[3]	150	300	150/ 300[3]	150/ 300[3]	150
Telstra	600	150/ 300[3]	-	150	150	150	300	150	150	150
Water (<200dn)	600/750[6]	150	150	150	150/ 500[4]	500	500	225	150	150
Water (>200dn)	600/750[6]	150	150	150/ 500[4]	150/ 500[4]	500	500	225	150	150
Sewer (<300dn)	900/1200[7]	150 / 300[5]	150[8]/ 300[5]	500	500	150	300	225/ 300[5]	225/ 300[5]	150
Sewer (>300dn)	900/1200[7]	150/ 300[5]	150/ 300[5]	500	500	300	300	225/ 300[5]	150/ 300[5]	150
Electricity	600[8]	150/ 300[3]	150	225	225	225/ 300[5]	225/ 300[5]	-	300	150
Drainage	600	150/ 300[3]	300	150	150	150	300	300	-	150
Kerb	-	150	150	150	150	150	150	150	150	-

[3] 300mm vertical clearance is required if one of the installations is greater than 1.5m wide.
[4] 500mm vertical clearance is required if one of the water mains is greater than 375mm diameter.
[5] 300mm vertical clearance is required if either sewer or the other service is greater than 300mm diameter.
[6] 750mm vertical clearance is required if road where water pipeline is located is considered to be major roadway or pipe is located in an embankment.
[7] 1200mm vertical clearance is required if road where sewer is located is considered to be an arterial road or is unsealed.
[8] For 66kV enclosed in conduit or pipe, minimum depth shall be 750mm.

3.0 Electricity

Existing electricity supply lines are located on Ford, Verney and Grahamvale Roads (refer to plan in Appendix A).

To supply the site it is estimated that one or two 22kV feeders from the existing substation would be required. Within the development site, small substations supplying 15-60 lots each would be needed and new substation sites will be created within the developments.

All substations require exclusion zones – 5m x 3.3m (if located within the road reserve) or 5m x 5.3m (if not located on a road reserve). Location of the substations needs to avoid gas and other services infrastructure.

Powercor contributes 100% of cost of high voltage lines into the site, whilst the developer pays for the provision of public lighting and a proportion of the low voltage cabling.

All electricity services should be designed in accordance with the requirements of the relevant authority.

4.0 Gas

Existing gas infrastructure in the vicinity of the development site is the APA gas main on Verney Road. This main currently has capacity to accommodate residential development on the site. Appendix A shows the location Verney Road on the west side of the development.

Developer contributions may be required for out of sequence development from either Ford or Grahamvale Roads. Developer contributions would not be required if the development commenced at Verney Road (on the western boundary of the development site). APA should be consulted further during ODP development regarding contributions by the developer and residents. As the existing gas assets are located to the west of the development area it would minimise the costs associated with providing this service by starting development in this area, rather than in the east or south.

Gas infrastructure requires a minimum cover and must be at a minimum offset from telecommunications and electrical infrastructure in road reserves. Gas Infrastructure can share a trench with water supply pipelines provided the minimum offset is maintained (to be confirmed by gas authority and water authorities).

The development requires a 63mm diameter feeder pipeline.

All gas infrastructure should be designed and constructed in accordance with the requirements of the relevant authority.

5.0 Roads

Roads bordering the development site include:

- Ford Road;
- Grahamvale Road; and
- Verney Road.

The plan included in Appendix A shows the location of these roads.

Grahamvale Road is declared as a VicRoads road while all the other roads within the area are local roads under the authority of City of Greater Shepparton. City of Greater Shepparton will be the responsible authority for all roads within the development.

Speed limits for roads are subject to approval by VicRoads. Roads should be designed to allow for emergency vehicle access.

As Grahamvale Road is considered a key North-South route, a service road will be required to access the development from Grahamvale Road. Two entrances from Grahamvale Road to the service road are possible, spaced at minimum 200 metres apart. It is proposed that the service road will be located in the 30m buffer between the Grahamvale Road drainage channel and proposed properties within the development.

As the site develops, a roundabout could be required at Ford/Grahamvale Rd intersection.

VicRoads indicated that it is preferable to direct traffic to Grahamvale Road or to upgrade the intersection of Doyles/Verney Road and Ford Road and the Goulburn Valley Highway.

VicRoads indicted that Grahamvale Road is unlikely to be upgraded to 4 lanes due to the narrow (22m) road reserve. It was stated that it would be difficult to expand the road reserve due to the drainage channel along the western side.

It should be noted that completion of the Shepparton Bypass may be 10 years away. Stage One may funnel some freight traffic accessing industrial area to south of site along Ford/Grahamvale Rd.

A connected layout of roads is required within the development area (as shown on the plan in Appendix A).

Traffic and transport impacts including (but not limited to):

- Residents accessing the city centre
- Trucks from the Shepparton bypass.

Road reserves shall be finished (including street lighting, signs and line markings) to suit the character of the surrounding residential areas, the *City of Greater Shepparton Urban Design Manual (2000)* and any additional requirements imposed by City of Greater Shepparton. Trees planted within the road reserve shall be in accordance with the *City of Greater Shepparton Street Tree Masterplan*.

Roadways should be designed to allow for cycle and pedestrian use and ensure connectivity to major destinations (eg educational facilities and public open spaces). Roadways should also allow for on-street parking. Where possible, cycle areas and vehicle parking should be separated to avoid safety issues.

All roads should be designed in accordance with City of Greater Shepparton requirements, VicRoads design standards and all relevant Australian Standards and laws.

