Appendix 6 – Bioscience Local Water Management Strategy and Addendum

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Jeff Glass
City of Gosnells

SOUTHERN RIVER PRECINCT 3E, LOCAL WATER MANAGEMENT STRATEGY.

The final version of the LWMS was lodged in December 2011, and includes minor amendments requested by the City of Gosnells in their emailed excel document to Bioscience received on the 8th November (attached and included as a cover with our submission of the revised LWMS.)

The City of Gosnells requested two further changes, which upon discussion with the property owners and urbanplan, were not changed. We acknowledge the City of Gosnells condition for lifting the discharge invert of subsoil drains, and to achieve a minimum clearance of finished lot levels to groundwater of 2 m.

These requests have not been included in the LWMS as the final design and finished lot levels are not complete, however the conditions are accepted on the basis that the extent of fill and levels of subsoil drainage will be readdressed during the Urban Water management Plan process when further supporting information can be provided.

Yours sincerely

Peter Keating

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			General	City of Gosnells agrees to proceed with the updated LWMS. and Submission of the final report is requested with the following amendments.	Provide the final report	Yes	
			General	Provide a separate sheet attached to the front of the report with responses to the City's comments and reference to the updated sections. This will in ensuring assist the City that the previous comments have been addressed or to why they have not been addressed.	Provide the response sheet with the	Yes	Attached
			General	currently an issue remains with the access road align connecting the site via a future road element to Holmes street. In the case the ODP layout is ultimately changed the LWMS will require amendment and modification accordingly			Noted
	41	3.0	Proposed development	As mentioned in the City's previous comments, at least a draft structure plan, landscape plan and context plan need to be provided.	Provide draft plans for information. Plans can be refined at a later with UWMP.	Yes	Updated Plans provided by urbanplan provided in appendices
	55	6.4	Stormwater and Sub-surface Water Treatment	According to the responses made to the City's previous comment under section 6.4, In order to manage the runoff up to 5 year ARI event a piped drainage system has been proposed for site. But no information 0n this systemhas been included in the report. why?	Update the LWMS and provide layout diagram.	Yes	To be provided with final Engineering Designs in UWMP
	44	4.0	Protection of Infrastructure	The City of Gosnells requests for the whole subsoil drainage network to beraised by another 200mm such that invert of the subsoil drain outlet rests at 20.4m AHD above the estimated Ballanup Lake drain winter rest level. Minimum separation of 2m is provided between the CGL and the finished floor level throughout the site. (Minimum finished lot level should be 22.5m AHD)	Update the LWMS and provide layout diagrams accordingly	Yes	Noted - To be provided with final engineering designs in UWMP
	64		Figure 19	It seems that the cross-section A-A was not drawn to a scale and depths are not proportional to each other.	Update and provide relevant information.	Yes	To be provided with final Engineering Designs in UWMP
	55	6.4	Stormwater and Sub-surface Water Treatment	Confirmation of winter base flows and winter rest levels within Ballanup Lake Drain are to be provided and their impact considered.	Provide relevant information.	Yes	To be provided with final Engineering Designs in UWMP

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LOCAL WATER MANAGEMENT STRATEGY (LWMS)

for

LOTS 13, 14, 21 & 22 SOUTHERN RIVER ROAD and LOTS 18-20 MATISON STREET, SOUTHERN RIVER

December 2011

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EXECUTIVE SUMMARY

This Local Water Management Strategy (LWMS) has been prepared by Bioscience Pty Ltd to support the application for approval to an Outline Development Plan over the Subject Site (comprising Lots 13, 14, 21 & 22 Southern River Rd and Lots 18-20 Matison Rd - in Southern River). The primary objective of this LWMS is to demonstrate that the development can be undertaken in such a way as to manage the total water cycle in a sustainable manner, whilst adhering to the principles of Water Sensitive Urban Design (WSUD) related to water conservation, water quantity and quality, groundwater, stormwater, ecosystem health, protection of infrastructure and issues relating to public health and social values. The targeted objectives are as encouraged by the Dept of Water and are summarised as follows.

Water Conservation - Where alternative water sources are available, the use of potable scheme water should be limited to use within homes only (WAPC, 2008).

Water Quantity - To maintain pre-development total water cycle balance within development areas.

Water Quality - To maintain surface water and groundwater quality at pre-development levels and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the (sub) catchment areas.

Ecosystem Health – To prevent the deterioration of ecosystem health.

Protection of Infrastructure - To protect infrastructure and assets from flooding and water logging.

Public Health - To minimise the public risk, including risk of injury or loss of life to the community.

Social Values - To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater.

Development - To ensure the delivery of best practice management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles.

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This LWMS is consistent with all of the above stated objectives. The key to achieving this lies:

- in the existing geomorphology of the land, having permeable soils with good separation between groundwater and the surface, thereby very good potential for local stormwater infiltration after suitable structural controls.
- the rehabilitation of the Balannup Lake Drain as a living stream to effectively set a controlled groundwater level and allow gradual egress of stormwater after detention within largely natural compensation systems.

Key LWMS Element	Compliance with Objectives
Topography (Section 2.3)	➢ **The site has minor variations in topography ranging from approximately 23m AHD on lots 13 and 14, down to approximately 20m AHD in the central areas of lots 18, 19, and 20.**
Geology/Geotech (Section 2.4 and 2.5)	➢ **The geology of the study area is predominantly Bassendean sands (Bassendean B) over the Guildford formation (Pinjarra P1b).** ➢ **The study area is characterised by low dunes of siliceous sand interspersed with poorly drained areas or wetlands.** ➢ **The site has three distinct geological areas.** ➢ **90% of the soils that underwent PSD analysis were classified as medium texture sands.** ➢ **All clayey soils had low to intermediate plasticity.** ➢ **The infiltration rates of the sands and sandy loams are fairly high thus able to meet infiltration requirements for storm events.**
Groundwater (Section 2.6)	➢ **AAMGL for the site varied from between 21.04 m AHD (DHW6) and 19.76 m AHD (DHW24).** ➢ **Depth below ground level ranged from a maximum depth of 3.65m BGL (DHW 8 on the 12th June 2009) to surface ponding of 0.04m above the natural ground levels (DHW 19 on the 4th October 2009).** ➢ **Pre-development Water quality results show groundwater has quite variable quality in terms of salinity and nutrient levels, and helps establish target levels for improvement.**
Surface Water & Wetlands (Section 2.7 and 2.8)	➢ **Two Local Authority drains exist within the property.** ➢ **The management category and boundaries of the wetland within the study area have been recently modified.** ➢ **A multiple use wetland and a resource enhancement wetland are located on site (UFI number 15288 and 13963, respectively)**
Acid Sulphate Soils (Section 2.9)	➢ **A desktop study conducted for the site identified the entire site is classified as having a moderate to low risk of ASS occurring at a depth greater than 3m.** ➢ **SPOCAS acid sulphate analysis indicates no acidification risk.**
Vegetation (Section 2.10)	➢ **The vegetation broadly fits within the community types described in Gibson et al 1994 as type 23a, Central *Banksia attenuata – B. menziesii* woodlands, type 4 *Melaleuca preissiana* damplands and type 5 mixed shrub damplands.** ➢ **Vegetation condition ranges on site from very good to completely degraded.**
Water Use and Sustainable Initiatives (Section 5)	➢ **Encouraging all residents to be "waterwise" by fitting water efficient fixtures and fitting (i.e. showerheads, taps, toilets, and appliances).** ➢ **Encouraging all residents to install rainwater tanks for irrigation and domestic purposes (toilet flushing and washing machines).** ➢ **Reduce the demand on potable water by promoting the installation of rainwater tanks for irrigation and domestic (toilet flushing).**

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	➢ **Promote water wise landscaping and the use of drought tolerant native species in all POS.** ➢ **Reducing the size of lots within the development to reduce external (garden) water use.**
Surface and Stormwater Management (Section 6)	➢ **Use of major minor approach to stormwater management will be adopted (i.e. roadside drains/swales will act as detention/retention basins for 1 in 1 year ARI events, runoff generated from greater than 1 year ARI events will be discharged to gross pollutant trapping devices, swales, living streams and wetlands.** ➢ **Stormwater runoff will be collected and infiltrated as close to the source as possible using a number of structural controls – retention/detention areas, gross pollutant trapping devices, swales, living streams and wetlands.** ➢ **Pre- and Post-development flows have been modelled for 1:1, to 1: 100 year ARI, considering the site in 4 sub-catchments. The modelling shows that even in extreme rainfall events, stormwater can be retained on site.** ➢ **Building foundations will have a separation distance of 2m to AAMGL where possible to ensure effectiveness of soakwells.** ➢ **A 0.3m separation from the base of swales to AAMGL will be maintained to reduce water ponding.** ➢ **Roads will have a minimum separation of 0.9m from AAMGL.** ➢ **Protection of downstream areas will occur by restricting stormwater discharge to existing levels for storm events up to 1 in 100 year ARI flood levels.** ➢ **Pre-development 1 in 1 year ARI flow paths, discharge volumes and peak flow rates for existing catchments will be maintained post-development.** ➢ **Maintain all event flows up to and including the critical 1:5 yr ARI from the Study Area to at or below current discharge levels.** ➢ **Regeneration of existing drains to living streams.**
Groundwater Management (Section 7)	➢ **To maximise infiltration opportunities using soakwells, open based manholes, and swales.** ➢ **Bio-retention areas set at 2% of the equivalent impervious area of development consistent with DWMP requirements.** ➢ **Controlled Groundwater Level (CGL) to be implemented at AAMGL to control seasonal groundwater rise via groundwater discharge into existing drains.**
Wetland and Environmental Water Management (Section 8)	➢ **There are no Conservation Category Wetlands (CCW) or Environmental Protection Policy lakes (EPP) within the development area.** ➢ **To protect the existing hydrological and ecological regime of the wetlands by maintaining pre-development peak winter groundwater levels.**
Construction Management (Section 9)	➢ **Maintain a minimum separation distance of 0.5m between the base of development and 1 in 100 year ARI flood levels.** ➢ **Should dewatering be required, care must be taken to ensure neighbouring wetlands or groundwater dependent ecosystems are not adversely affected.**
Monitoring (Section 10)	➢ **The monitoring program is designed to operate over a three year post-development period including construction and establishmenr to allow for time lag for full impacts of development on the receiving environment to occur** ➢ **Post development trigger values will be described in the UWMP.**
Implementation (Section 11)	➢ **The roles and responsibilities involved in the implementation of LWMS have been identified.**
Future Work (Section 12)	➢ **Additional/Future work required for the Urban Water Management Plan (UWMP).**

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1. INTRODUCTION

1.1. Background

The Department of Housing (DoH) in collaboration with two private land owners intends to develop seven adjoining lots of land, collectively 25.778 hectares, in Southern River towards urban subdivision. Land ownership details are summarised in Table 1. Lots, 13, 14, 21 and 22 Southern River Road and Lots 18, 19 and 20 Matison Street are located approximately 20km south southeast of Perth CBD, within the City of Gosnells (Figure 1). Bioscience was engaged by the landowners to prepare a Local Water Management Strategy (LWMS) to support the submission of an Outline Development Plan (ODP) (drafted by **urbanplan**) to the City of Gosnells.

Table 1 - Legal Land Area and Description

Lot No.	Certificate of Title	Registered Owner	Land Area
13	208/84A	The State Housing Commission	4.0494ha
14	27/389A	The State Housing Commission	4.0469ha
21	1813/671	The State Housing Commission	2.0011ha
22	1813/672	The State Housing Commission	2.2199ha
18	358/11A	Carmelo Radici and Rosina Radici	4.5072ha
19	1342/833	The State Housing Commission	4.5881ha
20	1311/770	Landflow Holdings Pty Ltd care of Turco & Co	4.3655ha
		TOTAL	25.7781ha

Within the Southern River region, the City of Gosnells has identified several precincts, of which the site is located within Precinct 3. Precinct 3 is bounded by Southern River Road, Ranford Road, Matison Road and the Southern River and is characterised by areas of flat, low lying land and a relatively high water table. There are dominant surface water features such as the Southern River, Forrestdale Main and Balannup Lake Drains. The Precinct also contains significant areas of wetlands that have hydrological groundwater linkages with these waterways.

The Precinct has also been affected by current and previous land uses, such as intensive agriculture, animal-based industries, other rural pursuits and a former waste

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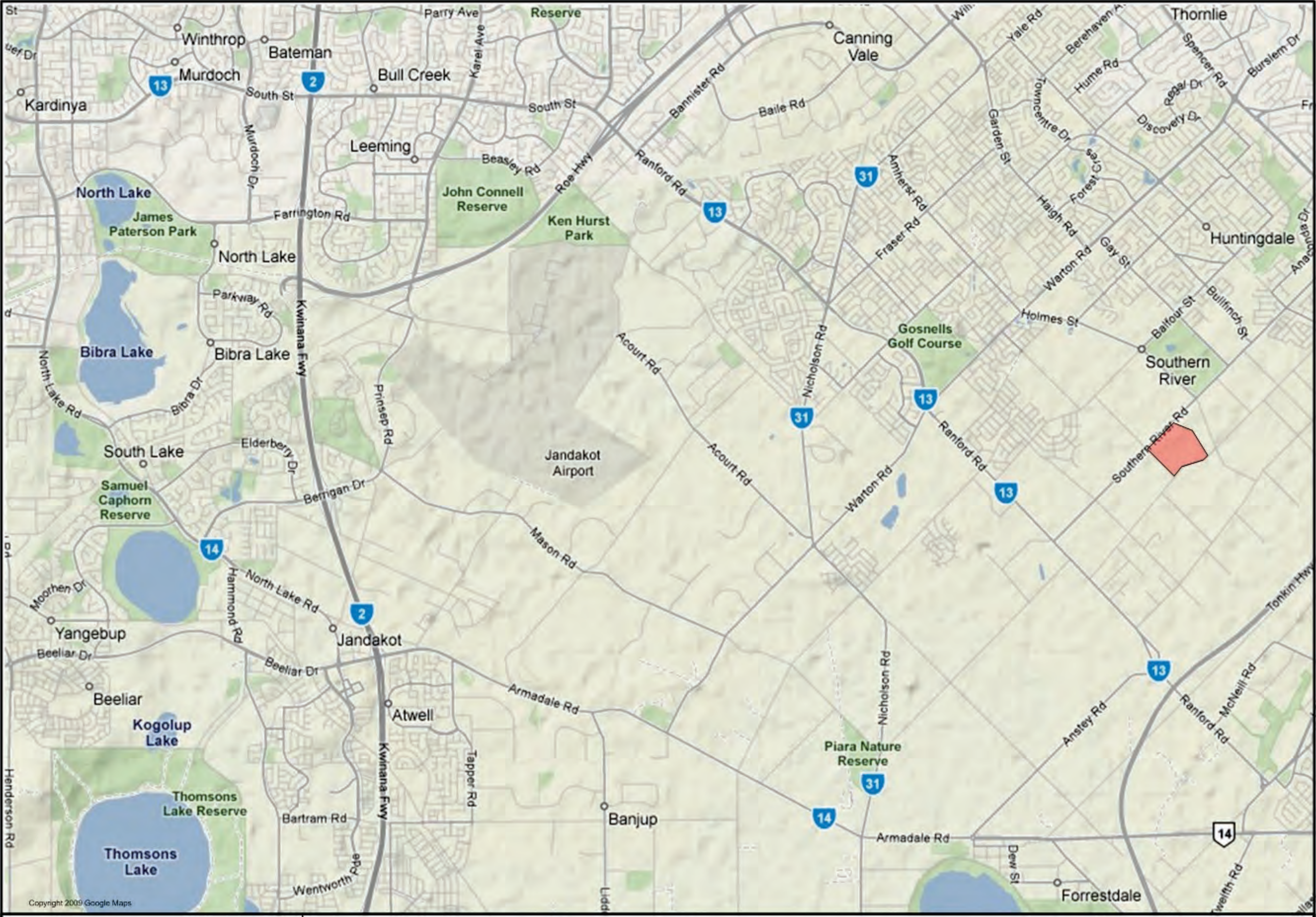

Figure 1 - Site Location of Lots 13, 14, 21 and 22 Southern River Road and Lots 18, 19 and 20 Matison Street

Legend

Site Location

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disposal site, which have left a legacy for water management plans to address. Further, as Precinct 3 lies towards the bottom of a large regional drainage catchment, there is a need to ensure stormwater is managed to avoid flooding and to address water quality issues. Water management is therefore a significant and important consideration for the planning and development of Precinct 3.

1.2. Total Water Cycle Management Objectives

The primary objective of this LWMS is to ensure the proposed development will manage the total water cycle in a sustainable manner, whilst adhering to the principles of Water Sensitive Urban Design (WSUD).

This report is drafted to:

- Provide a description of existing site characteristics including land use, geotechnical parameters, groundwater characteristics, and surface water characteristics.
- Identify relevant regulations and guidelines governing water management.
- Identify relevant total water cycle management and water-sensitive urban design principles that would apply in this instance, and to ensure that development is consistent with current best management practices and best planning practices for the sustainable use of water resources.
- Identify possible impacts on local groundwater quality and quantity to ensure post-development conditions are equal to or better than pre-development conditions.
- Promote management of the urban water cycle as a single system in which all urban water flows are recognised as a potential resource and where the interconnectedness of water supply, stormwater, wastewater, flooding, water quality, waterways, estuaries and coastal waters is recognised.
- Maximise the opportunities for compliance with best practice stormwater management including retention of stormwater on site/at the source.
- Promote use of water conservation mechanisms that increase the efficiency of the use of water.
- Identify site constraints and opportunities for the re-use and recycling of water, particularly stormwater and grey water, consistent with state water strategy recycling objectives.
- Conserve and/or re-vegetate local native vegetation to minimise water use and maximise filtration, particularly where landscaping is proposed.

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1.3. Planning Background

1.3.1. Zoning

The subject site, Sub-precinct 3E, is bordered to the north east by the Balannup Lake Drain, to the south east by Matison Street, to the south west by the Landers Street road reservation, and to the north west by Southern River Rd (Figure 2). Currently the development area is zoned URBAN by the Metropolitan Region Scheme and RESIDENTIAL DEVELOPMENT under the Local Scheme, requiring the preparation of an ODP.

1.3.2. District Structure Plan

On a district scale the site is located within the area of the Southern River/ Forrestdale/ Brookdale/ Wungong District Structure Plan (DSP). Prepared by the Western Australian Planning Commission (WAPC) in 2001, the DSP provides a broad framework for land use and development including major community facilities, conservation areas, public open space (POS) and potential areas for development together with the management of key environmental issues for a region facing increasing development pressures.

In 2002, the WAPC commissioned Jim Davies & Associates (JDA) to develop a district Urban Water Management Strategy (UWMS) for the area. The UWMS included goals which aimed to protect water resources, ensure an enhanced living environment for the community and provide protection from flooding. After reviewing the UWMS, the EPA expressed significant concerns with the planned urbanisation of the area, which led to a memorandum of understanding being entered into by a range of agencies and other bodies involved in land use and water management, including the DEC, the Water and Rivers Commission (now Department of Water), the Dept of Planning (DoP), Water Corporation, Armadale Redevelopment Authority and the Cities of Armadale and Gosnells. Under the terms of the memorandum of understanding, the Water Corporation was made responsible for the coordination and project management of the development of a Water Cycle Plan, in consultation and agreement with all parties.

The aims of the Water Cycle Plan were to achieve the objectives and recommendations of the UWMS. It was intended to be performance-based and detail the management requirements of the Water Corporation and the Cities of Armadale

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Figure 2 – Southern River Precinct 3E

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and Gosnells in relation to ‘total water cycle' management, including water conservation, excess water management during storm events, water quality, monitoring, reporting and cost recovery. Early in the process of addressing implementation of the UWMS and total water cycle management, the importance of integrating the total water cycle management approach with land development processes was recognised. This was reflected in the title of the project being changed to an Integrated Land and Water Management Plan.

The subsequent Southern River Integrated Land and Water Management Plan (ILWMP) was gazetted by the DoW in January 2009. Both of these documents recognised water and drainage as one of the key issues for development in the Southern River area.

1.4. Previous Studies

Other relevant previous studies into land and water management in the area include:

- *Southern River Area: Groundwater modelling to assess effects of climate variation, and proposed development* (Rockwater, 2005).
- *Forrestdale Main Drain Arterial Drainage Strategy* (Dept of Water, 2009).
- *Precinct 3 Environmental Review* undertaken by ENV for City of Gosnells.

1.5. Key Environmental Policies

This LWMS is drafted to conform to the wide range of State Government policy, in particular to State Planning Policy 2.9: Water Resources (WAPC, 2007), and it considers the following guidances.

- Better Urban Water Management (WAPC/DoP, Oct 2008)
- Southern River Integrated Land and Water Management Plan (DoW, Jan 2009)
- Stormwater Management Manual for Western Australia (DoW 2004 – 2007)
- Forrestdale Main Drain Arterial Drainage Strategy (DoW, Jan 2009)

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2. PRE-DEVELOPMENT ENVIRONMENT

2.1. Land Use

In the past the land was used for agricultural purposes with some of the land cleared and fenced for grazing. More recently, land use has been for rural living with some evidence of minor home industry use. With the exception of lots 18 and 20, dwellings have been demolished and the land is currently vacant and unused.

2.2. Climate

The south west of Western Australia is characterised by a Mediterranean climate comprising hot dry summers and cool wet winters. According to the Bureau of Meteorology the average annual rainfall within the vicinity of the proposed development is 837mm (Jandakot Aero No. 009172). The monthly distribution of rainfall (Figure 3) indicates approximately 85% of the rainfall occurs during the months of May to October. The average annual evaporation of the area is 1800 mm (Davidson and Yu, 2006).

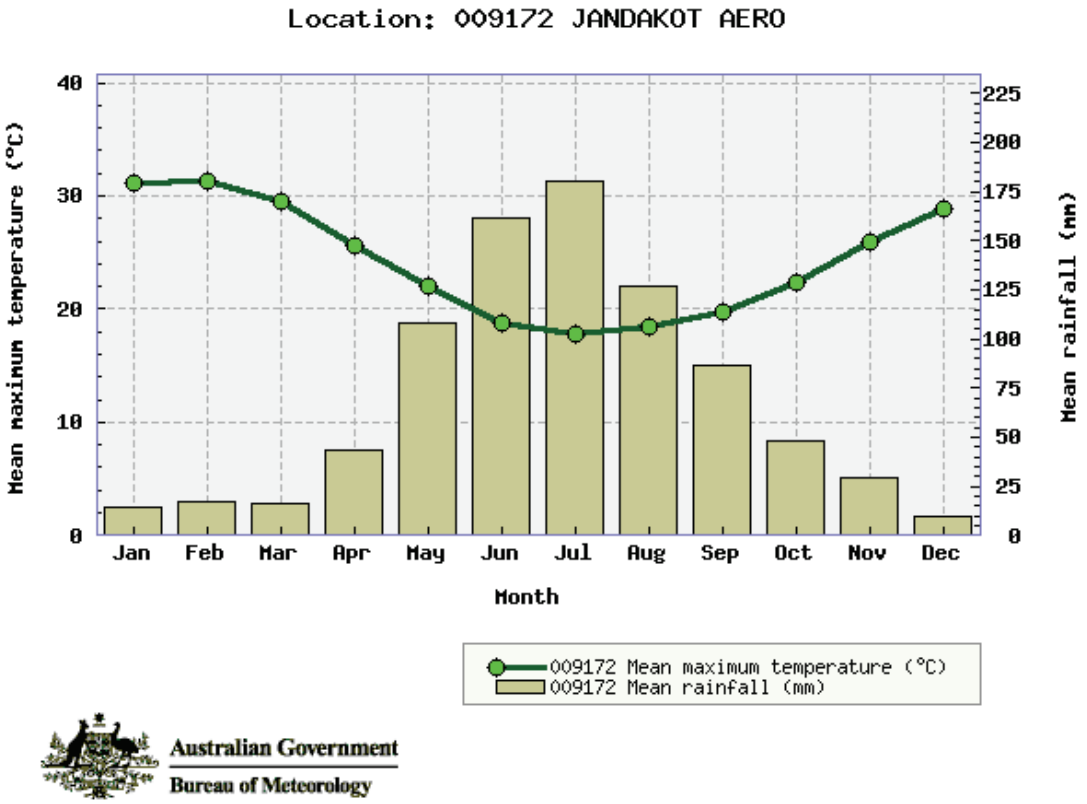

Figure 3 - BoM Jandakot Aero Station Average Monthly Rainfall Data.

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2.3. Topography

Generally the area has a low relief with minor variations in topography. The site has a gentle slope from the centre of lots 13 and 14 at approximately 23m AHD towards the northern areas of lots 22 and 21 in addition to the central areas of lots 18, 19, and 20 down to approximately 20m AHD (Figure 5).

2.4. Geology

The subject site is located on the Swan Coastal Plain within the Bassendean dune system, an area characterised by low dunes of siliceous sand interspersed with poorly drained areas or wetlands. Two soil types occur within the site (Figure 4):

- Bassendean B1 Phase which are described as extremely low to very low relief dunes, undulating sand plains and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 m.
- Pinjarra P1b Phase which are described as being flat to very gently undulating plain with deep acidic mottled yellow duplex soils. Moderately deep pale sand to loamy sand over clay: imperfectly drained and moderately susceptible to salinity in limited areas.

The geology at the site as per the Geological Survey of Western Australia 1:50000 Environmental Geological Series Armadale Map Sheets 2033 I and 2133 IV are either:

- SP1 – PEATY SAND – grey to black, fine-medium grained, moderately sorted quartz sand, slightly peaty of lacustrine origin.
- S8 – SAND – white to pale grey at surface, yellow at depth, fine-medium grained, moderately sorted, subangular and subrounded, minor heavy minerals of Aeolian origin. (Bassendean Sand).
- S10 – SAND – as S8 over sandy clay to clayey sand of the Guildford Formation of Aeolian origin, (Bassendean Sand over Guildford Formation).

2.5. Geotechnical Site Investigation

Preliminary field investigations for this project was undertaken on the 31st October 2008, 9th March 2009, 12th June 2009, and the 7th July 2009 and followed by a more

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0 100 200m

Figure 4 – Soil Geology mapped by the DoA.

Legend

Pinjarra P1b Phase

Bassendean B1 Phase

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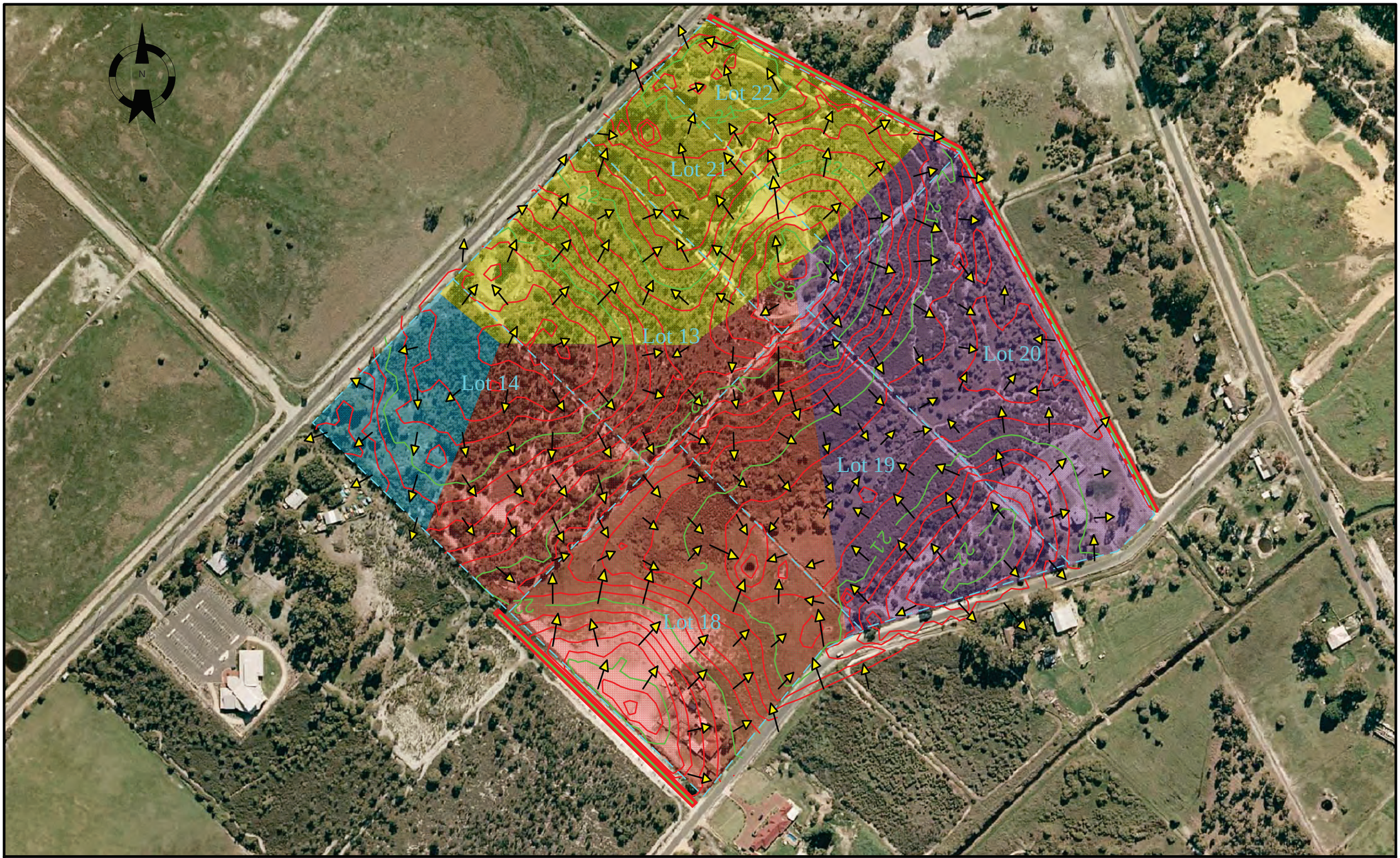

Figure 5 – Site Topography (m AHD), Pre-development Surface Runoff Flow and Catchments.

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0 100 200m

Legend

- Lot Boundaries
- Minor Contour (0.2m)
- Major Contour (1.0m)
- Surface Runoff Flow
- Catchment 1
- Catchment 2
- Catchment3
- Catchment 4

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intensive investigation undertaken on the 11th February 2010. The earlier field work component of the project involved installing 25 piezometers (DHW1to DHW25) from which representative soil samples were photographed and collected for laboratory testing. The later component involved excavation of the 15 test pits (DHW-H1 to DHW-H15) using a 14 tonne mechanical excavator and secondary collection of representative samples for laboratory testing. See Figure 10 for location of all geotechnical and hydrogeological sites.

2.5.1. Excavated Test Pits

Test pits locations were determined based on earlier desk top investigations, from piezometer experience and from field observation of surface soils. The fifteen test pits were excavated to investigate the sub-surface soil and groundwater conditions.

The site has three distinct geological areas. The first is uniform in regards to the geological layers and is summarised as possessing a light grey to grey organic sandy topsoil to a depth of approximately 250mm, overlying a grey to white medium texture, poorly sorted Bassendean sandy soil to a depth up to 3000mm.

The second area is relatively uniform in regards to the geological layers and is summarised as possessing a dark grey to grey organic sandy topsoil to a depth of approximately 250mm, overlying a light grey to white medium texture, poorly sorted Bassendean sandy soil to a depth of approximately 700mm, overlying a mottled cream to orange loamy sand to sandy loam to a sandy clay loam with increasing depth to approximately 2000mm, overlying a mottled green to grey sandy loam to sandy clay loam with increasing depth to approximately 3000mm.

The third appears to be a transition zone between the first and second areas, however is more similar to the second geological area in that it possess a dark grey to grey organic sandy topsoil to a depth of approximately 250mm, overlying a light grey to white medium texture, poorly sorted Bassendean sandy soil to a depth of approximately 1000 to 1500mm, overlying a dark brown to black, rocky ferruginous indurations or “coffee rock” layer to a depth of approximately 2000mm, overlying a mottled green to grey sandy loam to sandy clay loam with increasing depth to approximately 3000mm.

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2.5.2. Particle size distribution

Particle size distribution (PSD) was determined on soil samples collected during the geotechnical investigation. Of the 54 soil tested, the vast majority (39 samples) contained over 90% of particles within the 2mm to 0.075mm range (sand fraction), and thus classified as medium texture sandy soils. Of the remaining, six samples were classified as loamy sands as each had greater that 80% but less than 90% of particles within the 2mm to 0.075mm range (sand fraction); and another six were classified as sandy loams as each had greater that 70% but less than 80% of particles within the 2mm to 0.075mm range (sand fraction). The remaining 3 samples were consolidated rock like material and did not undergo PSD.

2.5.3. Atterberg Limit

The Atterberg limits tests are simple standardized tests that were developed to determine the water contents that will induce particular behaviour, and provides a useful measure of potential soil reactivity and ground movements, which are fundamental in foundation design. Of the samples collected during the excavation of the 12 test pits, four samples of interest underwent Atterberg limits investigations.

Without exception, all four soils samples tested plot above the "A" line and have LL less than 50%, thus they are referred to as clays with low or intermediate plasticity. Of the four representative soil samples tested, two have low plasticity, whereas the other two have intermediate plasticity. Raw results are summarised on Table 2 .

Table 2 - Atterberg Limits Results.

Borehole	Sample Depth (mm)		Cobble (%) >6.3mm	Gravel (%) >2mm	Sand (%) <2mm	Silt/Clay (%) <0.075mm	Fines (%) <0.425mm	LL (%)	PL (%)	PI (%)	LS (%)
DHW-H5	1500	3000	0.0	0.1	79.2	20.8	89.9	36.3	17.6	18.7	3.3
DHW-H5	1000	1500	0.0	0.2	73.2	26.6	62.6	39.9	16.9	23.0	5.3
DHW-H12	1600	3000	0.0	0.2	73.2	27.5	56.4	33.6	17.2	16.4	2.7
DHW-H4	700	2000	0.0	0.1	79.2	21.5	54.7	31.6	17.1	14.5	1.3

The Geotechnical Investigation concluded that most of the site was Class A, with parts surrounding the wetland areas classed as S due to there being less than 1.2 m separation to slightly reactive clay. It recommended areas where there was a sufficient depth of suitable sand fill to achieve a Class A rating across the entire development area.

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2.5.4. Infiltration and Drainage

The permeability or infiltration rates of the various soil found on site is related to the particle size distribution. The infiltration rates of precipitation on the sandy soils are approximately $1x10^{-3}$ m/s, whereas the infiltration rates on the loamy sands and sandy loams soils is approximately $1x10^{-7}$ m/s and $1x10^{-8}$ m/s, respectively. Consequently, drainage is considered to be good throughout the sandy soil areas and poor in the finer loamy sands to sandy loams areas.

Constant head permeability testing was undertaken at six locations around the site. The results of these ranged from $1.55*10^{-4}$ m/s at test location 5 (fastest) to $1.92*10^{-5}$ m/s at test location 6 (slowest). Results and location of permeability tests can be seen in figure 6. These tests show the site to be suitable for onsite disposal of stormwater.

2.6. Groundwater

2.6.1. Regional Hydrology

The hydrology of the Southern River area on a broad scale is characterised by flat land of Bassendean sand dunes with quite low relief hosting a superficial aquifer which is about 30 m thick. The Southern River itself acts as a local discharge point for this superficial aquifer and is thus the lowest local groundwater level. The Perth Groundwater Atlas (2004) shows the groundwater contours slope downwards in a north easterly direction parallel with the local alignment of the Southern River. The groundwater atlas suggests that groundwater is between 3 – 4 m below the surface across the site, based on May 2003 data when local groundwater would be approaching annual minimum levels (Figure 7). Groundwater monitoring and modelling of the southern river district was conducted initially by JDA (2002) and then by Rockwater (2005). Both the JDA and Rockwater reports indicate that groundwater flow on the site is in a generally easterly direction, towards Southern River with an Average Annual Maximum Groundwater Levels (AAMGL) varying between 20.5m AHD towards the west of the property sloping down to19.5m AHD towards the east.

2.6.2. Groundwater Monitoring

Initially five piezometers were installed on the 31st October 2008 to traverse an area which demonstrated clear geomorphic, vegetation and surface soil evidence of being a wetland. These were placed to form an east-west, and a north-south transect. On the 9th April 2009 ten additional piezometers were then installed outside this core area.

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The proposed locations were firstly conveyed to the DEC's wetland office, and after discussions and their recommendations, the locations were modified where necessary to capture the most useful data. In July 2009, another ten piezometers were installed, four on lot 18 and six on lot 20.

All piezometers were installed using a hand auger and were made from 50 mm PVC pipe with 1m of slotted interval buried to at least 0.5 m below the water table in March, when the water table was expected to be at or near the minimum level. The initial five piezometers installed in October were deepened where necessary. After installation and development, water was collected (if present) from each piezometer for chemical analyses, and monthly measurement of depth from the natural surface was commenced.

Seven (i.e. DHW2, 4, 5, 6, 9, 14, and 15) of the piezometers did not intersect the March groundwater level due to an impenetrable layer formed by the indurated ferruginous deposit or "coffee rock" layer. Given such deposits typically only occur below the maximum water table, it is likely that as water levels rise, these piezometers will fill with water.

The site was surveyed by licensed surveyors who recorded the location and height of each piezometer to 1 mm, and who produced a surface contour map to 100 mm lines. The data from the surveying instruments was directly imported into CAD and GIS systems and into the hydrological modelling suite Hydro GeoAnalyst v2009.1 to accurately model groundwater levels and depth to groundwater or meters below ground level (m BGL).

Groundwater levels have been monitored since the 30th October 2008, and most recently on the 22nd September 2011, thus included two winters. Details of the groundwater levels in meters AHD and meters BGL are contained in Appendix 1 and 2, respectively. Groundwater levels varied significantly throughout the site from a maximum of 21.348m AHD (DHW6 on the 9th October 2009) to a minimum of 17.83m AHD (DHW21 on the 21st January 2011) (Figure 8). In relation to depth below ground level a maximum depth of 3.75m BGL (DHW 7 on the 22nd June 2011) and a minimum of -0.08 m BGL or 0.08m above the natural ground levels was recorded (DHW 1 on the 22nd September 20011) (Figure 9).

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Figure 6
Southern River 3E
Permeability Testing
Locations and Results



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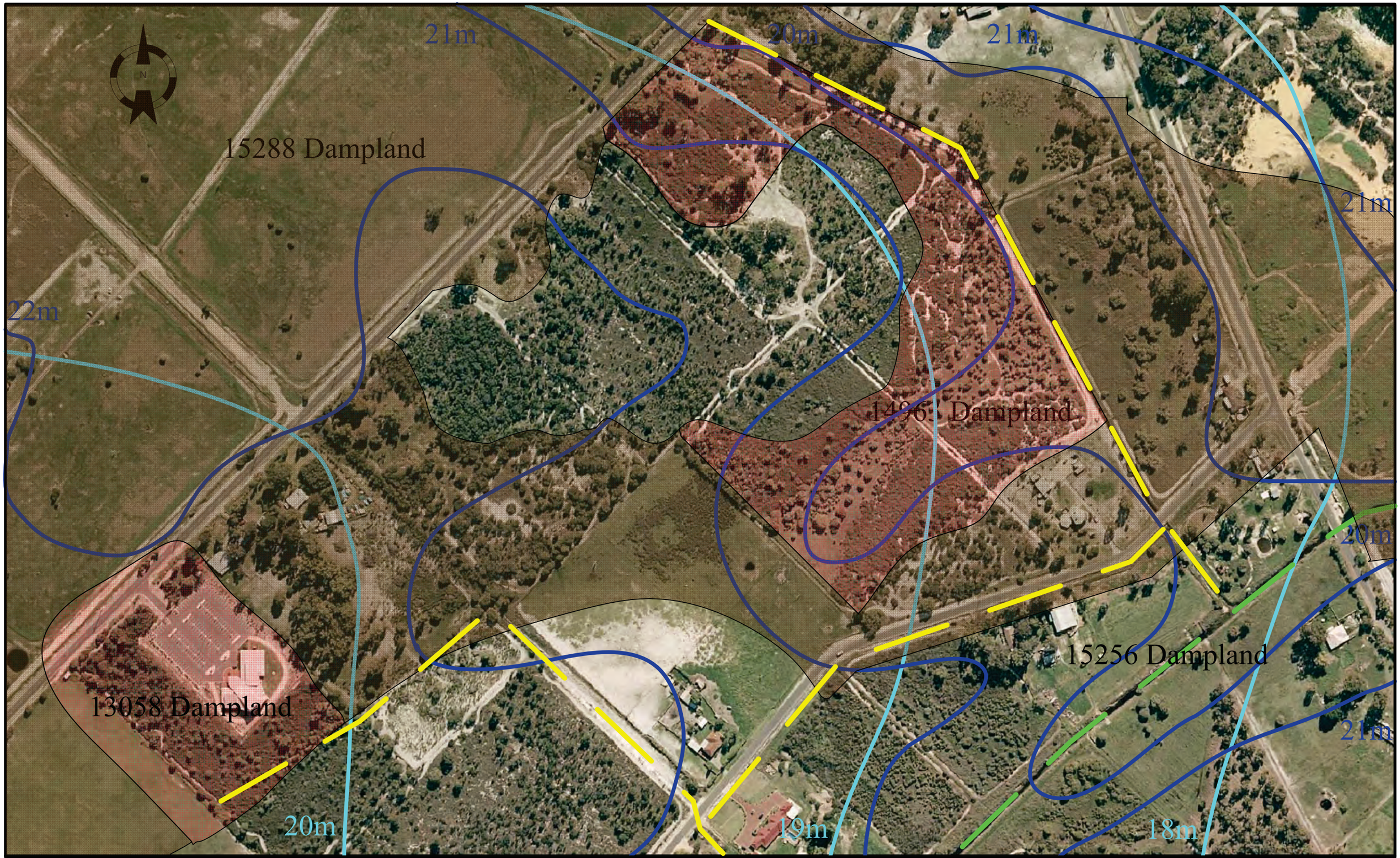

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0 100 200m

Figure 7 – Current DEC Wetlands and DoW Regional Groundwater Data

Legend

- Multiple Use
- Rehabilitation
- Local Authority Drain
- Max Groundwater Contours
- Groundwater Contours May 2003
- Forrestdale Main Drain

Note: Data from the online Perth Groundwater Atlas, accessed at www. water.wa.gov.au

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Average Annual Lowest Groundwater Level (AALGL)

June 2009 groundwater levels varied from 20.07m AHD at DHW18 to 18.34m AHD at DHW1, although several piezometers were either not installed at this time (DHW20 to 25) or there was insufficient water for a reading to be taken (DHW2, 4, 6, 9 14, and 15). To more accurately determine the AALGL for the entire site, June 2009 groundwater levels were compared with 30 years of DoW monitoring bore records, specifically T75 (WIN ID 4880). Based on the calculation in Appendix 4 we have estimated that the AALGL for the site varied between 19.25 m AHD (DHW18) and 17.59 m AHD (DHW1).

Average Annual Maximum Groundwater Level (AAMGL)

October 2009 groundwater levels varied from 21.35m AHD at DHW6 to 20.05m AHD at DHW24. To more accurately determine the AAMGL for the entire site, October 2009 groundwater levels were compared with 30 years of DoW monitoring bore records, specifically T75 (WIN ID 4880). Based on the calculations in Appendix 3 we have estimated that the AAMGL for the site varied from between 21.04 m AHD (DHW6) and 19.76 m AHD (DHW24) (Figure 10). This estimate is in accord with work by JDA (2002) undertaken on the broader scale of the entire Southern River area. Figure 9 also shows the estimated depth to groundwater (expressed as AAMGL) from natural surface. The majority of lots 13 and 14 and to some degree the southern half of lots 20 and 21 and the south western half on lot 18 of the site has in excess of 1.2m clearance to AAMGL, whereas area of lots 18, 19 and 20 and the northern half of lots 20 and 21 typically have depth to AAMGL of less than 1.2m.

Extreme 1 in 100 Year Recurrence Interval

1 in 100 groundwater recurrence intervals were calculated (see Appendix 4 for calculations). Results indicated that groundwater levels vary from a maximum of 21.60 and to a minimum 20.29m ADH across the site. Depth to groundwater modelling indicates that a significant area of Lots 18, 19 and 20 have ponding surface water (Figure 11). Given the maximum level of Balannup Lake Drain (see Section 6.1) in 1:100 year events is below this level at 21.36 m, the drain will act as a discharge for the site in flood events.