6.0 Public Transport

The Department of Transport (DOT) requires adequate clearance to provide for potential future bus routes through the north-south and east-west major roads within the development.

DOT is to be provided with further development details (once ODP has been further developed) to discuss public transport requirements (eg turning circle of buses for collector roads). The *Public Transport Guidelines for Land Use and Development* (released in September 2008) should be used to guide the design of any roads that may need to provide for buses.

DOT is to provide details of route and service details for buses relevant to the development to assist planning.

Additional information regarding public transport requirements can be found in the Traffic Impact Assessment Report.

7.0 Telecommunications

Telstra currently has capability to supply telecommunications services to the site. Telstra indicated that existing Telstra mobile phone coverage to area is good.

The site can be connected to Telstra fibre optic cable supplying residential area on western side of Verney Road. Telstra has a preference for the western portion of the site to be developed first, to connect with existing infrastructure.

If telecommunications infrastructure is competitively tendered for the site, winning company must provide all services (including home phone lines, broadband etc).

Telstra will not contribute to the conduit installation costs, but will pay for all conduits, cabling etc. within conduits once constructed.

As ODP development plans progress, plans and details should be lodged on www.telstrasmartcommunity.com (this will be forwarded directly to Telstra's Melbourne office).

Minimum clearances and covers are as stipulated by the responsible authority/provider.

The following outline some additional clearance requirements (subject to approval by Telstra):

- All Telstra pits and manholes must be clear of driveways and property entries and must be available for access 24 hours a day, 7 days a week.
- For clearance distances relating to Telstra pillars, cabinets and RIMs/RCMs or any further information please contact Telstra Network Integrity Help Desk.

All telecommunications should be designed in accordance with the requirements of the telecommunications provider. Note: different providers may have differing requirements.

8.0 Water and Wastewater

Goulburn Valley Water is developing an overall master plan including this area by 2012. Information for input into the Water Master Plan should be made by July 2009.

In addition to the guidelines outlined in sections 8.1 and 8.2, all water and wastewater infrastructure should be designed in accordance with Goulburn Valley Water's requirements and WSAA guidelines.

8.1 Water

Goulburn Valley Water's preference is for development to begin on Verney Road frontage (west part of site) in order to utilise the existing water main along Verney Road. There may be a need to duplicate the water main on Grahamvale Road.

Goulburn Valley Water has indicated that it is desirable to link the large water main to the south with the development.

Water easements are to be in public space, preferably roads. GV Water would prefer a connected, grid-style street layout for both water and sewer supply.

The north-south and east-west water pipes should link through the development site.

At points where water mains cross sewer and/or stormwater drainage, water mains shall cross over these services wherever possible and overall depth maintained of less than 1.5 m.

8.2 Wastewater

Goulburn Valley Water estimated that three sewer pump stations would be needed to service the site, however the number of sewer pump stations should be minimised. It is proposed that sewage would be pumped down Dookie Road to the existing treatment facility. It is proposed that a new sewer main will be located along Grahamvale Road to carry waste to Dookie Road. In addition, there may be some capacity in the existing Verney Road sewer.

Rising sewer mains should be located within the road reserve.

Goulburn Valley Water is presently upgrading the sewer near the railway line. A new sewer main along Ford Road may be required in 3-4 years. Goulburn Valley Water requires information regarding the development requirements (including staging and timing) before December 2008 to ensure that the Ford Road main has sufficient capacity.

The Ford Estate (located on the corner of Ford Road and Verney Road) is currently serviced by septic tank. The City of Greater Shepparton Health Officer should be consulted regarding any additional sewer requirements relating to this estate as additional pump stations could be required.

At points where sewer cross water mains and/or stormwater drainage, sewer pipelines shall cross underneath water mains and stormwater drainage pipelines.

9.0 Drainage

The development site is located in an area of relatively flat terrain. The plan in Appendix A sets out the location of existing drainage channels within the development area.

Goulbourn-Murray Water advised that as this has capacity drainage on the site should generally drain to *Drain 3*, located along the southern boundary of the site. There is also scope to drain to Ford Road. Stormwater should not be drained to Verney Road as they are unsure of the capacity of the drain.

Stormwater pipes should be 375mm diameter (minimum) under trafficable surfaces. Pipelines shall be Rubber Ring Jointed. Pipes shall be a minimum of 0.5% grade and shall obtain self-cleaning velocities during a 5 Year ARI storm event. Stormwater drainage shall have a minimum cover of 600mm within the road reserve, and minimum of 450mm cover in other areas. A 20 mm drop in pipe invert level is required across stormwater pits. Drainage and overland flow paths shall be contained within the road reserve boundary or an appropriate easement.

Swale drains are required to run at a minimum grade of 1:500 and shall have a minimum side slope of 1:4.

All stormwater drainage should be designed in accordance with the requirements of the relevant authorities including G-MW and the City of Greater Shepparton. Section 16 of the Infrastructure Design Manual prepared by the Cities of Greater Bendigo and Shepparton and the Shire of Campaspe provides details of the design standards adopted by the City of Greater Shepparton.

Minor stormwater drainage shall be designed to accommodate 5 Year ARI storm events without overland flow. As a minimum, overland flow paths shall be designed to accommodate flow from 100 Year ARI storm events within the following parameters:

Current best practice urban stormwater management aims to satisfy multiple objectives including:

- Provision of stormwater conveyance capacity to provide safe passage of stormwater runoff, and to avoid nuisance flooding and flood damage to private property;
- Provision of stormwater retention within the public open space to mitigate the increased discharge rates and runoff volumes resulting from urban development. The objective is to protect the aquatic ecosystems of receiving waters and avoid increased flooding in downstream waterways and drainage systems;
- Provision of stormwater treatment measures to remove water borne contaminants transported within the urban stormwater runoff;
- Integration of stormwater conveyance and treatment systems into the overall urban and landscape design of urban residential areas; and
- The Major drainage system shall convey flows with a maximum depth less than 0.35 m on roads and a maximum velocity of 1.5 m/s. The maximum depth x velocity of flow shall not exceed 0.35 m^3/s.

The Victorian Planning Provisions requires new urban development to comply with the stormwater quality objectives provided in the Victorian Best Practice Environmental Management (BPEM) Guidelines. Water quality discharge parameters have been sourced from Goulburn-Murray Water (G-MW). The water quality objectives are summarised in Table 1 below.

Table 1 G-MW Water Quality Objectives

Pollutants	Receiving Water Objective	Current BPEM Best Practice
Suspended Solids	Not exceed the 90th percentile of 80mg/L	80% retention of the typical urban annual load
Total Phosphorous	Base flow concentration not to exceed 0.06mg/L	45% retention of the typical urban annual load
Total Nitrogen	Base flow concentration not to exceed 0.7mg/L	45 % retention of the typical urban annual load
Litter (BPEM Guidelines)	No litter in waterways	70% reduction of the typical urban annual load

This Surface Water Management Strategy has been developed based on the application of current best practice to achieve the pollutant load reduction targets.

Additionally, Goulburn-Murray Water has specified the maximum permissible discharge rate to their existing drainage infrastructure. For example, the maximum discharge rate to Drain 3 at the southern end of the area is limited to 1.2L/s/ha.

9.1 Stormwater Management Opportunities

9.1.1 Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) represents the broad philosophy that aims to substantially manage and conserve water in the urban environment. WSUD pertains specifically to the interaction between the built urban form i.e. roads, buildings, and landscaped areas and the urban water cycle.

The core initiatives of sustainable water resource management are conservation and reuse. Conservation initiatives ensure available water sources are used for the most appropriate purposes. The reuse of stormwater addresses both water conservation and stormwater management and reduces the demand on potable water resources and reduces the volume of stormwater runoff from the site.

There are a number of WSUD measures that can function within an overall network of stormwater elements to achieve management objectives. The selection of the most appropriate network of stormwater management measures for a particular site requires an understanding of the functionality of each measure and the operational limitations based on hydraulic loading, pollutant loading and site conditions. The stormwater treatment measures selected should complement drainage infrastructure in accordance with the “major minor” drainage approach.

9.1.2 Stormwater Reuse

Stormwater reuse at the allotment scale needs to be encouraged and implemented where practical as part of the strategy. Stormwater reuse would offer measurable benefits for mitigating stormwater discharge from the development and reducing the demand on mains water consumption where the water is directed to continuous uses such as hot water systems and toilet flushing. Appropriate support and encouragement should be provided to ensure rainwater tanks of at least 3-5 kL capacity will be fitted and suitably plumbed on houses within the development.

9.1.3 Treatment of Water in G-MW Drains

Existing Goulburn-Murray Water drainage infrastructure bounds the eastern and southern edges of the development area. Presently this stormwater is not treated before discharge. With open space available in the development area there is potential to provide water treatment measures in this space and incorporate into any water treatment measures nominated for the development.

9.2 Stormwater Management Strategy

Stormwater Management Strategy examines minor drainage and treatment infrastructure required for the Shepparton North-East Growth Area. The aim of this strategy is to provide an approach in conveying, treating and discharging minor stormwater flow that is in compliance with legislative rules and regulations mentioned earlier in this report.

There are a variety of methods and techniques used to harvest, convey and treat stormwater to acceptable standards, however each has its on unique capability. For this strategy structures including swales, sedimentation ponds and wetlands have been adopted and investigated bearing in mind factors such as area availability, ground conditions, cost and laws and regulations governing stormwater quality.

The methodology of harvesting, conveying and treating stormwater is that all stormwater generated from the catchment will be initially pre- treated and conveyed to a sedimentation pond via a swale. Once stormwater is conveyed to the sedimentation pond located, a limiting velocity inlet to a wetland will allow a controlled volume of stormwater to enter and continue the treatment cycle before being discharged into the existing G-MW drain (drain 3).

9.2.1 Catchment Areas

The Shepparton North-East Growth Area has been divided into 21 catchment areas. These areas are used to evaluate the volume and flow that is derived from each catchment. Appendix C contains a table showing the area of each of the catchments.

9.2.2 Fraction Impervious

The fraction impervious of a catchment is an essential parameter that allows reasonable estimates of likely runoff volumes expected from a catchment, the greater the imperviousness the larger the runoff. Evaluating and deciding on the fraction imperious for a catchment before the development is built holds reasonable amount of uncertainty and error. As no subdivision layout has been developed the fraction impervious has been assumed to be 50%, typifying imperviousness found in many low-medium density housing developments across Australia. As subdivisional layout plans become available, a more detailed study will be undertaken to confirm predicted flows.

9.2.3 Swales & Expected Runoff

Swales offer the capability of conveying and treating stormwater flows, offering not only an open surface route for minor flows but a preliminary treatment capability used to ensure removal of medium and coarse sediments. Swales are typically designed for a 5 year average recurrence interval (ARI) to guarantee that minor floods are safely conveyed without increasing flood risk to surrounding areas. Depending on catchment sizes and swale dimensions, stormwater quality in most cases will not meet best practice standards and thus would require further treatment measures downstream. Swales in the Shepparton North-East Growth Area will be primarily used to convey stormwater flows to tertiary treatment processes in sedimentation ponds and wetlands. The swales will serve as preliminary treatment before reaching the sedimentation pond and must not be excluded from water quality performance modelling.