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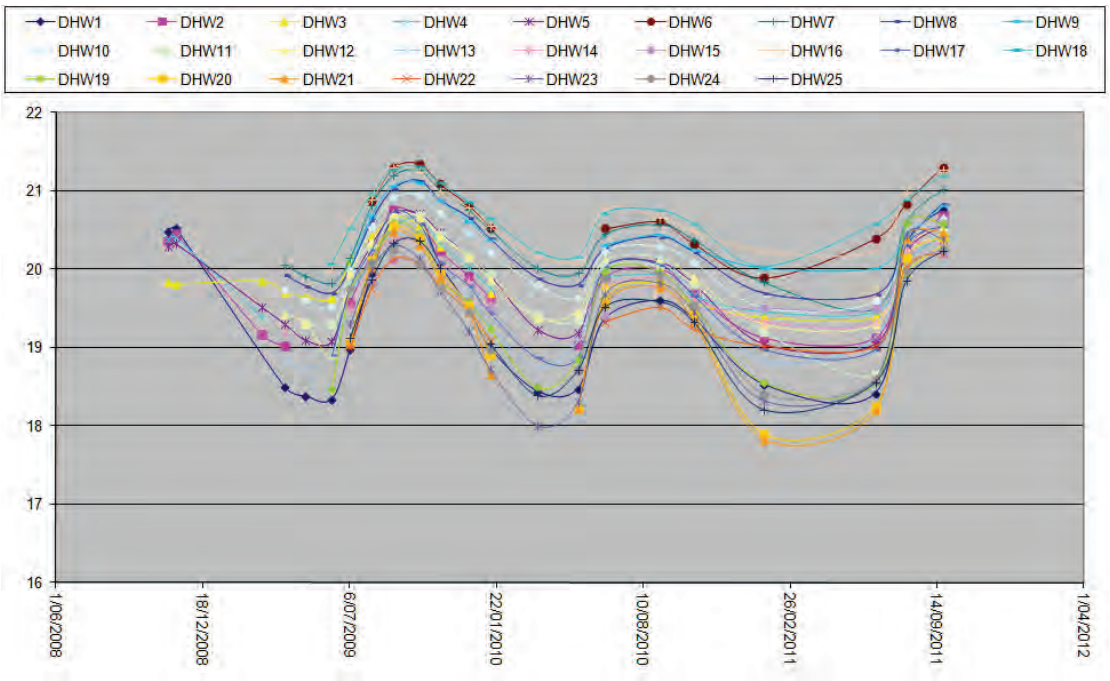

Figure 8 - Groundwater levels in meters Australian high datum (m AHD).

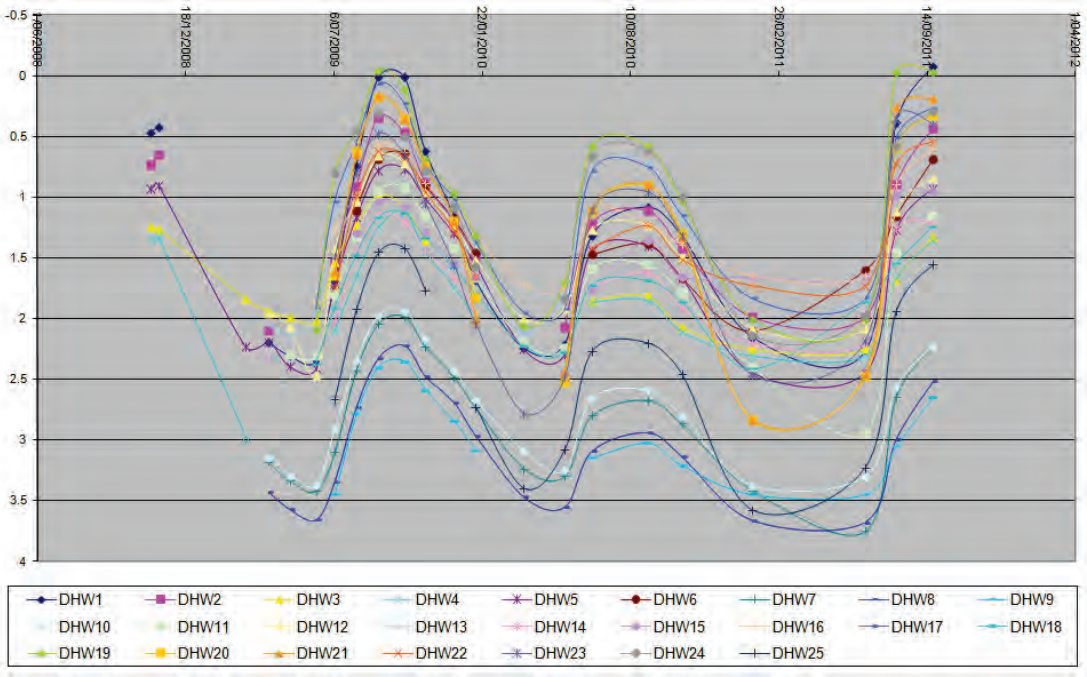

Figure 9 - Groundwater levels in meters below ground level (m BGL).

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2.6.3. Pre-Development Groundwater Quality

Typical existing concentrations measured in the Forrestdale main drain are 3.2 mg/L total nitrogen and 0.5 mg/L total phosphorous (Rockwater, 2005). The long-term targets for nutrient concentrations in the Southern River are 1.0 mg/L total nitrogen and 0.1 mg/L total phosphorus.

Water recovered from the installed piezometers on a quarterly basis was analysed and shown to vary across the site with respect to land use, being generally fresh and acidic pH over bushland areas but more saline with neutral pH in wetland areas, and containing nutrient ions from very low, to moderately high levels over former farmed areas. Summary results of water quality data to date are contained in Appendix 9.

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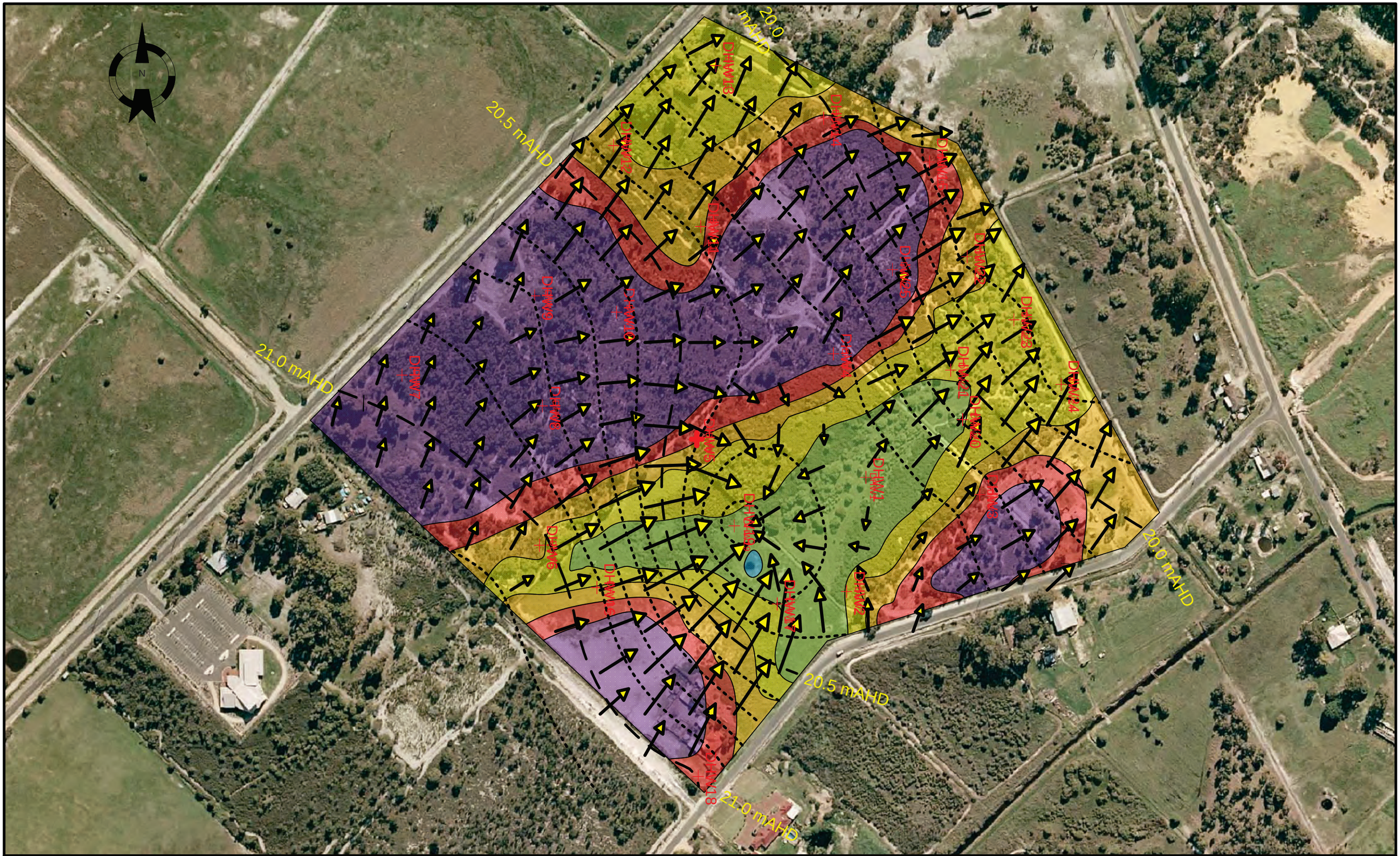

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0 100 200m

Figure 10 – AAMGL Contours (m AHD), Groundwater Flow and Depth Below Ground Level (m BGL) .

Legend

- GW Flow
- Surface Water
- 0.9 to 1.2M BGL
- Minor GW Contour (0.1m)
- 0 to 0.3m BGL
- 1.2 to 1.5m BGL
- Major GW Contour (0.5m)
- 0.3 to 0.6m BGL
- <1.5m BGL
- Piezometer
- 0.6 to 0.9m BGL

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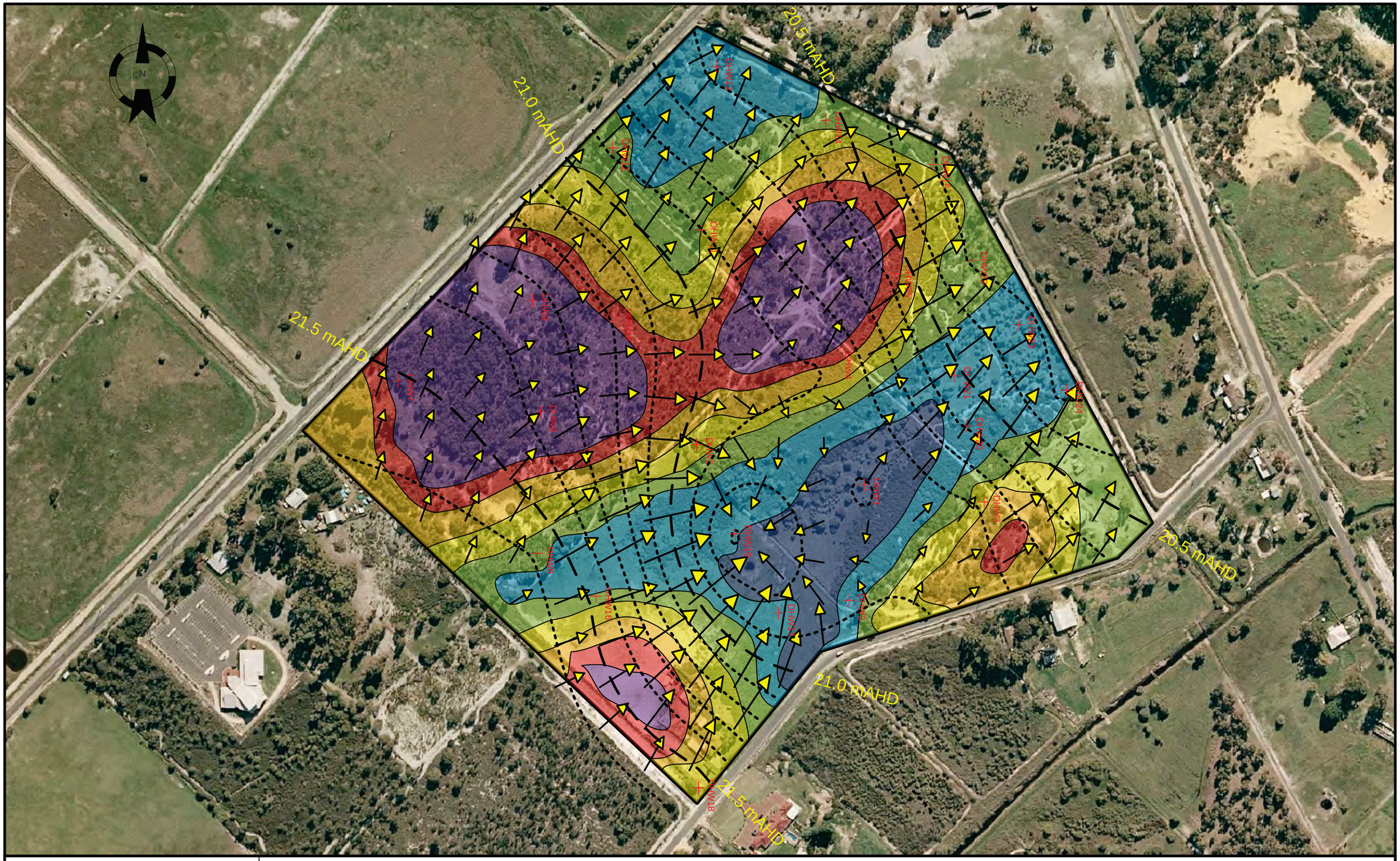

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Figure 11 – 1 in 100 Year Groundwater Contours (m AHD), Flow and Depth Below Ground Level (m BGL) .

Legend

- GW Flow
- Surface Water
- 0.9 to 1.2M BGL
- Minor GW Contour (0.1m)
- 0 to 0.3m BGL
- 1.2 to 1.5m BGL
- Major GW Contour (0.5m)
- 0.3 to 0.6m BGL
- <1.5m BGL
- Piezometer
- 0.6 to 0.9m BGL

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2.7. Surface Water

2.7.1. Regional Drainage Strategy

The regional drainage strategy for the area has been prepared by the Water Corporation for the Department of Water. It provides the details of the arterial drainage strategy for the Forrestdale main drain catchment discussed in the Southern River ILWMP.

The Forrestdale main drain connects Forrestdale Lake to the Southern River. It was constructed as a rural drain in the 1970s to manage the regional groundwater level and prevent the Westfield wastewater treatment site from being flooded. The Forrestdale main drain has levee banks along much of its length and it passes through or adjacent to a number of Bush Forever sites and conservation category wetlands.

According to JDA (2002) the Forrestdale Main Drain is currently 1.5 m to 2.0 m below natural surface and currently designed to handle a 3 to 5 year ARI. In the Forrestdale Main Drain Arterial Drainage Study (DoW, 2009), it is stated that the Forrestdale main drain requires widening within a linear public open space to create online flood storage areas between Phoebe Road and Holmes Street.

2.7.2. Site Surface Drainage

Three Local Authority drains exist directly adjacent to the site. The first is located along the south western boundary of lot 18 in the Lander St road reserve and has an invert of 21.07m AHD. This drain then extends northwards along Matison Street to join the third of the perimeter drains, which is located directly north east of lots 20 and 22 (the Balannup Lake Drain) and has an invert of 19.6m ADH (Photo 1). The purpose of these drains is to redirect and/or reduce surface water from accumulating on surrounding properties. However field observations indicate that surface water still ponds in low lying areas in winter months (Photo 2).

A Urban Water Management Strategy report from the Southern River / Forrestdale / Brookdale / Wungong, Structure Plan titled “Impact of Existing Drains and Proposed Living Streams on Groundwater Table and Nutrient Export” (JDA, 2002) specifies the drawdown influence of drains of varying depths within this region. Their results can be used to estimate desirable drains depth and distances from significant environmental features such as CCWs to provide protection from groundwater lowering (Table 3). Consequently, it can be used to deduce the impact a drain has on a wetland given its invert below AAMGL and distance are known.

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Photo 1 - Local Authority Drain.



Photo 2 – Surface Inundation, taken on the 4th September 2009.



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Table 3 – Impact of Drain Invert on AAMGL Drawdown.				
Drain Invert below AAMGL (m)	Drawdown of AAMGL at Varying Distance from Drain (m)			
	0m from Drain	100m from Drain	500m from Drain	1km from Drain
0.5	0.3	0.19	0.03	0
0.9	0.57	0.38	0.07	0.008
1	0.63	0.41	0.08	0.01
1.5	0.98	0.67	0.14	0.02

In relation to the site, the drain invert located on the south western boundary of lot 18 in the Landor St road reserve is approximately 0.3 m below AAMGL. Consequently, groundwater levels within 0.5km of this drain will decline logarithmically from between 0.30m to 0.03m, thus having an impact on groundwater levels within the vicinity of this drain.

The drain invert (the Balannup Lake Drain) located to the north east of lots 20 and 22 is approximately 0.9 m below AAMGL which is consistent with (JDA, 2002) findings of Local Authority drains within the area. Consequently, groundwater levels within 1km of this drain will decline logarithmically from between 0.57m to 0.08m, thus having a very significant impact on groundwater levels of the entire site.

2.7.3. Estimation of Annual Flows

Estimation of the runoff for the catchment areas as defined in Figure 5 are shown in Table 4 below. The Southern River/ Forrestdale/ Brookdale/ Wungong Structure Plan - Urban Water Management Strategy (2002) report estimated the mean annual runoff to be between 10% and 22% of annual rainfall. According to the BoM, the average annual rainfall at the Jandakot Aero station (located approximately 6km to the west of the site) is 837mm.

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Table 4 - Mean Annual Runoff Estimates					
Catchment	Catchment area (Ha)	10% of Annual Rainfall		22% of Annual Rainfall	
		Mean Annual Flow Estimate (m^3/year)	Mean Annual Flow Estimate (L/sec)	Mean Annual Flow Estimate (m^3/year)	Mean Annual Flow Estimate (L/sec)
1 (yellow)	5.99	5.01	0.16	8.87	0.28
2 (purple)	8.25	6.74	0.21	11.91	0.38
3 (red)	10.43	8.51	0.27	15.05	0.48
4 (blue)	1.6	1.33	0.04	2.35	0.07

2.8. Wetlands

Previous wetland mapping was examined in detail. Prior to 1993, the site was classified as a multiple use wetland (MUW) via the application of EPA Bulletin 374. As a result of the research conducted as part of the 1993 wetland vegetation assessment project, areas of this MUW were sub-classified by remnant vegetation. Consequently, as of Hill *et al* (1996) two wetlands were marked within the site, a MUW (i.e. No. 155, aka WIN No. 40204644804) and a conservation category wetland (CCW) (i.e. No155-V5, aka 40207644742) (Figure 12).

A search on the Shared Land Information Platform (SLIP) database in 2008 indicated that two wetlands were on the site, with the same boundaries as per Hill *et al* (1996), however in Hill *et al* (1996) the wetlands are described as being a MUW and CCW, whereas the SLIP portal records them as being MUW and a Resource enhancement wetland (REW) (UFI number 15288 and 13963, respectively) (Figure 12).

The REW located on the proposed development site is in poor condition and is more suited to a MUW category, consequently a detailed re-evaluation of wetland boundaries and management categories was undertaken by Bioscience, and resulted in a formal request to modify the Swan Coastal Plain Geomorphic Wetland Mapping to the wetland's office of the Department of Environment and Conservation . We conclude that the current wetland boundaries probably were accurate prior to local drainage being constructed. The wetland office agreed with our findings that a large proportion REW is in fact not wetlands, but rather is upland with vegetation dominated by upland species and have thus reclassified the boundaries (Figure 7).

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A very recent policy shift has come to light, regarding wetland classification (Conversation with Gordon Wyre, DEC's Director of Nature Conservation). REW are to be renamed "Rehabilitation Wetlands" (RW). The management objective of RW is similar to REW in that it aims to restore the values and attributes of such areas towards that of a CCW. However unlike REW policy, this process for RW is now at the discretion of the landowner, and likely to be judged on a case by case basis as there is wide variation between the environmental values of RWs. The classification thus no longer automatically constitutes a constraint on development for the site. (For further details, see email correspondence in Appendix 7).



Figure 12 – Wetland classification and boundary as per Hill et al (1996)

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2.9. Acid Sulphate Soil

2.9.1. Desktop Investigation

A desktop study conducted for the site identified the entire site is classified as having a moderate to low risk of ASS occurring at a depth greater than 3m (WAPC, 2004).

2.9.2. Field Investigation

Eleven soil samples were examined for their acid sulphate properties (i.e. SPOCAS suite). No single method, including SPOCAS, will provide all the answers to the complex chemistry involved in reactions of acid sulphate soils. However results the SPOCAS test procedures will provide guidance to identify ASS and the nature of cations contributing to total and potential acidity (Acid Sulphate Soils – Laboratory Methods Guideline, 2004). Action criteria are defined and give advice when soils disturbed at a site will require ASS management. These action criteria are based on the sum of existing plus potential acidity (Table 5).

Table 5 – Acid Sulphate Soil Action Criteria (Ahern et al, 1998).

Type of Material		Action Criteria, <1000 tonnes		Action Criteria, >1000 tonnes	
Texture	Approx. Clay Content (%<0.002mm)	Sulphur Trail SPOS %	Acid Trail TPA mole H^+/t	Sulphur Trail SPOS %	Acid Trail TPA mole H^+/t
Coarse (sand)	≤5	0.03	18	0.03	18
Medium (Loams to Light Clays)	5 to 40	0.06	36	0.03	18
Fines (Silts and Clays)	≥40	0.10	62	0.03	18

Results (Appendix 5) indicate that none of the 11 samples tested exceeds the action criteria for both TPA and total Sulphur (Note, S_{POS} gives a measure of the maximum "oxidisable" sulphur present in a soil sample, where as total sulphur S_{TOTAL} (as measured in this report) gives a measure of total sulphur present with a soil sample, consequently S_{TOTAL} will always be equal to or greater than S_{POS}). Three of the 11 samples do exceed the Titratable Peroxide Acidity (TPA), however as they all possess S_{TOTAL} less than the action criteria (i.e. 0.03%) are considered to have an inconsequential ASS risk.

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2.9.3. ASS Management Strategy

Both the desktop and preliminary field investigations suggest that ASS is only a concern where site works disrupt soil greater than 3m from the natural soil surface. The only a foreseeable site works that might disrupt soil greater than 3m from the natural soil is sewer construction, thus further assessment maybe required prior to the submission of a dewatering licence (if required). As the sewer excavation depths at this point in time are unknown, undertaking an ASS assessment before plans are finalised may results in samples being undertaken in inappropriate locations and depths. Should the proposed investigations indicate actual and/or potential ASS are present on the site, then an ASS management plan will be developed.

2.10. Vegetation

The vegetation broadly fits within the community types described in Gibson et al 1994 as type 23a, Central *Banksia attenuata – B. menziesii* woodlands, type 4 *Melaleuca preissiana* damplands and type 5 mixed shrub damplands. There is evidence that much of the land has been previously cleared for grazing, and more recently it has been disturbed through the dumping of domestic and building rubbish.

The current community types are defined by the accompanying map. The following are the community descriptions according to each numbered area on the map (Figure 13).

Vegetation Community 1a: Tall open shrubland/low open woodland of *Adenanthos cygnorum*, *Kunzea glabrescens*, and *Daviesia divaricata* with a few *Macrozamia riedlei* and *Allocasuarina fraseriana* and occasional *Podotheca gnaphalioides*. No other native taxa were found. The understorey is almost completely weeds with velt grass, pigface and *Briza major*.

Vegetation Community 1b: Very similar to area 1 with the exception that *Macrozamia riedlei* and *Allocasuarina fraseriana* were not present, a single specimen of *Desmocladus flexuosus* and of *Regelia ciliata* were found however the soil was for the most part bare earth rather than weeds.

Vegetation Community 2a: Low closed woodland of *Banksia menziesii* and *Eucalyptus todtiana* over shrubland of *Kunzea glabrescens, Acacia pulchella, Adenanthos cygnorum, Hibbertia subvaginata* and the herbs *Anagozanthus manglesi*,

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and *Laxmannia squarrosa*. The understorey is almost completely weeds with velt grass, pigface and *Briza major*.

Vegetation Community 2b: Originally similar to 2a, however has undergone extensive clearing.

Vegetation Community 3: Woodland of *Eucalyptus todtiana* and *E. decipiens* with single specimens of *Xanthorrhoea preissii, Patersonia occidentalis, Acacia pulchella, Nuytsia floribunda*. The understorey is exclusively weeds including velt grass, pigface, erum lilly, watsonia gladiolus lovegrass and serradella.

Vegetation Community 4: Cleared and degraded, with only native present being isolated *Lepidospernum longitudinale* over pasture weeds including fescue, perennial ryegrass, brome grass, Avena sativa, dock.

Vegetation Community 5a: Closed shrubland of *Regelia ciliata, Pericalymma ellipticum, Astartea affinis, Phlebocarya cilliata,* and *Juncus subsecundus* and *Schoenus sp*.on edges. Weeds include Gladiolus, *Avena sativa, Briza major*.

Vegetation Community 5b: Very similar to 5a but with *Melaleuca priessiana*.

Vegetation Community 5c: Very similar to Area 5a, however with lower diversity and greater invasion of weeds cover than 5a.

Vegetation Community 5d: Almost identical to 5b, however has greater disturbance and weeds.

Vegetation Community 5e: Almost identical to 5a, however has greater disturbance and weeds

Vegetation Community 5f: Superficially similar to area 5a, but evidence of previous clearing, resulting in essentially a dense monoculture of *Regelea ciliatea*, with occasional *Melaleuca tymoides, Xanthorrhoea preissii* and *Juncus* sp.

Vegetation Community 5g: Similar unit to vegetation community 5a, but with *Boisseae sp, Pericalymma elipticum* and some small *Melaleuca priessiana* and *Nyutsia floribunda.* Degraded by previous clearing and by extensive weed invasion.

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Vegetation Community 5h: Very similar to Area 5a, however with scattered low trees of *Melaleuca priessiana Allocasuarina fraseriana, Xanthorrhoea preissii* and *Bossiaea* sp.

Vegetation Community 5i: Very similar to 5b but with an invasion of a Non-endemic eucalypts species.

Vegetation Community 6a: Low woodland to low open woodland of *Melaleuca raphiophilla* as the only native present over weeds including cooch, serradella, fescue, dandelion, dock.

Vegetation Community 6b: Low closed woodland of *Melaleuca raphiophylla* over weeds – cooch, wild oats, lovegrass, and nightshade.

Vegetation Community 6c: Very similar to 5b but with greater weed invasion and disturbance.

Vegetation Community 7: Previously cleared, mono culture of *Kunzea glabrescens*.

Vegetation Community 8: Open woodland of *Melaleuca priessiana, Kunzea glabrescens, Nuytsia floribunda* over Shrubland of *Regelia ciliata, Pericalymma ellipticum, Hypocalymma augustifolium, Astartea affinis, Pattersonia occidentalis.* Weeds include erum lily, fescue, dandelion, Briza major.

Vegetation Community 9a: Transition zone between 5a and 10a. Contains all of 5, but this gradually diminishes northward and is progressively replaced by *Eucalyptus.todtiana, Allocasuarina. fraseriana, Xanthorrhoea preissii, Banksia menziesii, Melaleuca thymoides.* Weeds generally less but include velt grass, gladiolus, Briza Major.

Vegetation Community 9b: Very similar to 9a, however has greater disturbance and lower diversity.

Vegetation Community 10a: Low woodland of B*anksia menziesii, B.attanuata, B.ilicifolia, Eucalyptus todtiana. Allocasuarina fraseriana, Nuytsia floribunda*, over herbland of *Conostylus aculeate, Patersonia occidentalis.* Weeds include Velt grass, Briza major, Gladeolus.

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Vegetation Community 10b: Originally same as 10a but trees cleared and only contains short *Adenanthos cygnorum* and *Banksia menziesii.*

Vegetation Community 10c: Similar to area 10a, but with no *Allocasuarina*, Understorey also contains *Pimelea rosea, Petrophile axillaris*. Weeds include velt grass, gladiolus, *Briza major* but generally in better condition than surrounds.

Vegetation Community 10d: Low open woodland of B*anksia menziesii, B.attanuata, B.ilicifolia, Eucalyptus todtiana. Allocasuarina fraseriana, Nuytsia floribunda*, over herbland of *Conostylus aculeate, Patersonia occidentalis.* Some cleared areas regenerated to *Kunzea glabrescens* and *Adenanthos cygnorum.* Weeds include Velt grass, Briza major, Gladeolus.

Vegetation Community 10e: Originally similar to area 10a however cleared and severely disturbed and/or extensive evidence of Banksia death due to *Phytophthora.* Very weedy and degraded.

Vegetation Community 11: Open woodland of *Allocasuarina fraseriana* over shrubland of *Acacia pulchella, Xanthorrhoea preissii, Conostylus aculeate.* Minor weeds of Briza major, velt grass.

Vegetation Community 12: Woodland of *Eucalyptus todtiana* and *Melaleuca priessiana* over *Patersonia occidentalis* and dense weeds including velt grass, pigface and Briza major

Vegetation Community 13: Previously parkland cleared with, understorey regeneration of *Kunzea glabrescens*, otherwise weeds.

Vegetation Community 14: Non-endemic eucalypts over weeds.

Vegetation Community 15: Previously cleared low closed shrubland of *Astaria affinis* with occasional *Regelia ciliata* with understorey of *Patersonia occidentalis*. Understorey mostly weeds including dandelion, serradella.

The site is located within approximately 2 km of seven Bush Forever Sites 125, 413, 340, 465, 255, 464, and 246 which have a total area of 293.88 ha (Figure 14). At the regional scale, the vegetation complex of the area is a combination of Bassendean Dunes/Pinjarra Plain Southern River Complex. Only 17% of this complex remains.

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Some 1775 ha are protected as Parks and Recreation under the MRS, Department of Environment and Conservation (DEC) managed lands and Crown Reserves with a Conservation Purpose. This, together with the 1372 ha under Bush Forever, protects 10% of the Southern River complex.

The Bush Forever Site No. 125 is part of a regionally significant fragmented bushland/wetland linkage. Whilst only limited surveys of the Bush Forever site has been undertaken, more than 80% of the vegetation condition is excellent (with some areas considered pristine) and the remaining ranked as very good to good. In contrast the subject site vegetation condition is rated to be good to completely degraded, despite having some vegetation in very good condition. In addition, no significant flora including two DRF orchid species (*Diuris purdiei* and *Caladenia hueglii*) known to reside in Bush Forever Site No. 125, were found on the site. Consequently, the significance of this site, in terms of conservation value is relatively low. Despite this, an area within the site that has been classified as being in very good condition will be protected and conserved as part of the public open space within the proposed development.

2.11. Site Characteristics Summary

There are a number of potential opportunities and constrains that affect water management design identified in within the site, which include;

- The depth to groundwater over a considerable proportion of the site is greater than 1.2 m at AAMGL, so it is unlikely a large volume of imported fill is required. Ongoing groundwater monitoring will result in an improved understanding of the hydrogeology and allow for implementation of controlled groundwater levels (CGL), and thus confirm fill requirements.
- CGL will be maintained at AAMGL by ensuring any subsoil drainage is at or above AAMGL.
- Despite a CCW being located approximately 500m east of the site, the proposed implementation of CGL is not expected to adversely affect this wetland. Likewise, the CGL appears to unconstrained by any ASS risk, as both mapping and soil analysis are suggestive of little to no risk of AASS or PASS occurring within 3m of natural ground levels.
- Although infiltration rates elsewhere are high, the infiltration rates of the loamy sands and sandy loams in the wetland areas of Lot 19 are low and this will likely lead to groundwater discharging into the local authority Balannup Drain after storm events.

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- Areas of coffee rock and impervious clays were only found in wetland areas which will not be disturbed by development.
- The proposed development will result in an increase in groundwater recharge. This has the potential to increase post-development groundwater levels to undesirable levels. The proposed implementation of CGL is therefore required to prevent this from occurring. This will require free outlets of subsoil drainage to develop a functional CGL system.

3. PROPOSED DEVELOPMENT

In accordance with the Southern River / Forrestdale / Brookdale / Wungong District Structure Plan (DSP), the Southern River Integrated Land and Water Management Plan (ILWMP) and the Southern River Precinct 3 Local Structure Plan (LSP) the area is proposed to be developed for residential and public open space purposes.

The land is proposed for standard residential development with a base density of R20, with medium density developments of R30 and R40 in areas close to Public Open Space (POS). Retail, commercial and industrial land uses are not proposed nor are schools or community specific sites.

The distribution of the proposed POS areas will be strategically located to maximise the conservation of remnant bushland and for natural drainage and filtration of groundwater and/or rainwater.

At present the Outline Development Plan (ODP) for this study area has not been approved. Consequently, we are unable at this point to provide specific information such as the structure plan, landscape plan. This information will be specified in the forth coming UWMP. The ODP Diagram is included in this LMWS as Appendix 8 for completeness, noting that the LWMS forms part of the ODP statutory planning process.

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Figure 13 – Vegetation Community Type, Condition and Photograph Location with Field of View

Bioscience

0 100 200m

Legend

- Pristine
- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded
- 1 Vegetation Community Type
- 1 Photo Location

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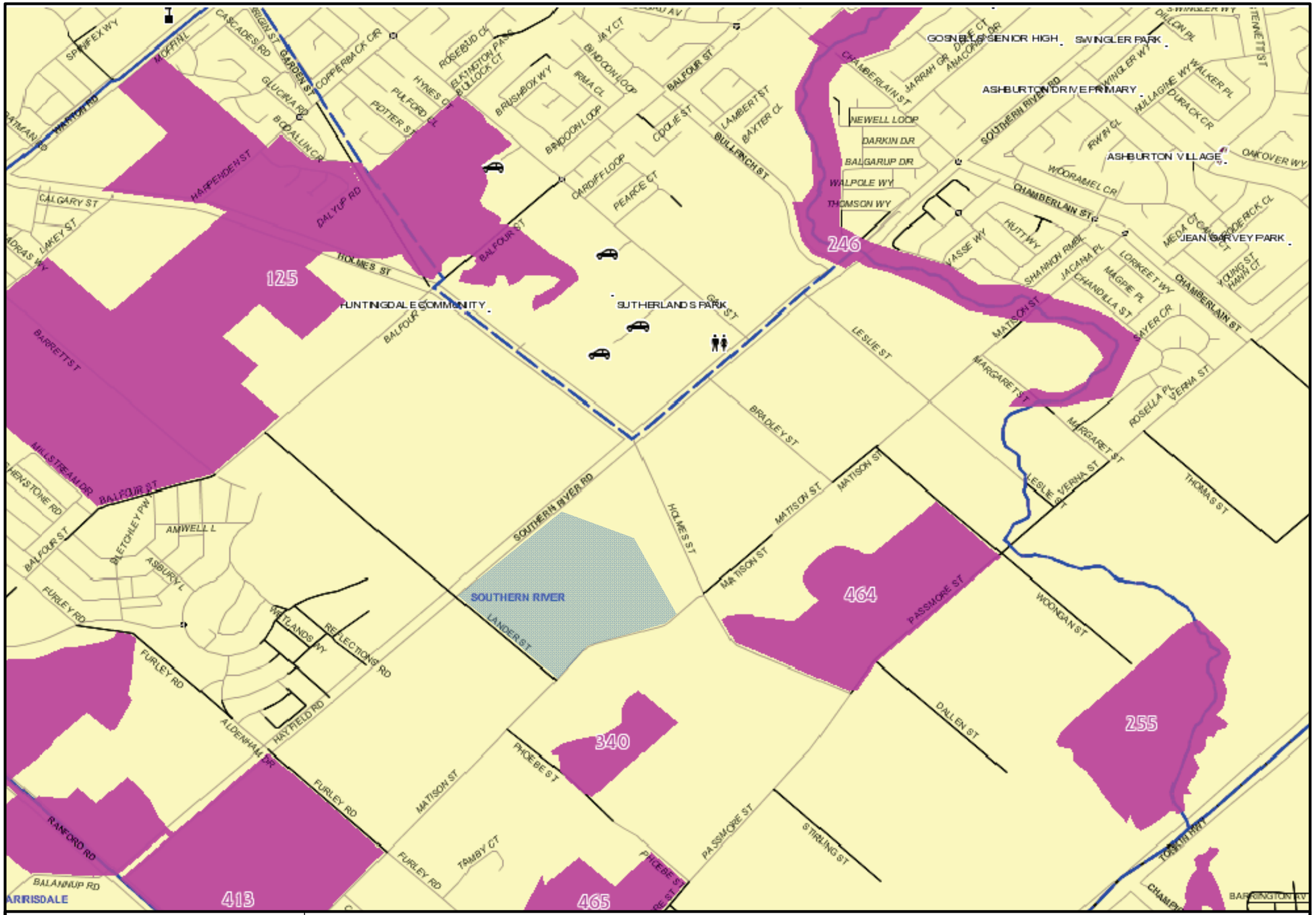

Bioscience

Figure 14 – Local Bush Forever Sites

Legend

Site Location

Bush Forever Sites

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4. DESIGN CRITERIA

Based on this desktop review of literature, a set of water management objectives for the development are provided below. These objectives cover the areas of water conservation, water quantity and quality, groundwater, stormwater, ecosystem health, protection of infrastructure and issues relating to public health and social values.

Water Conservation - Where alternative water sources are available, the use of potable scheme water should be limited to use within homes only (WAPC, 2008).

- Implement water efficiency and demand management measures in and outside the house.
- Maximise stormwater infiltration opportunities.
- Use of native plantings in POS areas and passive POS areas to minimise irrigation.

Water Quantity - To maintain pre-development total water cycle balance within development areas.

- Maintain flow paths for existing catchments.
- Maintain at source retention of 1 in 1 year and 1 hr rainfall events.
- Maintain all event flows up to and including 1 in 5 and 1 in 100 year ARI peak flows from the Study Area to at or below current discharge levels.
- To maintain pre-development peak winter groundwater levels at groundwater dependent wetlands.
- Stormwater detention area outlets set at defined CGL and maintained as free slow outlets.
- Maximise infiltration opportunities.
- Identify areas susceptible to erosion and implement best management practices for its prevention.

Water Quality - To maintain surface water and groundwater quality at pre-development levels and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the (sub) catchment areas.

- Change in land use and WSUD to reduce nutrient input in the Study Area.
- Where possible infiltrate frequently occurring events using soakwells, open based manholes, and swales.
- Bio-retention areas set at a minimum of 2% of the equivalent impervious area of development consistent with the Southern River ILWMP requirements.

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- Regeneration of existing drains to living streams.
- Use of major minor approach to stormwater management.
- Application of source controls – education to reduce nutrient application, native plantings, swales, passive POS areas and lot soakwells.
- Application of structural controls – retention/detention areas, gross pollutant trapping devices, swales, living streams.
- Ongoing predevelopment and post development monitoring programs and performance review process.

Ecosystem Health - To protect ecosystem health.

- To protect the existing hydrological and ecological regime of the wetlands by maintaining pre-development peak winter groundwater levels.
- Existing resource enhancement wetlands to be rehabilitated, revegetated, and retained.
- Creation of vegetation and habitat linkage via multiple use corridors.
- Gross pollutant trapping devices to be installed on outlets to significant receiving water bodies.

Protection of Infrastructure - To protect infrastructure and assets from flooding and water logging.

- Provision of 1 in 100 year ARI flood protection.
- Protection of downstream areas by restricting stormwater discharge to existing pre-development levels for all storm events up to 1 in 100 year ARI flood levels.
- Controlled Groundwater Level (CGL) to be implemented at AAMGL to control seasonal groundwater rise via subsoil drainage.
- Maintain a minimum separation distance of 0.5m between the base of development and 1 in 100 year ARI flood levels.
- Implementing a drainage design that limits the peak outflow from the development to pre-development levels through storage and infiltration on site.

Public Health - To minimise the public risk, including risk of injury or loss of life to the community.

- Design in accordance with relevant design standards, best management practices, council regulations and government agency requirements.

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Social Values - To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater.

- Existing resource enhancements wetland areas to be rehabilitated and retained as POS.
- Regeneration of existing drains to living streams.
- Integration of drainage and POS functions.

Development - To ensure the delivery of best practice management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles.

- Development of the LWMS in accordance with government agency guidelines and best management practice recommendations.
- Use of Controlled Groundwater Level (CGL) to minimise large scale trucking of fill consistent with sustainability principles.
- Use outcomes of continuing pre-development and post-development monitoring programs to help guide future water management.

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5. WATER USE AND SUSTAINABILITY INITIATIVES

According to Rockwater (2005) the total annual water use expected for a water wise house without restrictions is 304kL/house/year, of which 149kL/house/year is used internally and 155kL/house/year is used externally.

A residential consumption target for potable scheme water usage of 100kL/person/year has been recommended by State Water Plan (2007), however the more recent Better Urban Water Management (WAPC, 2008) recommend a target for potable scheme water usage of between 40-60kL/person/yr. Considering the average occupancy rate per house is 2.4 people (Australian Bureau of Statistics website, accessed 08/01/2010), this represents a target of 96 to 144kl/house/year and a reduction from current levels in the order 68 to 47%, which is somewhat ambitious. Consequently, methods for sustainable water use, conservation and reuse of water should be implemented within the development where possible.

As 51% of potable scheme water is used externally on gardens, possibly the greatest opportunity to reduce potable water usage involves reducing this external use whilst encouraging owners to become waterwise internally.

5.1. Rainwater Tanks & Stormwater Harvesting

Rainwater from roofs and other hardstand areas can be collected in rainwater tanks, and used in gardens (51% total residential water usage) and internally for toilets (9% internal water usage) and washing machines (11% internal water usage). Due to the seasonal nature of Perth rainfall (i.e. 85% occurring during the months of May to October) very large storage tanks of approximately 100m^3 would be required to irrigate over the summer months, however tanks of this size are not feasible in urban residential areas. Notwithstanding, smaller tanks can still have a substantial impact on reducing the use of scheme water.

5.2. Groundwater Use

Approximately one third of all households in Perth use groundwater for irrigation purposes. The shallow depth to groundwater in the Southern River area makes this a cost effective option. Currently the DoW considers the City of Gosnells groundwater supplies are not fully allocated, thus groundwater licences are available for irrigation public open space. As the majority of the POS with the proposed development is

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comprised of native vegetation, there is little requirement for this area to be irrigated. The areas of active recreation POS will be turf which will be irrigated so a modest groundwater licence will be required.

5.3. Waterwise Landscaping

Reducing the amount of water used for irrigation can be achieved via planting drought tolerant species, reducing the area of lawn, improving soil water holding capacity and via the installation of water efficient irrigation.

Another method of water conservation is through the establishment of native vegetation that has minimal or no irrigation requirements. Such plants also help to promote a more natural environment and minimise the introduction of alien species. A substantial proportion of the proposed POS areas have been strategically located to maximise the conservation of native vegetation. The areas of active recreation POS required under Livable Neighbourhoods Policy will be irrigated according to the restrictions in place at the time, but will generally be outside of daylight hours when evaporation rates are at their lowest and be no more than twice per week.

Where landscaping establishment requires temporary irrigation, such as within swales and buffer strips, suitable native species should be selected. Where irrigation of vegetated areas cannot be avoided, it should be restricted during the daylight hours.

5.4. Domestic Greywater

Greywater is water that has previously been used, either in baths, showers, bathroom wash basins, washing machines or dishwashers. Greywater recycling involves installing a system that treats greywater to a quality that is deemed suitable for other uses such as toilet flushing or sprinkler irrigation. Whilst greywater use is technically feasible (excluding the possible concern of nutrient loading to groundwater) the associated costs means this remains a personal lifestyle choice and requires conformance with Department of Health policy.