Swale systems that are not enclosed by area constraints can be heavily modified in a number of designs that in turn produce the same flow capacities. The swale design methodology involves the design of 8 swales that incorporates incoming flows from individual catchment areas. Appendix C contains the details of the swale calculations.

It is proposed to run the swales down the middle of the connector road shown in Appendix A. The road will be divided with the swales acting as a median between each direction of traffic. There will need to be some culvert crossings over the swale at various points along the road. This is considered a better option than to have the swales down either side of the road, where each driveway would require an individual crossing.

9.2.4 Sedimentation Basins and Wetlands

The primary function served by a sedimentation basin is the process in removing Total Suspended Solids (TSS) from stormwater. Sedimentation basins are designed for a 5 year ARI and are normally positioned before a wetland in a treatment train, ensuring that TSS is removed before entering sensitive habitats. If TSS is overlooked in a wetland sensitive vegetated regions (macrophyte) can be severely damaged hence detrimental on their ability to remove fine particles and affecting overall treatment performance. Sedimentation basins also have the capability to be converted into temporary storage used during high flow periods.

Constructed wetlands are shallow, heavily vegetated areas primarily used to enhance sedimentation, filtration and pollutant removal by natural processes including ultra violet disinfections. The vegetated component of the wetland is referred to as the macrophyte zone, used to extract fine sediments from stormwater before discharge. To maintain and protect sensitive vegetation, scouring velocities and TSS concentrations must be analysed and designed against. Control structures at the basin inlet and outlet will allow normal flows to pass through the sedimentation basin to the wetland at a specified velocity to minimise scouring. As a sedimentation pond a wetland can be also used as a high flow storage basin, providing a means of temporarily storing flood waters.

Treated water will be discharged into the existing Drain 3, which runs along the southern border of the study site. The maximum permissible discharge rate to Drain 3 is limited to 1.2 L/s/ha as specified by G-MW. As a result the maximum permissible discharge from the Shepparton North-East Growth Area is 0.2 m^3/s. The storage necessary to contain the peak 100 year ARI event whilst allowing 0.2 m^3/s to discharge into drain 3 is 49,500 m^3. This storage is in excess of the total storage available in the sedimentation pond and wetland combined. An additional storage of 39,500 m^3 is required to achieve this storage requirement. An additional area of 31,600 m^2 with a depth of 1.25 m can be provided above the storage provided by the sedimentation pond and wetland to provide this. As a result, a total area of approximately 4.2 hectares is necessary for stormwater treatment and storage. This value does not allow for landscaping and safe batter slopes or the additional storage that is available in the swales.

Table 2 below indicates the surface areas and volumes required to achieve the necessary water quality objectives. A depth of 1m has been used for both the sedimentation pond and wetland.

Table 2 Wetland and Sedimentation Pond surface areas and volumes

	Wetland	Sedimentation Pond	Additional Storage	Total
Surface Area (m^2)	7,500	2,500	31,600	41,600
Volume (m^3)	7,500	2,500	39,500	49,500

The sedimentation basin and wetland have been sized using the methods set out in *WSUD Engineering Procedures: Stormwater*, Melbourne Water, CSIRO Publishing, 2005.

9.2.5 Conveyance of 100 Year ARI Flows

Conveyance of the 1 in 100 year ARI flood is to be provided by roads and road reserves within the development. For a specified maximum depth of 0.35m and a peak 100 year ARI flow of 15.33m^3/s the width necessary to convey this flow is 19.25m.

9.2.6 Stormwater Quality Modelling

A sedimentation pond and wetland arrangement has been sized by manual calculations and the use of the software package MUSIC (Model for Urban Stormwater Improvement Conceptualisation). The modelling undertaken shows that the Best Practise Environment Management targets in Table 1 have been met. Appendix D contains the final results from the MUSIC model.

9.3 Alternative Treatment Schemes

Although the recommended stormwater management strategy at Section 9.4 provides a robust method of storing, treating and discharging stormwater runoff, the following alternatives could also be used in achieving the same aims.

9.3.1 Alternative 1 – Multiple Ponds and Swales

The aim of this alternative is to retain the flow at a neighbourhood level rather than a subdivision level. Multiple ponds could be placed along the main swale drain. These ponds would have a permanent volume of water, along with the ability to detain higher flows temporarily during large flow events so as to buffer the flow rate exiting the development. A retarding basin or wetland would still be required at the south end of the development however it would be smaller than required under the recommended scheme. The size of the swales connecting the ponds may also be able to be reduced as the ponds would be retaining some of the flow, reducing the peak flow rate that the swales need to convey. This alternative can have implications on the low flow levels, as detaining water in the catchment in ponds can prevent it from being discharged to the receiving waters under low flow conditions.

9.3.2 Alternative 2 – Multiple Retarding Basins and Swales

The aim of this alternative is to retard the flow at a neighbourhood level rather than a subdivision level. One or two retarding basins could be placed along the path of the swale drains in a similar style to alternative one. The main difference would be that retarding basins would be designed to be dry the majority of the time with no permanent body of water. The size of the swales could be reduced downstream of the retarding basins as they will release the flow at a slower rate. It will still be necessary to have a wetland or retarding basin at the downstream end of the catchment, however it will be smaller than under the proposed drainage scheme. This alternative can have implications on the low flow levels, as detaining water in the catchment in retarding basins can prevent it from being discharged to the receiving waters under low flow conditions.