5.5. Water Efficient Fittings & Appliances

The use of waterwise fixtures such as showerheads, taps, toilets and washing machines is recommended where possible. According to Rockwater (2005) a 12% reduction in internal potable scheme water can be achieve via the installation of waterwise fitting and appliances.

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5.6. Agreed Actions of Implementation

Several water conservation initiatives in accordance with the Water Corporation's water wise development guidelines will be implemented to reduce water consumption with the development, including;

- Encouraging all residents to be "waterwise" by fitting water efficient fixtures and fitting (i.e. showerheads, taps, toilets, and appliances).
- Reduce the demand on potable water by encouraging all residents to install rainwater tanks for irrigation and domestic purposes (toilet flushing and washing machines).
- Promote water wise landscaping and the use of drought tolerant native species in all POS.
- Reducing the size of lots within the development to reduce external (garden) water use.

5.7. Pre and Post Development Water Balance

The aim of the water balance is to ensure that surface and groundwater discharges are similar post and pre development. Under no circumstances should the post development water discharges be higher or lower than the pre development water balance as this is unsustainable and will ultimately result in the alteration of groundwater levels and decline of water dependent ecosystems.

Rockwater (2005) estimated the evapo-transpiration of the area to have accounted for 75% of total annual rainfall. Thus 25% of annual rainfall would recharge surface and groundwater systems. As the total area of the site is 25.778Ha and the average annual rainfall is 837mm/yr, the total volume of annual rainfall for the site is estimated to be 216 ML/yr, of which 54 ML/yr would actively recharge surface and groundwater systems.

Post-development water balance is considerably more complex that pre-development as it must take into account changes to runoff characteristics from impermeable surfaces such as rooves and roads. It must also take into account importation of potable water and its use externally. It is generally recognised that post-development groundwater recharge increases according to the proportion of hard surfaces due to

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reduced evapotranspiration, and may be by as much as twice that of pre-development conditions (i.e. up to 50% of annual precipitation). More information regarding post-development water balance will be undertaken during the development of an UWMP.

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6. STORMWATER MANAGEMENT STRATEGY

This stormwater management proposal is consistent with water sensitive design practices and aims to meet the objectives outlined as per the design criteria (section 4).

6.1. Background

The ODP area falls within the broader Study Area covered by the *Forrestdale Main Drain Arterial Drainage Study* (DoW, 2009). The Water Corporation commissioned that work so that a better understanding of the Forrestdale Main Drain could be established. The Study [the ADS] was needed to provide guidance to proposed development across the catchment – in terms of identifying minimum fill levels (for protection from flooding) and associated stormwater detention requirements

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The Forrestdale Main Drain Arterial Drainage Strategy (DoW, 2009) incorporates catchment planning for the area around the subject site, and provides HGL and flow details for the Balannup Lake Drain that extends across the north-eastern boundary of the Site. Relevant details for the Drain are summarised as follows.

Table 6: Balannup Lake Drain
HGL & Flow Details - Post Development

	Sthrn River Rd (b004)	Mid-point (b003)	Matison St (b002)
Ground level (m AHD)	21.91	21.50	21.30
Invert level (m AHD)	19.80	19.70	19.50
10yr ARI HGL level (m AHD)	21.08	21.07	21.06
100yr ARI HGL level (m AHD)	21.38	21.37	21.36
Max 10yr ARI flow (m^3/s)	0.83	0.88	0.61
Max 100yr ARI flow (m^3/s)	0.91	0.93	0.71

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The catchment planning in the ADS identified a sub-catchment that was labelled as Stirling St North and its extents largely coincide with that of the subject site. The following stormwater detention requirements were identified.

10yr ARI storage volume:	3590m^3
100yr ARI storage volume:	4190m^3
Proposed CGL:	20.24m AHD
Proposed detention area base level:	21.00m AHD
Proposed 10yr ARI Top Water Level:	22.07m AHD
Proposed 100yr ARI Top Water Level:	22.20m AHD

From these details, it can be inferred that a detention storage occupying approximately 4,700m^2 would be required to deliver the post-development outcomes set out in the ADS (based on a single storage area).

The ADS also identified a sub-catchment upstream of the ODP area (labelled as Lander St), overflow from which is assumed to drain across the ODP area and into the Balannup Lake Drain.

The ADS indicates that the anticipated peak (100yr) flow from the Stirling St North sub-catchment would be 0.1m^3/s, and 0.4m^3/s from the Lander St sub-catchment – resulting in a cumulative discharge of 0.5m^3/s into the Balannup Lake Drain.

This information is summarised in Figure 15.

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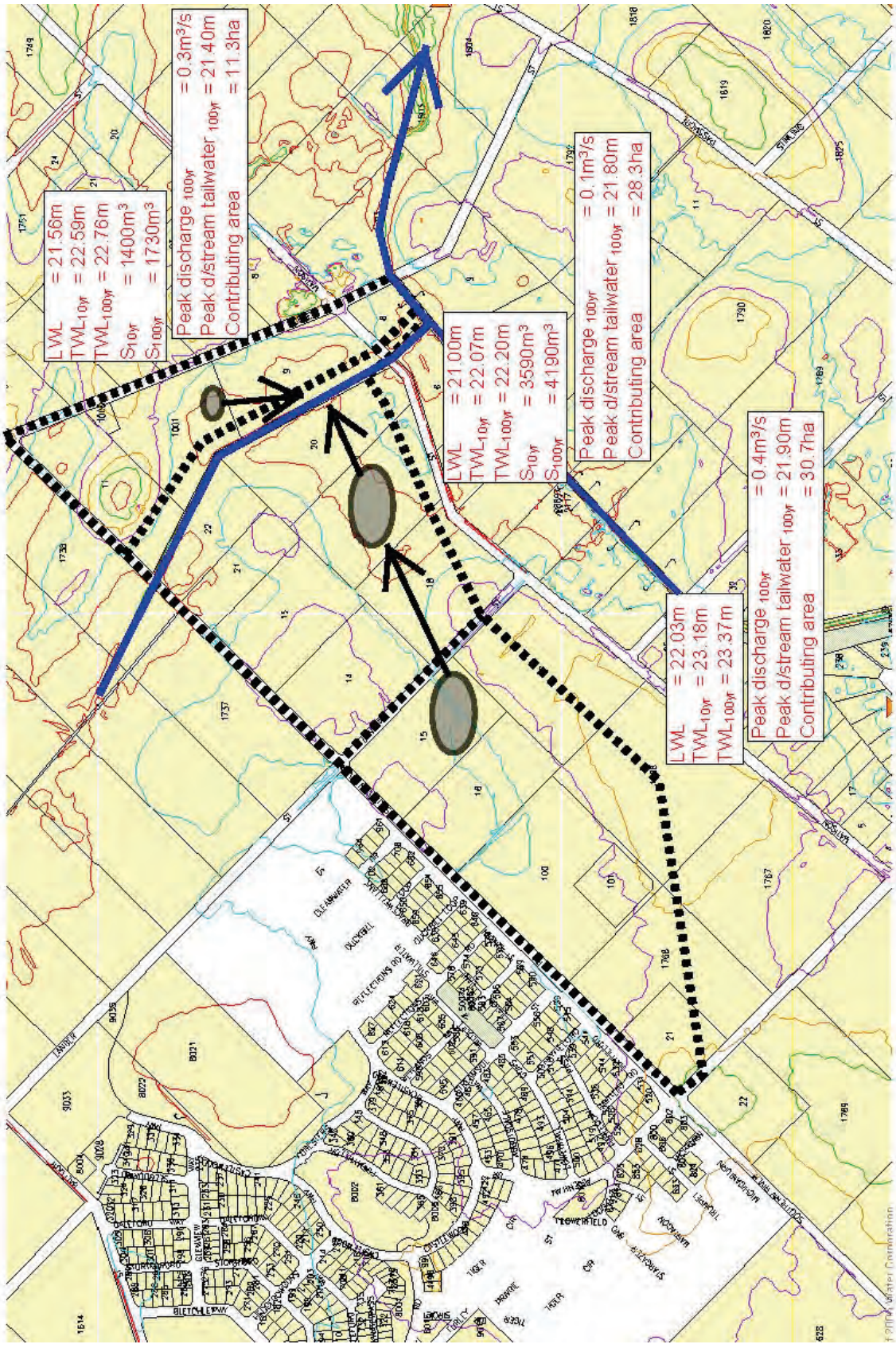

Figure 15: ADS Catchment Planning

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6.2. Modelling

Specific stormwater modelling has been carried out for the ODP area as part of the preparation of this LWMS document - using the XP SWMM software. Using the HGL and flow details for the receiving waters (i.e. the Balannup Lake Drain) that were specified in the ADS, stormwater detention requirements were then calculated. This modelling suggested that a higher level of attenuation is required than what was outlined in the ADS document. The results of the LWMS modelling are summarised as follows, and shown in Figure 16.

Table 7: Stormwater Detention Requirements

	Detention Volume	Detention Area
1yr ARI event	870 m^3	2,890m^2
5yr ARI event	3,760 m^3	8,640m^2
100yr ARI event	7,040 m^3	16,180m^2

The detention areas noted in Table 7 above were based on a maximum basin depth of 0.9m, and 1:6 side slopes.

With these storage provisions, flows from the ODP area are calculated to be as follows.

Peak flow from 5yr 48 hr ARI event: 120 L/s
Peak flow from 100yr 48 hr ARI event: 135 L/s

The modelling done for the ADS assumed that residential lots retain & infiltrate most of their runoff onsite, and adopted an equivalent runoff coefficient of 20% for all urban (i.e. lot) areas. Correspondence from the City of Gosnells has advised that smaller residential lots should adopt a runoff coefficient of 80%, and the remainder of lots adopt a runoff coefficient of 15%. These coefficients have been applied to the lots in Precinct 3E, with the higher runoff coefficient being applied to the proposed R40 lots. This approach resulted in an estimated storage volume that is significantly higher than the proposed storage volume recommended in the ADS.

Key modelling parameters are detailed in Appendix 11.

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These more conservative detention requirements have been adopted for the purpose of developing the ODP. It is noted though that the Dept of Water has suggested that an approach be made to the Water Corporation and/or GHD to access the more detailed information associated with the ADS modelling - to see whether there might be justification for the adoption of lesser values. It is proposed that these inquiries, along with further refinement of lot runoff coefficients, be followed through as part of the preparation of the subsequent Urban Water Management Plan (UWMP) for the site.

6.3. Lot Connection Strategy

Site investigation has identified that soakwells would be a viable option for the infiltration of roof runoff, subject to further fill being placed on proposed lots (where necessary) to establish an adequate separation to groundwater.. It is therefore proposed that no formal lot connections be provided for the lots that will be created within the ODP area.

Whilst the sub-surface investigation did identify the presence of “coffee rock” in several locations, it is anticipated that the excavation of trenches for sewer installation will penetrate this material in sufficient locations to ensure it does not lead to problems with perched water levels

The City has indicated that where there is not at least 2m separation between the anticipated AAMGL/CGL and finished level of lots, then there is a risk that soakwells may not perform effectively in all conditions. The City has asked that development (i.e. house construction) on such lots incorporate a formal overflow arrangement whereby runoff collected in soakwells can be conveyed from the properties towards road gutters. This can be achieved by linking each of the soakwells together and constructing one (in the front yard) with a grated lid to allow surplus runoff to surcharge out of the soakwell and across to the road. This overflow pit is ideally located within the driveway pavement, as this then provides an obvious route for surface flows to reach the road gutter.

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Figure 16: Post Development Catchment & Detention Details

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COMBINED INUNDATION AREAS

1 Year ARI = 2890m²
5 Year ARI = 11140m²
100 Year ARI = 17260m²

100yr ARI FLOODED AREA



-30 0 30 60 90 120 150 m
1:1500

REV	REVISION	DATE	APPROVED
C	CATCHMENT DETAILS CHANGED	2/05/11	GH
B	BASIN AREAS AMENDED		GH
A	ISSUED FOR APPROVAL	24/09/10	GH

CLIENT: DEPARTMENT OF HOUSING

DRAWN	J. Robertson
DESIGNED	K. White
CHECKED	G. Hall
APPROVED	
DATE	

TITLE: SOUTHERN RIVER PRECINCT 3E ODP
POST DEVELOPMENT STORMWATER RUNOFF
CATCHMENT & DETENTION REQUIREMENTS

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ORIGINAL SHEET SIZE	A1
DO NOT SCALE	
SCALE	1:1500
LEVEL DATUM	AHD
SHEET	OF
DRAWING No	7683-50
REV	C

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6.4. Stormwater and Sub-surface Water Treatment

Stormwater runoff from within the development is proposed to be conveyed to various detention areas within the ODP area, where it will be detained until it either infiltrates into the groundwater table or flows out into the Balannup Lake Drain. The largest of these detention areas will occupy the central POS area that straddles Lots 19 & 20. Two other small detention areas are proposed to be created alongside the Balannup Lake Drain.

Whilst the opportunity exists to introduce roadside treatment structures across the ODP area to encourage infiltration at source, the City is presently unsure as to what form such structures should take. It is trialling the use of rain gardens and tree pits elsewhere at present and it is hoped that preferred structures might be identified prior to the subdivision and development of this Site. For the purposes of this LWMS though, it is assumed that all runoff is conveyed to the main detention areas for treatment and disposal. Treatment will be achieved via the placement of appropriate soils and plantings in the vicinity of each stormwater outlet. As per requirement, the area that is inundated by runoff from the 1yr ARI event has been deducted from POS calculations. Surface stormwater flow paths and finished lot levels can be seen in figure 17.

Treatment of sub-surface flows is not proposed. The subsoil drainage infrastructure will be a separate system, so sub-surface flows will not be mixed with surface runoff. Discharge will be directly into the Balannup Lake Drain.

It is noted that the invert of proposed subsoil drains should be close to estimated maximum groundwater levels, therefore these drains should only carry flows following infiltration from heavier rainfall events.

6.5. Detention Areas

The main detention area occupies the lowest part of the ODP area. Following discussions with the City, the value of retaining existing vegetation in this area has been acknowledged. Hence, the detention area is effectively being created by filling of the proposed development areas on either side of the POS corridor, and by constructing a berm between the Balannup Lake Drain and the POS. This berm serves

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to hold runoff within the ODP area so that required limits on peak flows into the Drain can be met.

This low-lying area will act as an ephemeral wetland, with existing vegetation supplementary by complementary landscaping at time of subdivision. Subsoil drainage is proposed to be installed along the edges of this area to ensure problems with long-standing water do not eventuate.

These details are illustrated in Figure 18, 19 and 20, which show the detention area with inundated areas, Balannup lake drain cross sections and subsoil drainage layout.

Stormwater runoff which is conveyed to this detention area will disperse across the largely flat area of the POS. Once the water ponds to a certain level, it will develop sufficient 'head' to drain out to the Balannup Lake Drain. As water levels fall back down again, flows to the Drain will cease and the water will simply pond across the detention area until it infiltrates into the groundwater or is lost to evaporation.

The other two detention areas will follow the same principles, but will be bounded by retaining structures forming vertical sides to the detention area. The enclosed areas will be heavily planted as they do not form part of the public open space and access will not be encouraged.

Outflows to the Balannup Lake Drain will be via culverts located in the berms that separate the detention areas from the Drain. The invert level of these culverts will allow for water in the Drain to backflow into the detention areas when the Drain is "in flood". This effect has been considered in the modelling of the ODP.

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Figure 17: Stormwater Surface Flows and Finished Lot Levels

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LEGEND

- DIRECTION OF STORMWATER FLOWS
- 23.00 INDICATIVE FINISHED LEVELS
- CATCHMENT BOUNDARY

SOUTHERN RIVER ROAD

LANDER STREET

MATISON STREET

BALANNUP LAKE DRAIN

HOLMES STREET

23.00 23.00 23.00 22.50 23.50

23.00 23.00 22.50

23.25 23.50 23.00 22.50

23.25 22.00 22.00

23.00 23.50 23.00

23.00 22.00

22.75 22.50

22.00

-25 0 25 50 75 100 125m
1:1250

REV	REVISION	DATE	APPROVED
A	ISSUED FOR APPROVAL		

CLIENT: DEPARTMENT OF HOUSING
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DRAWN
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TITLE: SOUTHERN RIVER PRECINCT 3E ODP
FINISHED LEVELS & FLOW PATH DETAILS

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WAPC No

ORIGINAL SHEET SIZE A1
DO NOT SCALE

SCALE 1:1250
LEVEL DATUM : AHD
SHEET OF
DRAWING No 7683-71
REV A

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Figure 18: Detention Area with Inundation

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LEGEND

1 Year

5 Year

100 Year



-10 0 10 20 30 40 50m

1:500

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INUNDATION AREAS

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SCALE 1:500
LEVEL DATUM : AHD
SHEET OF
DRAWING No 7683-72
REV A

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Figure 19: Cross Section Through POS/Balannup Lake Drain Interface

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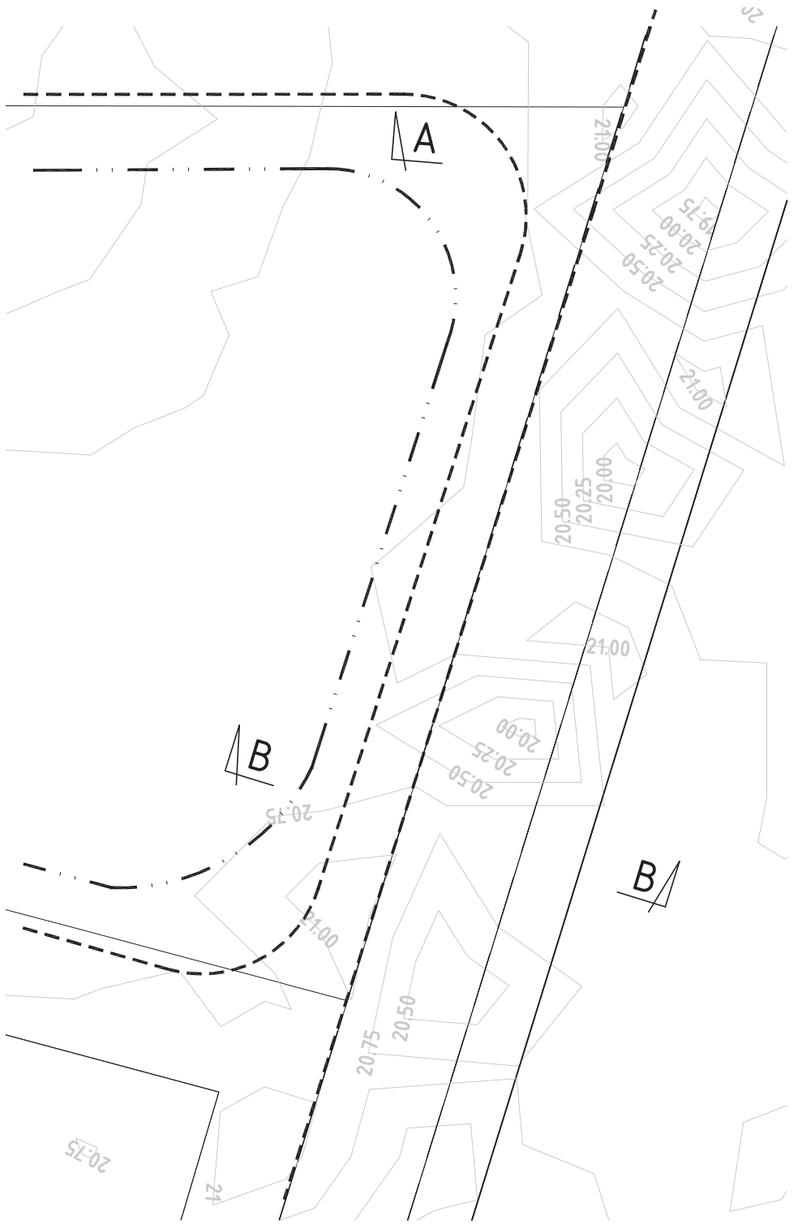
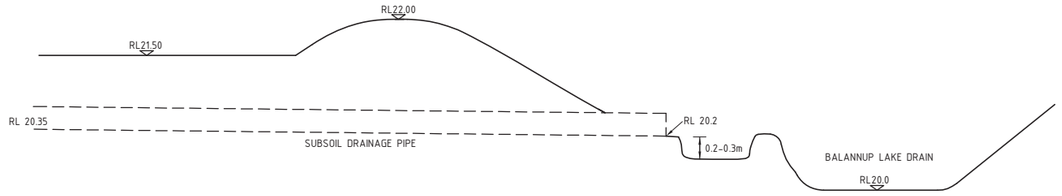
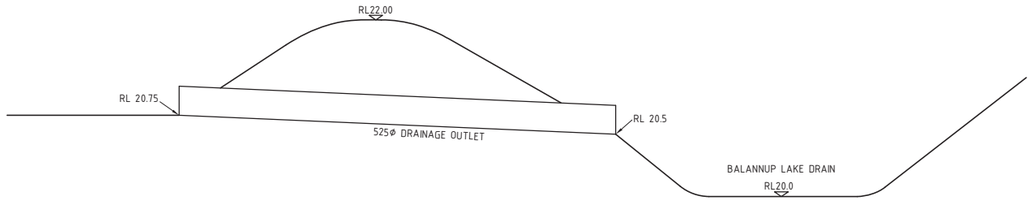


PLAN



SUBSOIL OUTLET
SECTION A-A



BASIN/WETLAND OUTLET
SECTION B-B

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TITLE
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CROSS SECTION THRU POS/BALANNUP
LAKE DRAIN INTERFACE

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ORIGINAL SHEET SIZE	A1
DO NOT SCALE	
SCALE	N.T.S
LEVEL DATUM	AHD
SHEET	OF
DRAWING No	7683-73
REV	A

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

Figure 20: Subsoil Drainage Details

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LEGEND

S — PROPOSED SUBSOIL DRAINAGE & INVERT

MAXIMUM ESTIMATED GROUNDWATER LEVELS

SOUTHERN RIVER ROAD

MATISON STREET

LANDER STREET

MATISON STREET

MATISON STREET

21.5 21.0 20.90 21.05 20.85 20.75 20.5 21.70 21.30 21.15 20.90 21.40 21.30 20.50 20.20 20.90 20.80 20.20 21.10 21.00 21.5 21.0 20.5

REV	REVISION	DATE	APPROVED
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TITLE

SOUTHERN RIVER PRECINCT 3E ODP
SUBSOIL DRAINAGE DETAILS

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ORIGINAL SHEET SIZE	A1
DO NOT SCALE	
SCALE	1:500
LEVEL DATUM :	AHD
SHEET	OF
DRAWING No	7683-70
REV	A

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6.6. Proposed Finished Levels

The predicted water level in the Balannup Lake Drain in the 100yr ARI event dictates the minimum development level. With this level being calculated at RL21.38, no habitable area should be located at less than RL 21.88m. (Figure 17)

Figure 10 identifies the estimated maximum groundwater levels, which range from RL20.3m adjacent to the Balannup Lake Drain to RL21.6m along the Lander Street frontage. Ideally finished lot levels will be 2m above these levels to ensure effective soakwell performance.