9.3.3 Alternative 3 – Individual Lot Detention Tanks, Small Retarding Basin and Swales

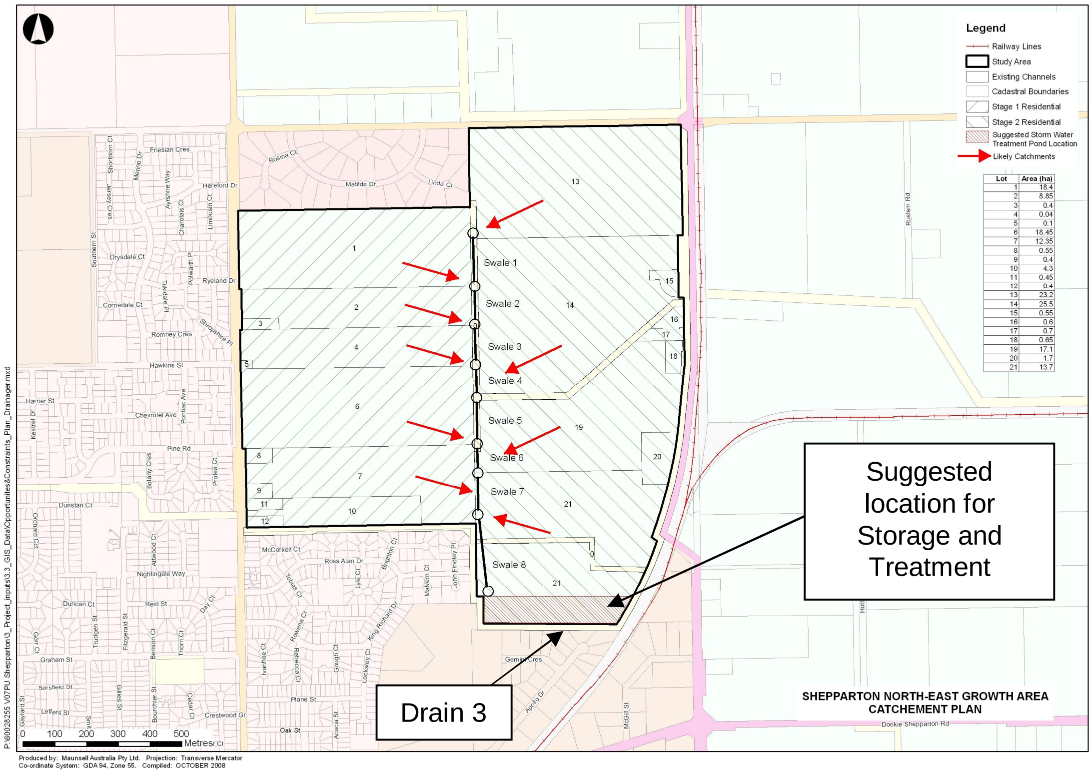
The aim of this alternative design is to retard the flow at an individual lot level rather than a neighbourhood or subdivision scale. Each individual house or lot would be fitted with a detention tank, which would capture the rainfall that fell within the property and would release it at a slow rate until the tank was empty again. This tank would not be intended to operate as a rainwater tank for reuse, as the tank would need to be empty when a rainfall event occurred to be of maximum benefit. This would reduce the rate of runoff, meaning that smaller swales and a smaller wetlands/retarding basin would be needed. Individual lot detention tanks would not be sized to detain the entire 100 year ARI flow event as this would require excessively large tanks. To capture the 100 year ARI events will require retarding basins downstream.

9.4 Recommendations

This stormwater management strategy recommends that swales by used in the Shepparton North-East Growth Area to convey flows to tertiary treatment processes in the form of a sedimentation pond and wetland. The swales will serve as preliminary treatment before reaching the sedimentation pond and wetland. Swale sizes are presented in Section 4.3.

In regards to location, it is recommended that a single sedimentation pond and wetland arrangement be positioned to the south of the catchment to minimise the distance between the wetland and discharge drain (drain 3). The sedimentation pond and wetland can also serve to provide a buffer between the residential development on the site and the existing light industrial areas to the south. Refer to Figure 2 for a preliminary plan view of the location of treatment infrastructure (note that size is not to scale). Figure 3 in Appendix C shows the indicative catchments of the proposed swales in more detail.

Figure 2 Location for Proposed Stormwater Treatment and Storage



Treated water is proposed to be discharged into existing Drain 3 with a maximum permissible discharge rate of 0.2m^3/s as specified by G-MW. The storage necessary to contain the peak 100 year ARI event whilst allowing 0.2m^3/s to discharge into drain 3 is 49,500 m^3. An approximate area of 4.2 hectares is necessary for stormwater treatment and storage. This value does not allow for landscaping and safe batter slopes or the face that additional storage is available in the swales.

10.0 Irrigation Channels

A buffer of 30m from the water line of the channel on Grahamvale Road to proposed dwellings is a requirement of Goulburn Murray Water. Discussions with Goulburn Murray Water have indicated that a road may be constructed within the 30m buffer zone. Furthermore they require the channel to be fenced. The requirements for fencing should be discussed with Goulburn Murray Water; however consideration must be given to:

- Operations;
- Maintenance; and
- Safety.