Achieving these finished levels will require the importation of fill. This fill material should comprise clean free-draining granular soil that has a permeability of at least 1m/day. Ideally, the fill material should also have a phosphorous retention index [PRI] that is better than a typical Bassendean sand. It is, however, recognised that sand fill is a rapidly diminishing material within the Perth metropolitan area. The developer may be forced to use whatever sand material are available at the time. The subsequent treatment of the surface layout at the time of landscaping the open space areas within the development (to aid in phosphorous retention) is likely to be a more pragmatic approach. Bioscience is continuing to develop techniques which aid in restoring the natural resilience of native soils and their ability to hold nutrients.

6.7. Emergency Access

It is not anticipated that a major stormwater event would cause any unmanageable nuisance to road users. Any flooding over road pavement would be limited to shallow ponding and/or gutter flows. Stormwater detention areas are of sufficient size to fully contain the runoff from a 100yr ARI event without spreading out onto roadways.

The greatest depth of water over roads will occur as a result of stormwater runoff passing through the ODP area from the area south of Lander Street. This may see water depths of up to 200mm across the affected local roads, but this will be reduced where it crosses over the main “east-west” road [ROAD A as labelled on the ODP] via the upsizing of a pipe culvert under this road.

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7. GROUNDWATER MANAGEMENT

There are three primary objectives for groundwater protection and management for the proposed development, these include:

- Protection of infrastructure and assets from flooding and inundation which may be brought about by high groundwater levels.
- Protection of groundwater dependent ecosystems from modified run-off following development.
- Maintaining and managing groundwater levels and quality following development.

Subsoil drains are proposed to be constructed across the ODP area to ensure that groundwater levels do not rise above the estimated maximum levels as a result of urban development. This is necessary to ensure the ongoing performance of soakwells which will be used to infiltrate stormwater runoff from rooved areas on proposed lots.

The subsoil drains will outflow into the Balannup Lake Drain. It will be ensured that the subsoil drains have a "free-flowing" outlet.

The subsoil drainage infrastructure will be constructed independently of the conveyance infrastructure for surface flows. This means that the flows in the subsoil drains do not require treatment, and that flatter gradients can be used for the construction of these drains given there should be no sediment load

7.1. Protection of Infrastructure and Assets

The depth to groundwater (greater than 1.2m BGL in most areas, see Figure 10 and 11) and good infiltration potential decreases the potential risk of damage to infrastructure to flooding. The implementation of controlled groundwater levels (CGL) within a development area is dependent on a range of local and site conditions including the soil type and its relationship to groundwater levels (regional and/or perched), the presence of ASS, the existence of pollutants or nutrients within groundwater, and the need to protect wetlands and groundwater dependant ecosystems.

According to the ILWMP there is a requirement to determine the controlled groundwater levels for the development area, to enable the setting of minimum

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drainage invert levels and to calculate the extent of land filling requirements. We propose establishing a CGL at pre-development AAMGL within the development area; however this will continue to be updated and refined throughout the UWMP process.

Despite the control of groundwater levels, flooding still remains a risk to infrastructure. The primary method of protecting buildings/infrastructure from flooding and inundation is through the implementation of an acceptable separation distance between the AAMGL and the base of the building foundations and infrastructure. This separation distance is required to maintain free-draining soils, to allow for the installation of underground services, avoid water-logging and encourage soil filtration/aerobic microbial action to attenuate leached contaminants. In areas where insufficient separation exists between AAMGL and natural surface levels, engineering fill will be required.

7.2. Protection of Groundwater-Dependent Ecosystems

While it is acknowledged that development in the district structure plan area will require some degree of groundwater management to protect infrastructure and assets, care should be taken to maintain the requirements of groundwater dependent ecosystems.

An increase in groundwater levels may result in upland vegetation being unable to tolerate wetland like conditions; likewise a decrease to groundwater levels may result in wetland vegetation being unable to tolerate dryer conditions. It is likely that the majority of remnant vegetation within the proposed POS located on lot 19 is to some extent dependent on shallow groundwater, whereas the remnant vegetation within the proposed POS located on lot 13 at its maximum is at least 2m above groundwater levels and thus dependent on upland conditions.

Post-development groundwater levels may decrease due to an increase in abstraction of groundwater for residential irrigation (particularly during summer), or due to the control of groundwater levels thought discharge into existing drains (during winter) and increase due to greater stormwater infiltration.

Several considerations have been proposed to minimise the impacts of the development on groundwater levels. To protect upland and wetland vegetation alike there will be no construction of subsurface drains below AAMGL; and secondly, to

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discourage residential use of superficial groundwater for irrigation and in the alternative be encouraged to adopt water wise gardening practice.

7.3. Groundwater Quantity

Post-development annual discharge volume and peak flow be maintained relative to pre-development conditions, unless otherwise established through determination of ecological water requirements for sensitive environments (DoW, 2008).

7.4. Groundwater Quality

Flows from the subsoil drainage infrastructure that will be installed to maintain the CGL and aid in keeping infiltration areas free-draining will be directed through appropriate treatment structures prior to be discharged into the Balannup Lake Drain.

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8. WETLAND AND ENVIRONMENTAL WATER MANAGEMENT

There are no Conservation Category Wetlands (CCW) or Environmental Protection Policy lakes (EPP) within the development area. There is however a CCW located approximately 200m east of lot 20.

A rehabilitation wetland (RW) is located on the proposed development site. Surveys undertaken for the Department of Housing by Bioscience (2009) indicate that this RW is in poor condition. Consequently this area is proposed to become a living stream within a POS corridor.

Directly north of the site is a Local Authority drain with an approximate depth of 19.6m ADH or 0.9m below AAMGL. The purpose of this drain is to remove surface water from the surrounding area and direct it towards the Forrestdale drain, where it is redirected into the Southern River. An Urban Water Management Strategy report from the Southern River/Forrestdale/Brookdale/Wungong Structure Plan titled "Impact of Existing Drains and Proposed Living Streams on Groundwater Table and Nutrient Export" (JDA, 2002) specifies the drawdown influence of drains of varying depths within this region. Their results can be used to estimate desirable drain depth and distances from significant environmental features such as CCW to provide protection from groundwater lowering (Table 3). Consequently, it can be used in the reverse manner to deduce the impact a drain has on a wetland given its invert below AAMGL and distance are known.

In relation to the site, the drain invert is approximately 0.9 m below AAMGL, consequently, groundwater levels within 1km of this drain will be reduced logarithmically from between 0.57m to 0.08m, and this has a significant drying effect of the REW located on the site.

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9. CONSTRUCTION MANAGEMENT

9.1. Imported Fill Material and Compaction

The permeability of imported soil is an important consideration, particularly where there is a shallow depth to groundwater. The permeability of a soil is proportional to the amount of fine particles (i.e. <0.075mm) within a soil. If needed, Bioscience considers most sandy soils on site are suitable fill material as they contains less than 5% fines, have a maximum particle size of less than 10 mm and are mostly free of any organic or deleterious material. Several upland area on site have been identified as being suitable for fill excavation, as they have natural sand cover and a distance to AAMGL of greater than 2m (Figure 10).

Fill materials, placement and compaction methods and quality control should apply with relevant structure fill requirements according to standard industry practice and AS 3798 “Guidelines on Earthworks for Commercial and Residential Developments”. The fill should generally be placed in loose layers not exceeding 300mm thickness and each layer should be compacted with suitable equipment to a minimum of 95% modified maximum density or 70% density index as appropriate.

9.2. Dewatering

Throughout the construction phase of the development dewatering may be required. Prior to the commencement of any dewatering a licence to take water will be required through application to DoW. If possible, site preparation should occur during dry periods to reduce or eliminate dewatering requirements. Should dewatering be required, care must be taken to ensure neighbouring wetlands or groundwater dependent ecosystems are not adversely affected.

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10. MONITORING

A monitoring program has been designed in accordance with the joint Australian/New Zealand Standards (1998 a, b, c) to allow quantitative assessment of hydrological impacts of proposed development within the area. In particular the program addresses the monitoring of surface water quality, and seasonal fluctuation of groundwater levels and quality within the development area. The program may need to be modified as data is collected to increase or decrease the monitoring effort in a particular area or to alter the scope of the program itself. Any modification to the program would require the agreement of all parties (DoW, CoG, and the developer). The program is designed to operate over a three year post-development period including construction to allow for time lag for full impacts of development on the receiving environment to occur (Table 8).

Table 8: Monitoring Schedule

Monitoring Type	Parameter	Location	Method	Frequency	Reporting
Groundwater Levels	Water levels (mAHD)	25 monitoring bores pre-development and 10 monitoring bores post-development providing spatial coverage.	Water Interface Probe/meter	Monthly for 2 pre-development and 3 years post-development.	Annual assessment reports to be submitted to DoW & CoG for 3 years post-development. Suitability of existing monitoring and reporting frequencies to be assessed annually with any modifications requiring agreement by all parties (DoW,CoG, & Developer)
Groundwater Quality	pH, EC, Nitrogen, Phosphorus, major Cation and Anions	25 monitoring bores pre-development and 10 monitoring bores post-development providing spatial coverage	Pumped bore sample	Quarterly for 2 pre-development and 3 years post-development (typically Jan, Apr, Jul and Oct).	
Surface Water Quality	pH, EC, TSS, Nitrogen, Phosphorus, major Cation and Anions	At inflow points to infiltration and/or water quality treatment areas and, at outflow from the water quality treatment areas.	Surface collection	Monthly sampling when flowing, typically June to October for 5 years. Frequency to be reviewed following initial 12 month sampling period.	
POS Usability	Water levels (mAHD)	Water level recorder at POS flood storage area frequency and duration of inundation to be assessed.	Continuous water level measurements via water level data logger and periodic visual inspections.	3 years post-development	
Vegetation	Number of dead plants and weeds	Areas where plants have been planted in POS areas.	Visual inspection	3 years post-development	
Erosion	Signs of erosion	Along the entire drainage corridor.	Visual inspection	3 years post-development	

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11. IMPLEMENTATION

Details regarding the roles and responsibilities are detailed in table 9 below.

Table 9: Table of Responsibility			
Item	**Development**	**Interim Maintenance (first three years)**	**Long-term Maintenance**
Waterwise Fittings	Developer in consultation with Residents	Residents	Residents
Landscaping Packages	Developer	Residents	Residents
Rainwater tanks	Developer in consultation with Residents	Residents	Residents
Swales and Drainage	Developer	Developer	Council
Monitoring the Development	Developer	Developer	Council

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12. FUTURE WORK - SUBDIVISION AND UWMP

The following actions will need to be taken as part of preparing the Urban Water Management Plan for this development.

- Detailed landscaping plans need to be prepared for each of the detention areas, for consultation with the City of Gosnells.
- The City of Gosnells needs to be consulted on possible options for roadside treatment structures that will allow infiltration at source.
- The Water Corporation needs to be consulted as to its latest modelling of the performance of the Forrestdale Main Drain and in particular any impacts on the Balannup Lake Drain that may alter recommendations in the ADS.
- The post-development monitoring plan requires more detail as the subdivision is refined, when post-development monitoring bores are able to be selected, once the structure plan is finalised.
- Identifying potential enforcement methods to ensure water wise initiatives are implemented by residents.

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13. REFERENCES

Ahern C.R., Stone, Y., Blunden, B., (1998) Acid Sulphate Soil Assessment Guidelines. In "*Acid Sulphate Soils Manual 1998*". 99, 56-58 (Acid Sulphate Soil Management Advisory Committee: Wollongbar, NSW.

Davidson, WA & Yu, X (2006) *Perth regional aquifer modelling system (PRAMS) model development: Hydrogeology and groundwater modelling*, Department of Water, Western Australia, Hydrogeological record series no. HG 20.

Department of Water (2008) Interim: Developing a local water management strategy.
Joint Australian/New Zealand Standard (1998a) Water quality - sampling, part 1: guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples. (AS/NZS 5667.1:1998).

Department of Water (2009): Forrestdale Main Drain Arterial Drainage Strategy (Nov 2009)

Joint Australian/ New Zealand Standard (1998b) Water quality - sampling, part 6: guidance on sampling of rivers and streams. (AS/NZS 5667.6:1998).

Joint Australian/ New Zealand Standard (1998c) Water quality - sampling, part 11: guidance on sampling of groundwater. (AS/NZS 5667.11:1998)

Rockwater (2005) Southern River Development Area: Groundwater modelling to assess effects of climatic variations and planned developments.

Summers RN, Smirk DD, Karafilis D (1996) Phosphorus retention and leachates from sandy soil amended with bauxite residue (red mud). *Australian Journal of Soil Research* **34**, 555–567.

Water Corp Forrestdale Main Drain Arterial Drainage Strategy Maps (Aug 2009)

Western Australian Planning Commission (2008) Better Urban Water Management.

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Version: 1, Version Date: 24/07/2026

Appendix 1 – Groundwater Data (m AHD)

	31/10/2008	*11/11/2008*	*9/03/2009*	*9/04/2009*	*7/05/2009*	*12/06/2009*	*7/07/2009*	*5/08/2009*	*4/09/2009*	*9/10/2009*	*6/11/2009*	*15/12/2009*	*13/01/2010*
DHW 1	20.480	20.524	#N/A	18.490	18.377	18.340	18.985	19.941	20.671	20.671	20.065	19.528	18.998
DHW 2	20.369	20.450	19.167	19.017	#N/A	#N/A	19.577	20.204	20.764	20.639	20.237	19.913	19.631
DHW 3	19.835	19.813	19.856	19.708	19.656	19.634	20.112	20.418	20.667	20.564	20.289	#N/A	19.687
DHW 4	20.381	20.405	19.390	#N/A	#N/A	#N/A	19.673	20.115	20.526	20.655	20.326	20.033	19.769
DHW 5	20.294	20.330	19.513	19.296	19.092	19.074	19.774	20.314	20.706	20.718	20.473	20.183	19.926
DHW 6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	20.876	21.305	21.348	21.088	20.816	20.531
DHW 7	#N/A	#N/A	#N/A	20.062	19.914	19.828	20.148	20.821	21.204	21.265	21.017	20.764	20.514
DHW 8	#N/A	#N/A	#N/A	19.925	19.783	19.696	20.014	20.623	21.029	21.131	20.878	20.661	20.388
DHW 9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	20.017	20.680	21.065	21.108	20.874	20.615	20.375
DHW 10	#N/A	#N/A	#N/A	19.742	19.600	19.520	19.981	20.544	20.915	20.956	20.714	20.465	20.219
DHW 11	#N/A	#N/A	#N/A	#N/A	19.303	19.292	19.800	20.277	20.654	20.683	20.443	20.181	19.938
DHW 12	#N/A	#N/A	#N/A	19.424	19.310	18.921	19.949	20.348	20.722	20.662	20.420	20.157	19.868
DHW 13	#N/A	#N/A	#N/A	18.820	18.729	18.934	19.790	20.206	20.447	20.351	20.055	19.668	19.268
DHW 14	#N/A	#N/A	#N/A	19.200	#N/A	#N/A	19.502	20.094	20.382	20.325	20.087	19.851	19.562
DHW 15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	19.856	20.122	20.080	19.867	19.602	19.502
DHW 16	#N/A	#N/A	#N/A	#N/A	#N/A	19.990	20.623	20.884	21.303	21.242	20.990	20.786	20.550
DHW 17	#N/A	#N/A	#N/A	#N/A	#N/A	18.904	19.775	20.251	20.744	20.584	20.094	19.800	19.451
DHW 18	#N/A	#N/A	#N/A	#N/A	#N/A	20.072	20.527	20.962	21.274	21.313	21.108	20.860	20.650
DHW 19	#N/A	#N/A	#N/A	#N/A	#N/A	18.467	19.751	20.093	20.597	20.441	19.867	19.589	19.239
DHW 20	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	19.084	20.115	20.549	20.388	19.985	19.539	18.908
DHW 21	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	19.051	20.013	20.488	20.306	19.905	19.457	18.650
DHW 22	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	18.999	19.758	20.130	20.071	19.792	19.470	19.095
DHW 23	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	19.298	19.985	20.307	20.128	19.729	19.216	18.729
DHW 24	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	19.749	20.086	20.242	20.053	19.771	19.458	18.980
DHW 25	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	19.130	19.866	20.337	20.366	20.017	#N/A	19.056

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Appendix 2 – Groundwater Data (m GBL)

	31/10/2008	*11/11/2008*	*9/03/2009*	*9/04/2009*	*7/05/2009*	*12/06/2009*	*7/07/2009*	*5/08/2009*	*4/09/2009*	*9/10/2009*	*6/11/2009*	*15/12/2009*	*13/01/2010*
DHW1	0.465	0.421	#N/A	2.193	2.306	2.343	1.698	0.742	0.012	0.012	0.618	1.155	1.685
DHW2	0.730	0.649	#N/A	2.096	#N/A	#N/A	1.536	0.909	0.349	0.474	0.876	1.200	1.482
DHW3	1.241	1.263	1.838	1.936	1.988	2.010	1.532	1.226	0.977	1.080	1.355	#N/A	1.957
DHW4	1.354	1.330	2.973	#N/A	#N/A	#N/A	2.098	1.656	1.245	1.116	1.445	1.738	2.002
DHW5	0.935	0.899	2.230	2.189	2.393	2.411	1.711	1.171	0.779	0.767	1.012	1.302	1.559
DHW6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.113	0.684	0.641	0.901	1.173	1.458
DHW7	#N/A	#N/A	#N/A	3.184	3.332	3.418	3.098	2.425	2.042	1.981	2.229	2.482	2.732
DHW8	#N/A	#N/A	#N/A	3.427	3.569	3.656	3.338	2.729	2.323	2.221	2.474	2.691	2.964
DHW9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	3.443	2.780	2.395	2.352	2.586	2.845	3.085
DHW10	#N/A	#N/A	#N/A	3.148	3.290	3.370	2.909	2.346	1.975	1.934	2.176	2.425	2.671
DHW11	#N/A	#N/A	#N/A	#N/A	2.297	2.308	1.800	1.323	0.946	0.917	1.157	1.419	1.662
DHW12	#N/A	#N/A	#N/A	1.959	2.073	2.462	1.434	1.035	0.661	0.721	0.963	1.226	1.515
DHW13	#N/A	#N/A	#N/A	2.048	2.139	1.934	1.078	0.662	0.421	0.517	0.813	1.200	1.600
DHW14	#N/A	#N/A	#N/A	2.326	#N/A	#N/A	2.024	1.432	1.144	1.201	1.439	1.675	1.964
DHW15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.302	1.036	1.078	1.291	1.556	1.656
DHW16	#N/A	#N/A	#N/A	#N/A	#N/A	1.886	1.253	0.992	0.573	0.634	0.886	1.090	1.326
DHW17	#N/A	#N/A	#N/A	#N/A	#N/A	1.908	1.037	0.561	0.068	0.228	0.718	1.012	1.361
DHW18	#N/A	#N/A	#N/A	#N/A	#N/A	2.368	1.913	1.478	1.166	1.127	1.332	1.580	1.790
DHW19	#N/A	#N/A	#N/A	#N/A	#N/A	2.087	0.803	0.461	-0.043	0.113	0.687	0.965	1.315
DHW20	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.647	0.616	0.182	0.343	0.746	1.192	1.823
DHW21	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.609	0.647	0.172	0.354	0.755	1.203	2.010
DHW22	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.751	0.992	0.620	0.679	0.958	1.280	1.655
DHW23	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.484	0.797	0.475	0.654	1.053	1.566	2.053
DHW24	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.798	0.461	0.305	0.494	0.776	1.089	1.567
DHW25	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	2.659	1.923	1.452	1.423	1.772	#N/A	2.733

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Appendix 3 – Statistical Analysis of DoW monitoring bore T75 (Win ID 4880).

Maximum Groundwater Recurrence Intervals				*Minimum Groundwater Recurrence Intervals*			
Year	**Max Groundwater Levels (m AHD)**	**Recurrence Interval (years)**	**Groundwater Level (m AHD)**	**Year**	**Min Groundwater Levels (m AHD)**	**Recurrence Interval (years)**	**Groundwater Level (m AHD)**
1994	19.317	1	18.21	1980	16.63	1	15.79
1992	19.267	1.02	18.42	1978	16.64	1.02	16.32
1978	19.167	1.04	18.48	1982	16.67	1.04	16.47
1991	19.097	1.06	18.52	1981	16.73	1.06	16.57
1984	19.047	1.08	18.55	1977	16.76	1.08	16.65
1996	19.037	1.1	18.57	1983	16.82	1.1	16.71
2003	18.987	1.2	18.65	1988	16.85	1.2	16.92
1986	18.977	1.3	18.70	1987	16.88	1.3	17.05
1999	18.957	1.4	18.73	1991	17.03	1.4	17.15
1980	18.947	1.5	18.76	1989	17.04	1.5	17.23
1993	18.947	1.6	18.79	1984	17.06	1.6	17.29
1975	18.937	1.7	18.81	1976	17.26	1.7	17.35
1983	18.937	1.8	18.82	1986	17.28	1.8	17.40
2001	18.927	1.9	18.84	1979	17.38	1.9	17.44
2000	18.877	2	18.85	1995	17.39	2	17.48
1988	18.857	3	18.94	1994	17.43	3	17.75
2002	18.857	4	19.00	1985	17.44	4	17.90
1981	18.831	5	19.03	1975	17.53	5	18.01
1995	18.817	6	19.06	1998	17.69	6	18.09
2005	18.807	7	19.08	1990	17.81	7	18.16
1985	18.787	8	19.10	1993	17.81	8	18.21
1987	18.787	9	19.11	1992	17.83	9	18.26
2004	18.767	10	19.13	1999	17.83	10	18.30
1997	18.727	20	19.20	2000	18.06	20	18.54
1979	18.697	30	19.25	2003	18.12	30	18.67
1990	18.677	40	19.27	1996	18.16	40	18.76
2006	18.637	50	19.29	1997	18.17	50	18.82
1998	18.627	60	19.31	2001	18.19	60	18.87
1982	18.597	70	19.32	2006	18.27	70	18.92
1976	18.567	80	19.33	2004	18.40	80	18.95
1989	18.457	90	19.34	2002	18.41	90	18.99
1977	18.407	100	19.35	2005	18.68	100	19.01

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Appendix 4 – Site AALGL, AAMGL and 1 in 100 ARI Calculations.

AALGL				*AAMGL*				*1 in 100 ARI*			
Site	**June 09 Data**	**% Difference**	**AALGL**	**Site**	**Oct 09 Data**	**% Difference**	**AAMGL**	**Site**	**Oct 09 Data**	**% Difference**	**1 in 100**
T75	18.25	0.95781	17.48	T75	19.12	0.98564	18.85	T75	19.12	1.01179	19.35
DHW1	18.34	0.95781	17.57	DHW1	20.671	0.98564	20.37	DHW1	20.671	1.01179	20.91
DHW2	#N/A	0.95781	#N/A	DHW2	20.639	0.98564	20.34	DHW2	20.639	1.01179	20.88
DHW3	19.634	0.95781	18.81	DHW3	20.564	0.98564	20.27	DHW3	20.564	1.01179	20.81
DHW4	#N/A	0.95781	#N/A	DHW4	20.655	0.98564	20.36	DHW4	20.655	1.01179	20.90
DHW5	19.074	0.95781	18.27	DHW5	20.718	0.98564	20.42	DHW5	20.718	1.01179	20.96
DHW6	#N/A	0.95781	#N/A	DHW6	21.348	0.98564	21.04	DHW6	21.348	1.01179	21.60
DHW7	19.828	0.95781	18.99	DHW7	21.265	0.98564	20.96	DHW7	21.265	1.01179	21.52
DHW8	19.696	0.95781	18.86	DHW8	21.131	0.98564	20.83	DHW8	21.131	1.01179	21.38
DHW9	#N/A	0.95781	#N/A	DHW9	21.108	0.98564	20.80	DHW9	21.108	1.01179	21.36
DHW10	19.52	0.95781	18.70	DHW10	20.956	0.98564	20.66	DHW10	20.956	1.01179	21.20
DHW11	19.292	0.95781	18.48	DHW11	20.683	0.98564	20.39	DHW11	20.683	1.01179	20.93
DHW12	18.921	0.95781	18.12	DHW12	20.662	0.98564	20.37	DHW12	20.662	1.01179	20.91
DHW13	18.934	0.95781	18.14	DHW13	20.351	0.98564	20.06	DHW13	20.351	1.01179	20.59
DHW14	#N/A	0.95781	#N/A	DHW14	20.325	0.98564	20.03	DHW14	20.325	1.01179	20.56
DHW15	#N/A	0.95781	#N/A	DHW15	20.08	0.98564	19.79	DHW15	20.08	1.01179	20.32
DHW16	19.99	0.95781	19.15	DHW16	21.242	0.98564	20.94	DHW16	21.242	1.01179	21.49
DHW17	18.904	0.95781	18.11	DHW17	20.584	0.98564	20.29	DHW17	20.584	1.01179	20.83
DHW18	20.072	0.95781	19.23	DHW18	21.313	0.98564	21.01	DHW18	21.313	1.01179	21.56
DHW19	18.467	0.95781	17.69	DHW19	20.441	0.98564	20.15	DHW19	20.441	1.01179	20.68
DHW20	#N/A	0.95781	#N/A	DHW20	20.388	0.98564	20.10	DHW20	20.388	1.01179	20.63
DHW21	#N/A	0.95781	#N/A	DHW21	20.306	0.98564	20.01	DHW21	20.306	1.01179	20.55
DHW22	#N/A	0.95781	#N/A	DHW22	20.071	0.98564	19.78	DHW22	20.071	1.01179	20.31
DHW23	#N/A	0.95781	#N/A	DHW23	20.128	0.98564	19.84	DHW23	20.128	1.01179	20.37
DHW24	#N/A	0.95781	#N/A	DHW24	20.053	0.98564	19.77	DHW24	20.053	1.01179	20.29
DHW25	#N/A	0.95781	#N/A	DHW25	20.366	0.98564	20.07	DHW25	20.366	1.01179	20.61
		T75 AALGL	17.48			**T75 AAMGL**	18.85			**T75 1 in 100**	19.35
		Site Max	19.23			**Site Max**	21.04			**Site Max**	21.60
		Site Min	17.57			**Site Min**	19.77			**Site Min**	20.29

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Appendix 5 - SPOCAS Acid Sulfate Soil Results

Sample Name		*DHW1 300-400*	*DHW1 400-700*	*DHW1 700-800*	*DHW1 800-1500*	*DHW1 3200*	*DHW9 3800-3900*	*DHW12 1700-2500*	*DHW13 600-1600*	*DHW13 1600-2400*	*DHW13 2400-2900*	*DHW15 1800-2200*
pH	KCl	8.96	8.52	6.86	6.46	6.60	5.42	6.57	6.46	6.71	5.99	5.57
TAA	mol H+/t	<0.01	<0.01	<0.01	0.53	<0.01	8.58	<0.01	0.75	<0.01	0.91	64.44
	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10
	Mg	3.15	3.11	2.18	2.68	3.61	2.36	2.85	3.94	3.47	5.46	2.53
	Ca	0.46	0.53	0.28	0.32	0.57	0.25	0.64	0.81	0.87	0.85	0.48
pH	OX	5.57	5.48	5.36	5.09	4.40	2.46	2.43	3.43	5.39	5.15	2.01
TPA	mol H+/t	<0.01	<0.01	<0.01	<0.01	<0.01	81.77	44.20	<0.01	<0.01	<0.01	55.58
	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	0.13	0.07	<0.01	<0.01	<0.01	0.09
	Mg	3.48	3.70	2.00	2.92	6.34	2.76	1.78	3.73	2.95	4.72	3.60
	Ca	0.49	0.41	0.26	0.49	0.75	0.21	0.83	0.98	1.30	1.97	1.05
TSA	mol H+/t	<0.01	<0.01	<0.01	<0.01	<0.01	73.19	44.20	<0.01	0.00	<0.01	<0.01
	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	0.12	0.07	0.00	0.00	0.00	<0.01
	Mg	0.32	0.59	<0.01	0.24	2.73	0.41	<0.01	<0.01	<0.01	<0.01	1.07
	Ca	0.03	<0.01	<0.01	0.17	0.18	<0.01	0.19	0.17	0.42	1.11	0.57
Sulphate	S (T)	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.02	<0.01	<0.01	0.04	0.18
Carbon	C (T)	0.12	0.15	0.51	0.04	0.05	0.68	0.50	0.03	0.01	0.04	2.85

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Appendix 6 - Post Development Stormwater Modelling

1. Introduction

A conceptual stormwater drainage design has been completed for the Southern River Precinct 3E site, to estimate the areas which will need to be set aside within POS or road reserves to accommodate stormwater drainage. These storage areas have been designed to attenuate runoff from the developed site so that the peak discharge to the external drainage infrastructure is within pre-development levels.

The site is bounded by Southern River Road, Lander Street, Matison Street, and the Balannup Lake Drain, and stormwater from the site discharges to the Balannup Lake Drain along the site's northern boundary. The Balannup Lake Drain also conveys runoff from the Bletchley Park development and from catchments to the north and south of Precinct 3E, before the outfall to the Forrestdale Main Drain approximately 100m downstream of Matison Street.

The allowable flow rates for the site have been adopted from the Forrestdale Main Drain Arterial Drainage Strategy (DoW, 2009), which includes the Balannup Lake Drain the Precinct 3E catchment within the scope of the study.

2. Stormwater drainage design

Allowable flow rates for the site for the peak 10-year and 100-year ARI events were determined from the Forrestdale Main Drain Arterial Drainage Strategy (DoW, 2009). Table 0-1 below summarises the allowable flow rates from the Southern River Precinct 3E catchment area.

Table 0-1 - Allowable flow rates

	10year ARI	*100year ARI*
Allowable flow rate – per hectare of contributing catchment (L/s/ha)	5.1	6.5
Allowable flow rate- from Precinct 3E development (L/s)	110	140

To assess the impact of development on surface runoff, the post-development scenario was modelled using XP-Storm. If post-development peak flow rates exceed the allowable flow rates noted in Table 0-1 above, then on-site storage will be required to limit peak flows to within the allowable levels above.

Table 0-2 summarises the contributing catchment areas for the post-development scenario. These catchment areas and reference numbers are shown in Figure 14 of the LWMS.

Table 0-2 - Post-development catchment areas

Catchment number	*Road reserve area (ha)*	*Residential lot area – R30 & larger (ha)*	*Residential lot area – R40 & smaller (ha)*
1	1.01	1.84	0.77
2	2.74	3.72	1.15
3	1.40	0.14	1.29
4	0.66	1.07	0
5	0.26	0.17	0.29
6	0.74	1.65	0.64
7	0.17	0	0.33

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8	0.23	1.12	0.32
9	0.07	0	0.31

Depression storage & infiltration losses were applied to the different sub-catchments, as outlined in Table 0-3 below.

Table 0-3 - Post-development infiltration losses

Losses	*Road reserve*	*Residential lots – R30 & larger*	*Residential lots – R40 & smaller*
Initial loss	1 mm (depression storage)	17 mm (i.e. 1 yr 1 hr ARI rainfall)	17 mm (i.e. 1 yr 1 hr ARI rainfall)
Continuing loss	15% (i.e. 85% runoff)	85% (i.e. 15% runoff)	20% (i.e. 80% runoff)

Rainfall Intensity-Frequency-Duration (IFD) data was generated for the site from the Bureau of Meteorology's website – the IFD data used in the design calculations is shown in Table 0-4.

Table 0-4 - Rainfall IFD data

Duration	*Intensity (mm/h)*			
	1yr ARI	*5yr ARI*	*10yr ARI*	*100yr ARI*
10 min		78.3	90.5	154
30 min		41.6	47.3	77
1 hr	17.0	26.9	30.3	48.2
2 hr		17.2	19.2	30.0
6 hr		8.48	9.40	14.3
12 hr		5.49	6.08	9.23
24 hr		3.57	3.98	6.12
48 hr		2.29	2.58	4.07
72 hr		1.72	1.95	3.12

Based on the above parameters, peak post-development flow rates from the site were calculated using XP-Storm for each of the storm events in Table 0-4 above. The peak flow rates for the peak 5 year, 10 year, and 100 year ARI events are summarised in Table 0-5 below.

Table 0-5 - Post-development peak flow rates

Catchment number	*5yr 48hr ARI*	*10yr 48hr ARI*	*100yr 48hr ARI*
1	30 L/s	30 L/s	35 L/s
2	30 L/s	30 L/s	40 L/s
3	10 L/s	10 L/s	10 L/s
4	10 L/s	10 L/s	10 L/s
5	5 L/s	10 L/s	5 L/s
6	10 L/s	10 L/s	10 L/s
7	5 L/s	10 L/s	5 L/s
8	10 L/s	10 L/s	10 L/s
9	10 L/s	10 L/s	10 L/s

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TOTAL	**120 L/s**	**130 L/s**	**140 L/s**
Total allowable flow	**n/a**	**110 L/s**	**140 L/s**

The following detention storage volumes are required to achieve the post-development peak flow rates noted in Table 0-5 above.

Table 0-6 – Stormwater detention volumes

	Peak storage volume			
Catchment number	*1yr 1hr ARI*	*5yr ARI*	*10yr ARI*	*100yr ARI*
1	120 m^3	410 m^3	485 m^3	660 m^3
2	320 m^3	1375 m^3	1615 m^3	2565 m^3
3	165 m^3	1020 m^3	1190 m^3	2015 m^3
4	80 m^3	195 m^3	225 m^3	320 m^3
5	35 m^3	110 m^3	125 m^3	210 m^3
6	90 m^3	425 m^3	505 m^3	845 m^3
7	20 m^3	80 m^3	95 m^3	155 m^3
8	30 m^3	115 m^3	140 m^3	205 m^3
9	10 m^3	30 m^3	40 m^3	65 m^3
TOTAL REQ'D VOLUME	**870 m^3**	**3,760 m^3**	**4,420 m^3**	**7,040 m^3**

Indicative basin areas are included in Table 0-7 below. The areas shown below provide an indication of the extent of flooding that will be experienced, based on basin side slopes of 1:6 and a maximum depth of flooding of 0.9m in the 100 year ARI event.

Table 0-7 – Indicative flood areas

	Peak flooded area			
Catchment number	*1yr 1hr ARI*	*5yr ARI*	*10yr ARI*	*100yr ARI*
1	400 m^2	1,010 m^2	1,060 m^2	1,190 m^2
2	1,070 m^2	3,430 m^2	3,520 m^2	5,560 m^2
3	550 m^2	1,760 m^2	2,830 m^2	5,280 m^2
4	260 m^2	430 m^2	470 m^2	570 m^2
5	110 m^2	300 m^2	320 m^2	550 m^2
6	300 m^2	1,150 m^2	1,200 m^2	2,000 m^2
7	70 m^2	230 m^2	250 m^2	370 m^2
8	100 m^2	330 m^2	360 m^2	440 m^2
9	30 m^2	140 m^2	160 m^2	220 m^2
TOTAL REQ'D VOLUME	**2,890 m^2**	**8,640 m^2**	**11,110 m^2**	**16,180 m^2**

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Appendix 7 - Wetlands Correspondence

From: Wyre, Gordon [mailto:Gordon.Wyre@dec.wa.gov.au]
Sent: Thursday, 2 September 2010 2:52 PM
To: Craig Greaves
Subject: RE: Southern River - Dept of Housing Landholdings
Importance: High

Hi Craig
In response to your email, I can advise as follows. Sorry for the delay in replying.
I believe you may have misinterpreted the situation slightly, or at least over-abbreviated the situation.

1. While it is being proposed that the name for Resource Enhancement Wetlands may be changed to Rehabilitation Potential wetlands, this does not necessarily change the extent to which a wetland classified as Resource Enhancement may constrain a development proposal. This management category classification is a guide to the natural values of a wetland and should be considered in the context of development approval for the specific wetland and its surroundings. . Under current government practice, which is a development from past practice as discussed, Management Category classification of a wetland as Resource Enhancement (or Rehabilitation Potential) does **not** mean that it is automatically protected from an environment portfolio perspective, however specific wetland cases are being considered on their merits, with encouragement given to conserve higher value wetlands. DEC supports landholders seeking to rehabilitate wetlands wherever it is possible and practicable to do so, and in the past some developers have undertaken such rehabilitation as part of their overall environmental programs and development planning. Voluntary rehabilitation is therefore being maintained as a goal and we view this as preferable to wetland loss. In practice, while there are relatively few Resource Enhancement wetlands, their rehabilitation potential varies quite considerably and so one of the possibilities for the future may be the assignment of a rehabilitation potential score to such wetlands. This idea is, however, in the very early stages of development.

   It is also important to be aware that, separate from Government practice, the EPA maintains its own guidance advice on wetlands, which is to be taken into account in proposed developments that may be assessed by the EPA. In particular, EPA Guidance Statement No 33 for “resource enhancement” contains the following advice.

Management Category	General Description	EPA Objectives
Resource Enhancement *(proposed to possibly become Rehabilitation Potential)*	Wetlands which may have been modified or degraded, but still support substantial ecological attributes and functions.	To manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category by voluntary rehabilitation focusing on wetland functions, structure and biodiversity value.

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DEC is aware that many wetlands can have their values change over time, both increasing and decreasing their nature conservation value. We have provided a public document which guides proponents to request a reassessment of management boundaries and management categories of wetlands - "*Protocol for proposing modifications to the Geomorphic Wetlands Swan Coastal Plain dataset*" (DEC 2007). This can be obtained from the DEC Wetlands website at (http://www.dec.wa.gov.au/content/view/5310/1610/lang,en/). It is possible that a part of or a whole wetland may be assigned a different management category as a result of reassessment and DEC is aiming to continually improve scientific procedures associated with these reviews to make them as simple and usable as possible while maintaining scientific rigour to ensure accuracy, repeatability and equity.

2. The extent to which it may be possible to use classified Resource Enhancement wetlands for drainage is best considered in the context of the merits of the specific development case. As outlined above, there is not, from the DEC point of view, an automatic requirement to protect Resource Enhancement wetlands, but the contrary view that they can universally be considered for drainage, or development does not apply. A development proposal should consider the merits of the specific wetland and associated development.
3. I can confirm that collaboration between the Department of Planning and this department, with community input has been ongoing for several years and is progressing with a view to possibly replacing the current guidance for determining wetland buffer distances. The concept is that there would be two options available to developers, either to and it is anticipated that a final guidance document will be released during 2010

Gordon Wyre
Director of Nature Conservation
Department of Environment and Conservation
08 9442 0302

From: Craig Greaves [mailto:Craig.Greaves@housing.wa.gov.au]
Sent: Monday, 2 August 2010 5:24 PM
To: Wyre, Gordon
Cc: Vernon Langdon
Subject: Southern River - Dept of Housing Landholdings

Gordon

On the 26th February 2010 you met with Peter Keating from Bioscience along with Vernon Langdon and myself from the Dept of Housing in relation to the wetland classification of the Dept's landholding (lots 13, 14, 19, 21 & 22) in Southern River and 2 privately owner holdings (lots 18 &20). I have attached a plan for reference.

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At the meeting you advised that the policy in relation to Resource Enhancement Wetlands was to be redefined to Rehabilitation Wetlands and this would alter the responsibilities of the land owner. The understanding of those at the meeting was that under the proposed policy the landowners would then have discretion as to the extent wetland rehabilitation that needs to occur in relation to other considerations such as POS and the functionality of drainage across the site.

The Department and the private owners have progressed with the planning for this landholding on this basis and prepared an ODP to guide development. A wetland area has been retained along with an area of good quality vegetation to meet the POS requirements and deal with drainage consideration of the site. We are now working with the City of Gosnells to fine tune the supporting documentation for the ODP.

To assist the City of Gosnells in their deliberations it would be appreciated if you could confirm the following:

1. The change in management objectives for Rehabilitation Wetlands means they are no longer considered an environmental constraint on development, and as such, the revised mapping by DEC as a result of the lodged request does not impact on the current development proposal.
2. Whereas Resource Enhancement wetlands could not be used for drainage functions in urban developments, Rehabilitation wetlands can be used for drainage where the land owner opts to not rehabilitate such wetlands.
3. The calculation of buffer distances for Rehabilitation Wetlands will require revision of the current WAPC guidance. Can you confirm that discussion and coordination with WAPC is underway to reflect the new policy?

Can you also advise if the policy in relation to Rehabilitation Wetlands has been adopted, and if so It would also be appreciated if the Dept could obtain a copy of the policy? If the policy hasn't been adopted is it possible for you to advise of an indicative time frame and provide the Dept of Housing with a copy of the draft policy?

Please feel free to give me a call if you wish to discuss this further.