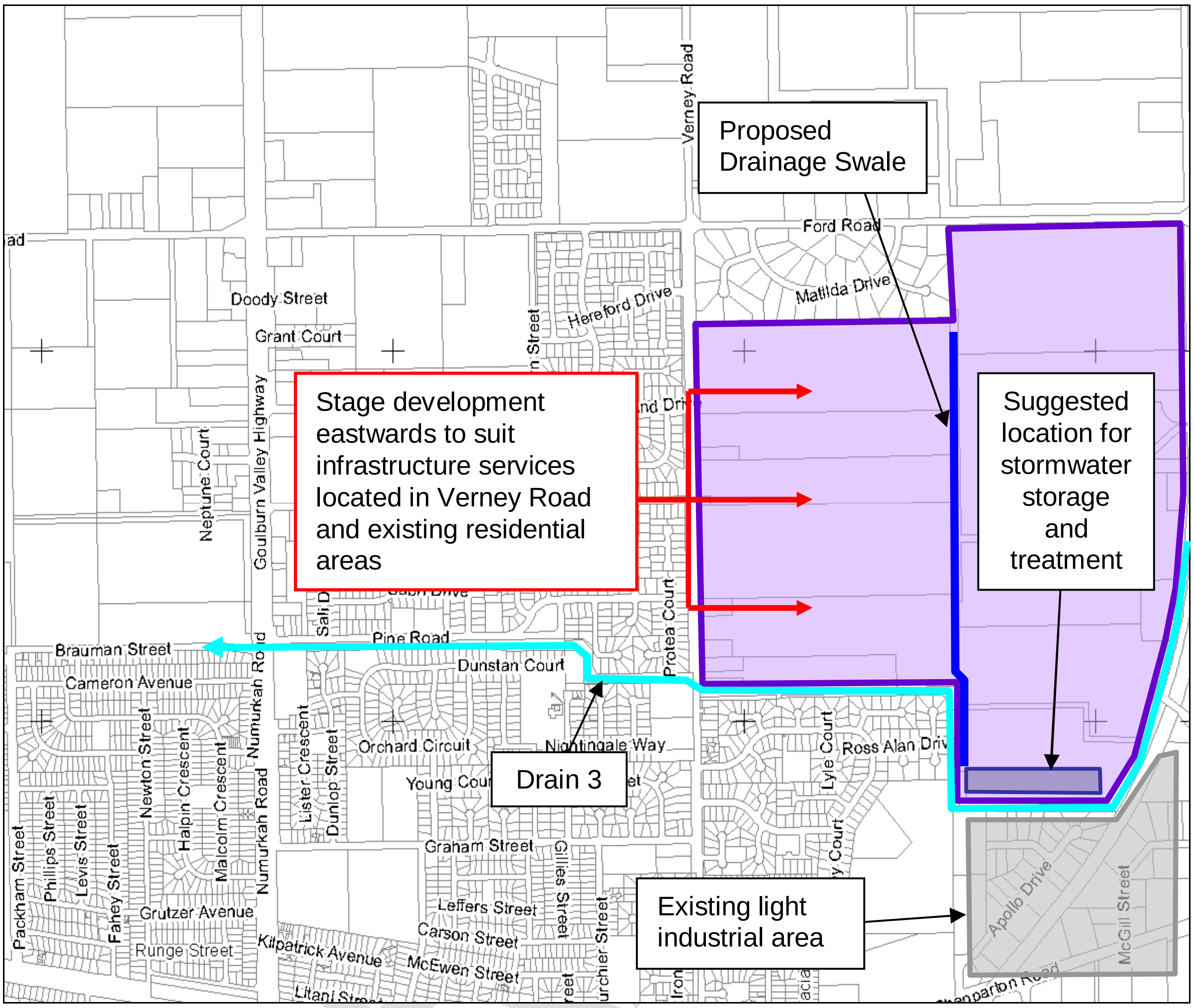
As part of the Food Bowl program, any irrigation channels with less than 50ML capacity will be transferred to private ownership; as it is estimated that channels within the development site would have less than 50ML capacity, Goulburn Murray Water did not raise major objections to decommissioning and removing any redundant infrastructure within the development. However, any infrastructure removal must be discussed in further detail with Goulburn Murray Water.

Domestic and stock irrigation supply to existing properties located on the corner of Ford Road and Verney Road must be maintained. However this supply is likely to be possible from Ford Road, therefore supply through the development site may not need to be maintained.

The aim of a Stormwater Management Strategy is to implement best practice stormwater management system for the area. This will ensure that new residential development does not have a detrimental impact on the existing drainage network, which has limited capacity.

Having regard to the existing topographical characteristics and drainage opportunities available to the Shepparton North-East ODP area as well as the overall planning objectives for the site, Maunsell has developed the Stormwater Management Strategy along with an associated Concept Plan to specifically address urban stormwater management objectives and water quality issues. In particular, the Strategy addresses the collection, conveyance and treatment of stormwater.

Appendix A Existing Services and Proposed Drainage and Stormwater Facilities Plan


Proposed Drainage Swale
Stage development eastwards to suit infrastructure services located in Verney Road and existing residential areas
Suggested location for stormwater storage and treatment
Drain 3
Existing light industrial area
Verney Road
Ford Road
Matilda Drive
Hereford Drive
Doody Street
Grant Court
Neptune Court
Goulburn Valley Highway
Brauman Street
Cameron Avenue
Pine Road
Dunstan Court
Orchard Circuit
Nightingale Way
Young Court
Graham Street
Leffers Street
Carson Street
McEwen Street
Kilpatrick Avenue
Grutzer Avenue
Runge Street
Protea Court
Lyle Court
Ross Alan Drive
Apollo Drive
McGill Street
Numurkah Road
Lister Crescent
Dunlop Street
Gillies Street
Newton Street
Halpin Crescent
Malcolm Crescent
Packham Street
Phillips Street
Levis Street
Fahey Street

Appendix B Authority Contacts

Authority Contacts

Name/Role	Organisation	Based in	Phone
Greg Hughes Strategic Planning Co-ordinator	City of Greater Shepparton	Shepparton	5832 9820
Anne Graesser Manager Water Systems Health	Goulburn-Murray Water *(Irrigation and Drainage)*	Tatura	5833 5786 or 0417 564 998
Nick Pearce Technical Officer Subdivisions Development	Goulburn Valley Water *(Supply and Sewerage)*	Shepparton	5832 0724
Bryan Sherritt Acting Director NE Region	VicRoads	Benalla	5761 1880
Ian Barry Manager Program Development	VicRoads	Benalla	5761 1861
Ian Ridgwell	VicRoads	Benalla	
Rod Armstrong	Powercor	Shepparton	5820 2610
Linh Du	Telstra	Melbourne	9634 1087
Steve Dellios Manager Forecasting & Area Planning	Telstra	Melbourne	9634 1193
Kevin Borrman Area Supervisor Victorian Network	APA *(Gas)*	Shepparton	0407 685 263
Lea Smith Team Leader Local Government Planning	DPCD		5761 1595
James Noy Planning Referrals Co-ordinator Public Transport Division	Department of Infrastructure	Melbourne	9095 4106

Appendix C Drainage Calculations

Appendix C Drainage Calculations

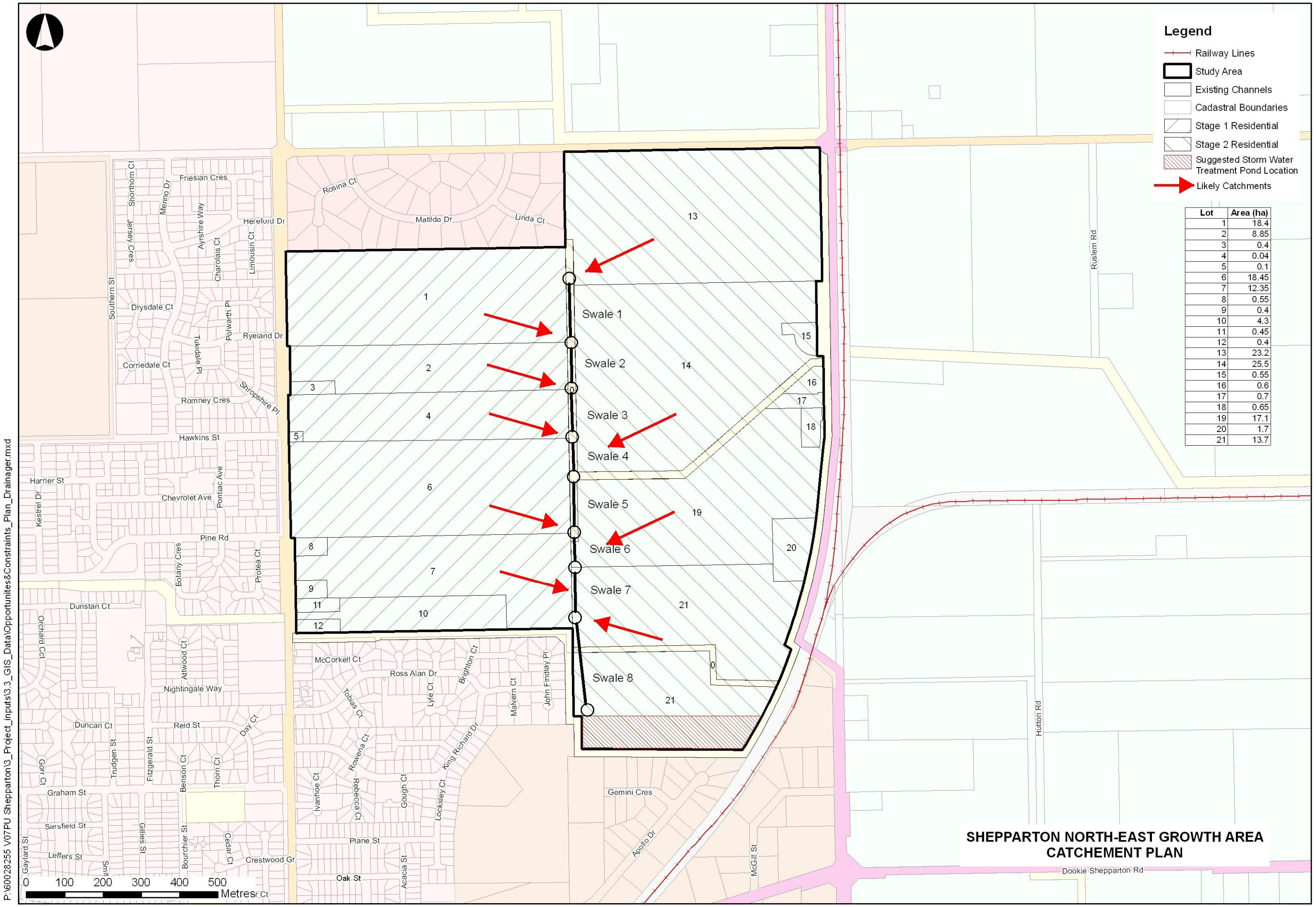
Table 3 below shows the catchment areas for each of the proposed catchments in development area. Figure 3 on the next page shows where each of the precincts is located in the development area.

Table 3 Shepparton North East Precinct Catchment Areas

Precinct ID	Catchment Area (Hectares)
1	18.40
2	8.85
3	0.40
4	9.04
5	0.10
6	18.45
7	12.35
8	0.55
9	0.40
10	4.30
11	0.45
12	0.40
13	23.20
14	25.50
15	0.55
16	0.60
17	0.70
18	0.65
19	17.10
20	1.70
21	13.70
Total	168.5 ha

D R A F T

Figure 3 Indicative catchment plan



Lot	Area (ha)
1	18.4
2	8.85
3	0.4
4	0.04
5	0.1
6	18.45
7	12.35
8	0.55
9	0.4
10	4.3
11	0.45
12	0.4
13	23.2
14	25.5
15	0.55
16	0.6
17	0.7
18	0.65
19	17.1
20	1.7
21	13.7

Produced by: Maunsell Australia Pty Ltd. Projection: Transverse Mercator
Co-ordinate System: GDA 94, Zone 55. Compiled: OCTOBER 2008

Table 4 below identifies expected flow rates required to be satisfied within the capacity of each swale.

Table 4 Shepparton North East – Swale Flows

Swale I.D	Length	Area	Tc	1 year ARI flow	5 year ARI flow	10 year ARI flow	100 year ARI flow
	m	km2	(mins)	m3/s	m3/s	m3/s	m3/s
Swale 1	147	0.23	26	0.78	1.28	1.64	3.39
Swale 2	123	0.41	33	1.25	2.04	2.60	5.35
Swale 3	123	0.50	35	1.44	2.36	3.00	6.17
Swale 4	84	0.59	37	1.65	2.69	3.43	7.05
Swale 5	131	0.85	43	2.20	3.58	4.55	9.32
Swale 6	85	1.03	46	2.54	4.11	5.23	10.69
Swale 7	162	1.48	53	3.39	5.47	6.95	14.18
Swale 8	320	1.66	55	3.67	5.93	7.53	15.33

Using the Mannings equation to determine swale capacities, Table 5 has been produced to provide swale configurations to ensure capacity is greater than the corresponding design flow. Similar swale capacities can be achieved by altering the swale configuration as desired.

Table 5 Minimum swale dimensions based on 5 year ARI flows – Manning's Equation

Swale I.D	Manning's N	Base Width	Depth	Top Width	Slope	Cross Sectional Area	Capacity	5 year ARI flow
		m	m	m	1 in	m2	m3/s	m3/s
Swale 1	0.04	1.00	0.55	5.40	4	1.76	1.45	1.28
Swale 2	0.04	1.00	0.65	6.20	4	2.34	2.12	2.04
Swale 3	0.04	1.00	0.70	6.60	4	2.66	2.52	2.36
Swale 4	0.04	1.00	0.75	7.00	4	3.00	2.96	2.69
Swale 5	0.04	1.00	0.85	7.80	4	3.74	3.98	3.58
Swale 6	0.04	1.00	0.91	8.28	4	4.22	4.68	4.11
Swale 7	0.04	1.00	1.05	9.40	4	5.46	6.60	5.47
Swale 8	0.04	1.00	1.05	9.40	4	5.46	6.60	5.93

The following are assumptions that have been made in calculating the above tables:

- Manning's Roughness Coefficient for swales n = 0.04
- Minimum longitudinal slope = 0.5%
- Freeboard allowance = 100mm
- Fraction Impervious

C_1 = 0.50
C_5 = 0.48
C_{10} = 0.53
C_{100} = 0.69

Estimates of stormwater runoff volumes for a 1,5,10 and 100 year ARI flows are tabulated in Table 6.

Table 6 Estimated runoff volumes based on 1,5,10 and 100 year ARI

	1 year ARI	5 year ARI	10 year ARI	100 year ARI
Area (ha)	166	166	166	166
Fraction Impervious	0.50	0.50	0.50	0.50
Tc (Minutes)	55.25	55.25	55.25	55.25
Intensity (mm/hr)	15.91	26.92	30.77	48.20
Runoff Coefficient C	0.50	0.48	0.53	0.69
Peak Flow m3/s	3.7	5.9	7.5	15.3
Estimated volume of runoff (m3)	12,200	19,700	25,000	50,900

	Wetland	Sedimentation Pond	Additional Storage	Total
Surface Area (m^2)	7,500	2,500	31,600	41,600
Volume (m^3)	7,500	2,500	39,500	49,500

The following parameters have been assumed in calculating sedimentation pond and wetland volumes:

- Sedimentation basin to treat 'very fine sand' (particle diameter of up to 125µm) with a settling velocity of 11mm/s;
- Wetland to treat 'fine silt' (particle diameter of 16 µm) with a settling velocity of 0.18mm/s;
- Hydraulic efficiency= 0.5 for sedimentation basin and 0.36 for wetland;
- Cross section batter slopes 1:4 (V:H).
- Wetlands and sedimentation pond only treating runoff from North-East corridor.
- Sedimentation basin permanent pool depth = 1m;
- Permanent pool depth for wetland system varies between 0-1m. An average depth of 0.3m has been used for calculations;
- Sedimentation basin extended detention depth is 0.5m.
- Wetland extended detention depth is 0.75m.
- Sedimentation basin Capture efficiency = 95%

Appendix D MUSIC modelling results

Appendix D MUSIC modelling results

	Source	Residual Load	% Reduction	BPEM target
Flow (ML/yr)	469	451	3.9	-
Total Suspended Solids (kg/yr)	92900	3710	96	80
Total Phosphorus (kg/yr)	192	31.2	83.8	45
Total Nitrogen (kg/yr)	1350	685	49.3	45
Gross Pollutants (kg/yr)	21000	0	100	70