Regards

Craig Greaves
Project Manager | Land & Housing Development | Department of Housing
99 Plain Street EAST PERTH WA 6004 | T: (08) 9222 4866 | F: (08) 9222 8142
Government of **Western Australia**
Department of **Housing**

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Appendix 8 - ODP Diagram

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urban | design
plan | development

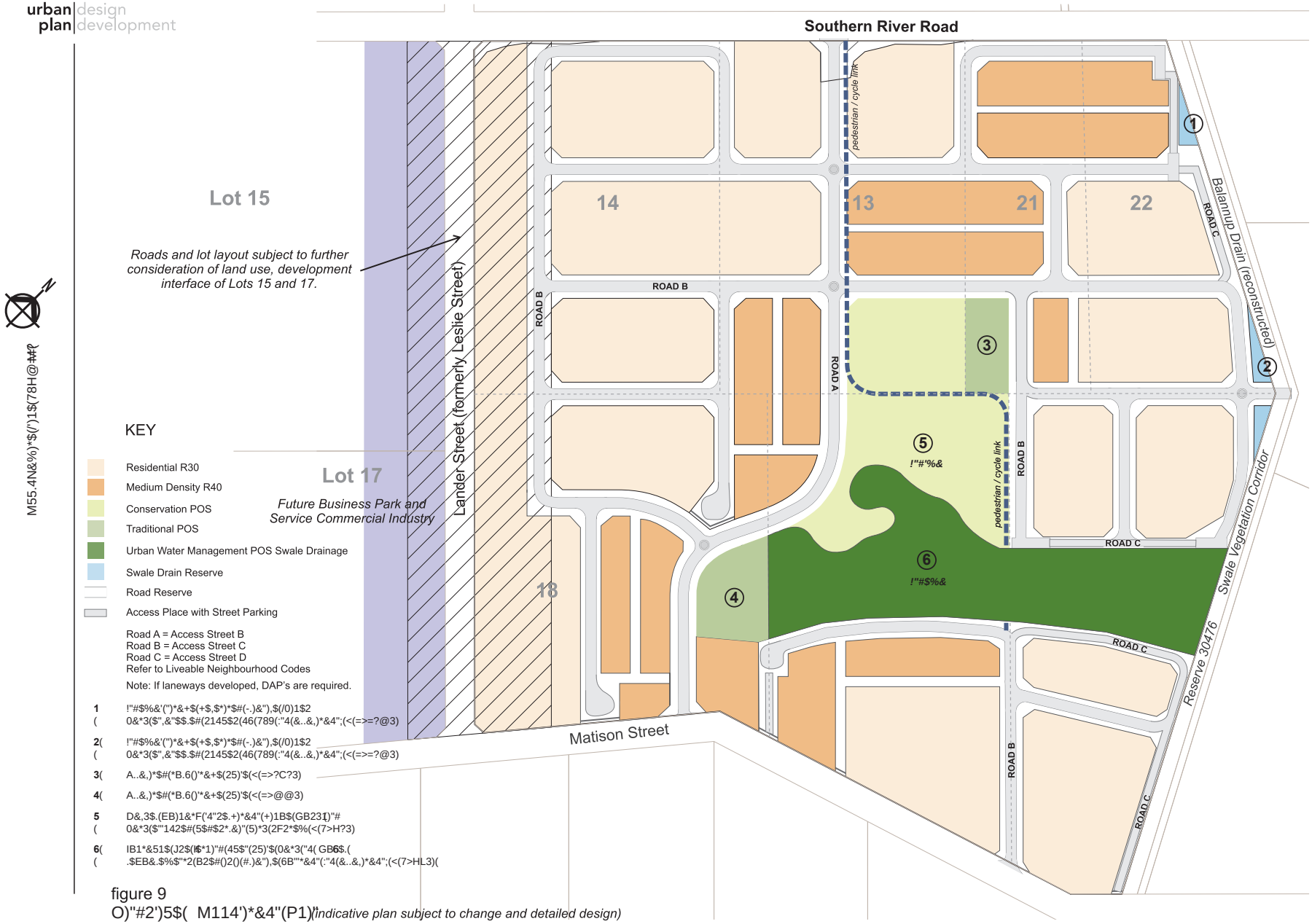

figure 9
O)"#2')5$(M114')*&4"(P1)" *(indicative plan subject to change and detailed design)*
Lots 13, 14, 18, 19, 20, 21 and 22 Southern River and Matison Street
(in collaboration with owners of lot 18 and 20)

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Appendix 9: Water Results Summary

Sample	pH range	EC (mS)	Nitrite N (mg/L)	Amm. N (mg/L)	Free Rea. P (mg/L)
DHW01	7.21-7.69	19.8-23.2	<0.01	0.45	0.78
DHW02	4.17 - 4.58	0.27 - 0.87	0.12	0.31 - 0.33	4.25
DHW03	5.42-5.92	0.42-0.91	0.024	0.03	
DHW04	3.83	1.12	0.076	0.06	
DHW05	3.4-3.57	0.66 - 0.62	0.018	0.2 - 0,26	0.32
DHW06					
DHW07	5.75- 5.93	0.904 - 1.01	<0.01	0.18	0.14
DHW08	2.85 - 3.4	1.931 - 2.40	0.018	0.5	0.26
DHW09	5.35	0.175	0.9	<0.01 - 0.2	
DHW10	4.17 -4.32	0.257-0.475	<0.01	0.04	0.18
DHW11	3.42 - 3.99	0.665 - 0.699	<0.01	0.07 - 0.26	1.86
DHW12	4.34 - 4.59	0.216 -0.254	<0.01	0.02	0.68
DHW13	6.80 - 6.82	5.44 - 5.52	<0.01	0.13 - 0.04	0.1
DHW14	3.34	2.08	<0.01	0.15	
DHW15					
DHW16	4.4 - 4.5	0.198 - 0.215	<0.01	0.06 - 0.12	2.26
DHW17	4.63	0.906	<0.01	0.11	
DHW18	5.10 -5.80	0.375 - 0.417	0.032	0.12 - 0.21	0.14
DHW19	7.02 - 7.10	1.98 - 2.28	0.04	<0.01 - 0.02	1.04
DHW20	6.34 - 6.49	2.45 - 3.66	<0.01	<0.01 - 0.06	0.42
DHW21	7.10-7.32	18.96 - 20.24	0.018	0.68 - 0.71	0.04
DHW22	4.37	0.968	<0.01		
DHW23	7.25 - 7.52	4.48 - 36.24	1.16	0.66	0.12
DHW24	4.71 - 6.38	0.52 - 1.509	0.059		2.1
DHW25	4.35 - 4.37	1.061 - 1.166	0.18		
DHW26	5.86	4.56		0.03	0.98

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Appendix 10: POS cross section

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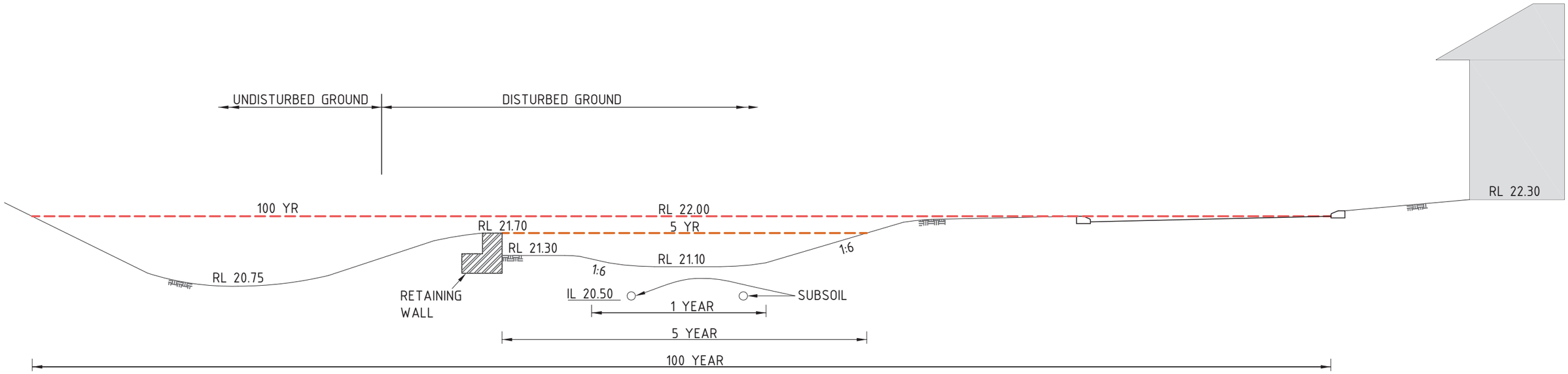

NOTES

1. RETAINING WALL EDGING PROPOSED TO LIMIT DISTURBANCE TO VEGETATION AND REDUCE POTENTIAL FOR INTRODUCED VEGETATION TO SPREAD INTO "BUSHLAND" AREAS.

2.HEIGHT OF RETAINING WALL SEPARATING BASIN FROM GENERAL P.O.S AREA CAN VARY DEPENDING UPON DESIGN EVENT BEING CONTAINED.

REV	REVISION	DATE	APPROVED
A	ISSUED FOR APPROVAL		

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38 Richardson Street
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thecivilgroup

DRAWN J.ROBERTSON
DESIGNED G.HALL
CHECKED
APPROVED
DATE

TITLE
SOUTHERN RIVER PRECINCT 3E ODP
POST DEVELOPMENT STORMWATER RUNOFF
TYPICAL CROSS SESTION THRU P.O.S

CLIENT DEPARTMENT OF HOUSING

SCALE N.T.S
WAPC No.
SHEET OF
DRAWING No. 7683-52
REV A

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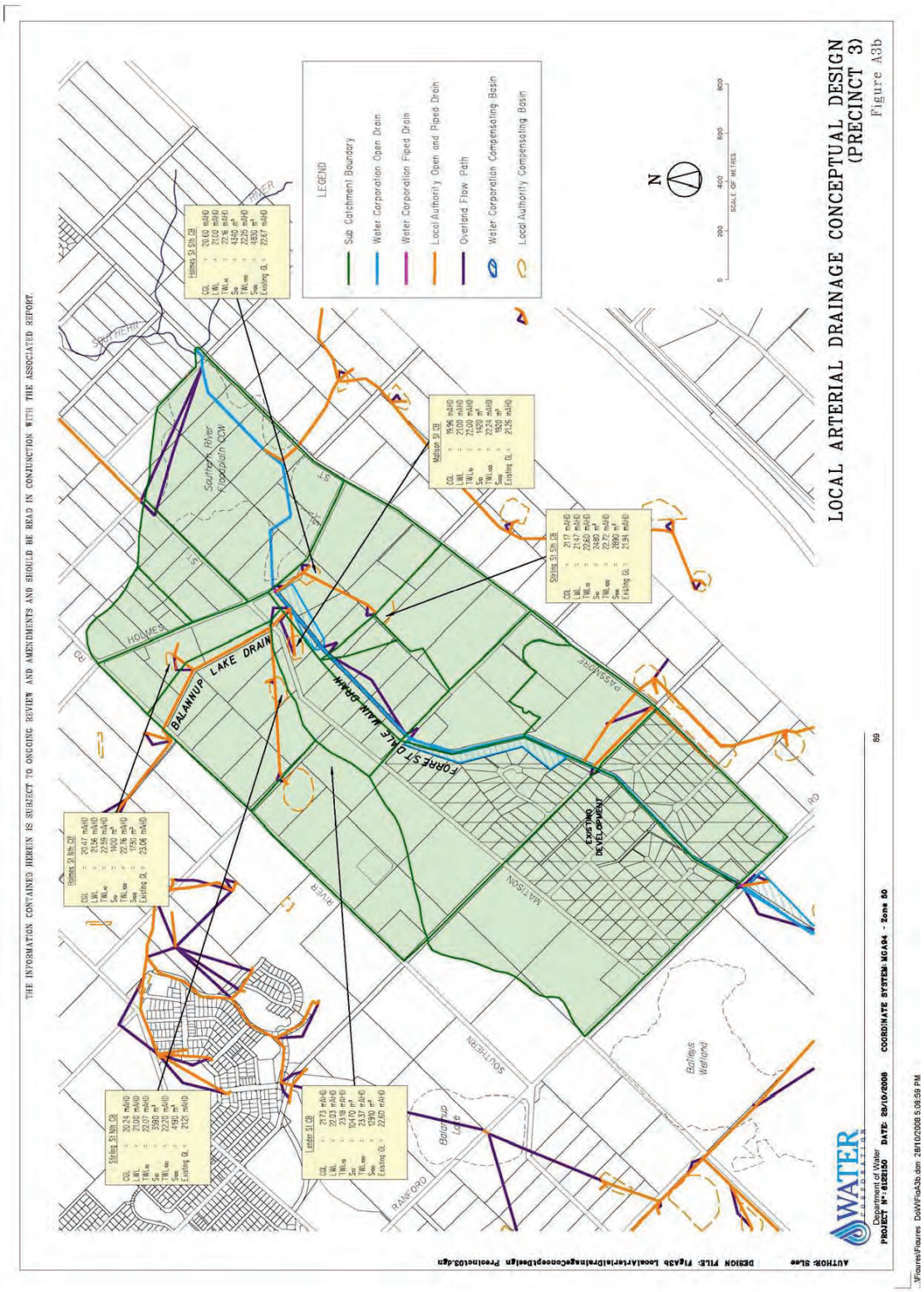
Appendix 11: Extract from Forrestdale Main Drain Arterial Drainage Strategy



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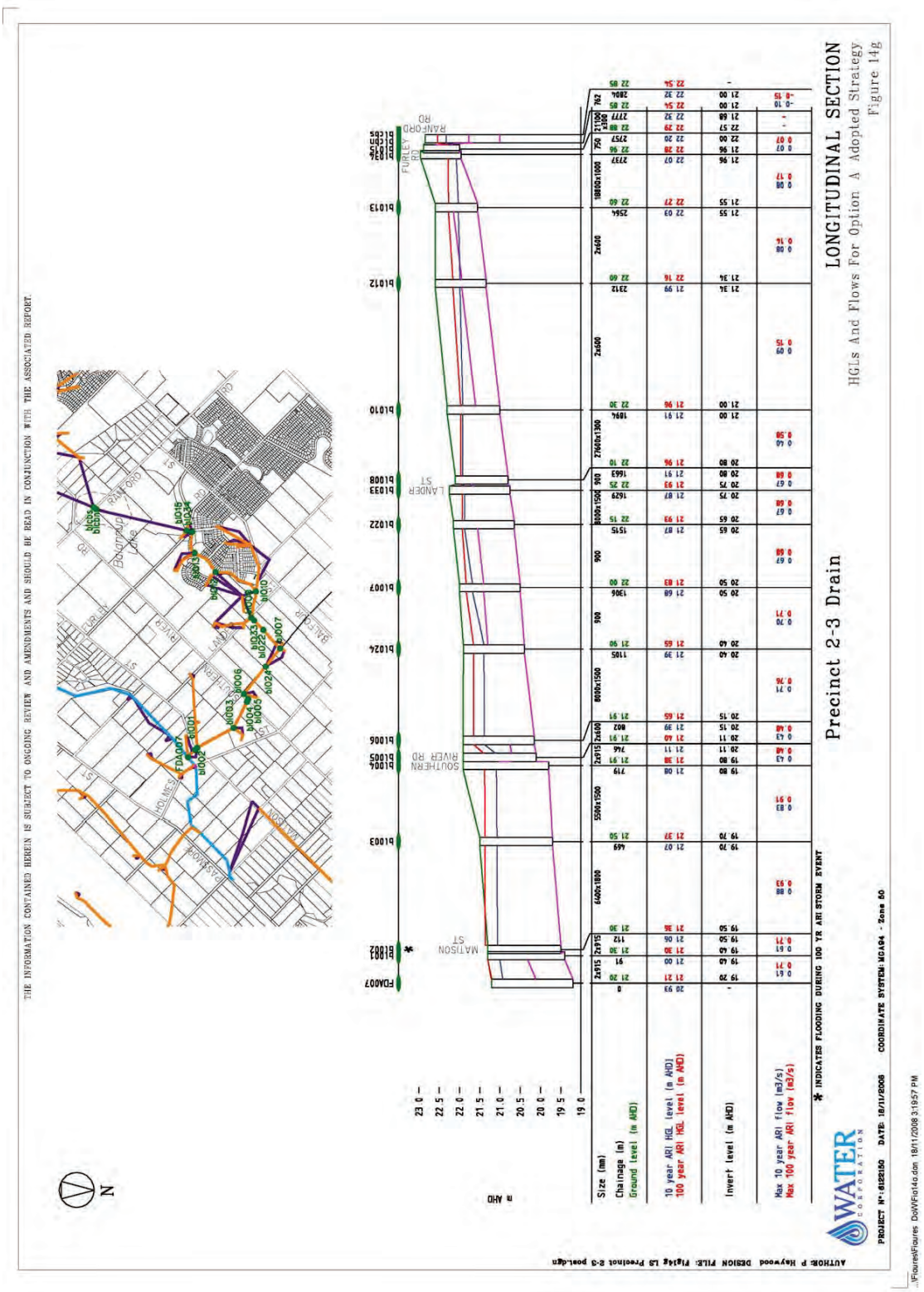

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Our Ref: L1606001

Email: kelly.lavell@rpsgroup.com.au
Date: 4 August 2016

Damal Kannangara
City of Gosnells
2120 Albany Highway
GOSNELLS WA 6110

Dear Damal

PRECINCT 3E SOUTHERN RIVER – LOCAL WATER MANAGEMENT STRATEGY

LWP Southern River Pty Ltd (LWP) recently purchased Lots 13, 14, 21 and 22 Southern River Road and Lot 19 Matison Street, Southern River from the Department of Housing. These land parcels are located within Precinct 3E of the Southern River Precinct 3 Structure Plan and encompass an area of approximately 16.90 ha.

A revised Local Structure Plan (LSP) for the entire Precinct 3E area of 25.7 ha was prepared by a Department of Housing (DoH) collaborative. To support the revised LSP, Cardno (on behalf of the DoH) prepared an addendum to the original LWMS (Bioscience 2011) which the City of Gosnells (CoG), Department of Water (DoW) and Department of Parks and Wildlife (DPaW) have reviewed and provided various comments.

A majority of these comments have since been addressed and the CoG has noted that the LWMS is generally acceptable and any changes required by the CoG or DoW are unlikely to significantly impact on the LSP design. Hence, at its Ordinary Council meeting on 14 June 2016, the CoG resolved to recommend to the WA Planning Commission (WAPC) that the LSP be approved subject to certain modifications and information being supplied to the CoG. The CoG resolved that prior to the revised LSP being approved by the WAPC, the LWMS should be formally endorsed by the City and the DoW, on the advice of the DPaW.

With the change in landownership, LWP and its consultant team is driving the process to receive endorsement of the revised Precinct 3E LSP through the CoG and WAPC. The primary purpose of this LWMS cover letter is to address the few outstanding LWMS comments to allow the WAPC to endorse the revised LSP.

Precinct 3E LSP Planning History

Precinct 3E is one of six sub-precincts of the broader Southern River Precinct 3 LSP (Plate 1) which extends over a large area of 365 ha and was endorsed by the WAPC in September 2009.

On 9 August 2011, the CoG considered a proposed LSP for the Southern River Precinct 3E area and resolved to adopt a modified version of the LSP to that which was advertised for public comment in mid-2011. Once the LSP was referred to the WAPC for determination, the WAPC raised concerns in relation to the inclusion of residential development within the 500 m buffer to the kennel zone. Following discussions with the then proponent, the WAPC notified the proponent that as a result of this issue, the LSP was unlikely to be supported by the WAPC.

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In July 2013, a new draft LSP for Precinct 3E was submitted and publicly advertised. The area within the 500 m kennel zone buffer is now shown to be "subject to further planning".

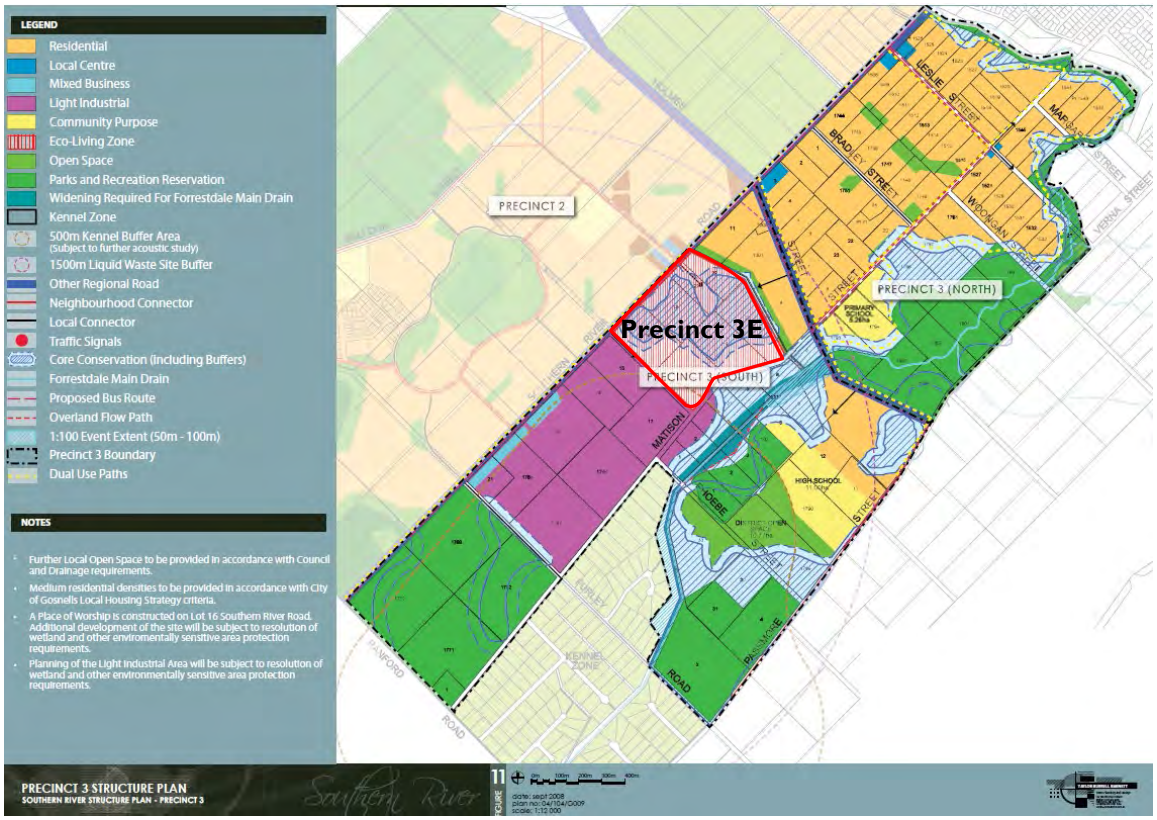

Plate 1: Precinct 3 Local Structure Plan

Previous Local Water Management Strategies

Bioscience prepared a LWMS for the entire Precinct 3E LSP to support the original LSP submission in 2011. The CoG and DoW reviewed and endorsed this document.

In October 2015, Cardno prepared an addendum to the Bioscience LWMS to support the revised 2013 Precinct 3E LSP. The addendum was a relatively brief document and provided additional information collected since 2011, including groundwater and surface water monitoring results and a modified drainage design from the Bioscience LWMS. This document was submitted to the CoG and DoW, and a copy is provided in Appendix 1.

The CoG provided comments on the LWMS addendum, as detailed in Table 1 below. The DoW advised that it has deferred the assessment and approval of the Cardno LWMS addendum to the CoG. The DoW has also advised it is satisfied for the CoG to assess and provide approval of this LWMS cover letter. Should the CoG specifically request the DoW's advice in assessing the information contained in this letter, DoW will provide comment direct to the CoG. A copy of this letter however will be provided to the DoW for their information only. Correspondence from the DoW to confirm this approach is provided in Appendix 2.

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LWMS Addendum Comments

The CoG provided a series of queries relating to the submitted LWMS addendum. Subsequently, a meeting was held in February 2016 between the proponent, consultants, CoG and DoW to discuss. A copy of the meeting minutes and further explanation from the CoG regarding each comment is provided in Appendix 3.

Table 1 below provides a summary of each CoG comment and a response from RPS describing how each has been addressed.

Table 1: City of Gosnells Comments on the LWMS Addendum

it snells ents	S es nses
LWMS to include a landscape concept plan.	An entirely new Landscape Concept Plan has been prepared by RPS' landscaping consultants and is provided in Appendix 4. This plan considers the drainage requirements for the development and has been prepared following discussions with Lesley Dunn at the CoG. A tree survey has recently been completed by LWP and again the outputs of this have been considered in the development of the landscape plan. At the request of the CoG, a key component of the landscape design is to keep all drainage out of the POS areas to maximise their useability.
Southern River Road widening will result in additional drainage. Precinct 3E will need to provide additional storage at the corner of Lander St and Southern River Rd to manage the run off generated from the 11,028 m^2 catchment area which is assumed to be 80% impervious. This needs to be considered in the detailed design phase (UWMP). The CoG would like to add this as a comment to the LWMS addendum as a record for future reference.	LWP and project engineers Cossill & Webley are aware of this additional storage area required to accommodate the Southern River Road widening. Detailed drainage plans will be provided in the UWMP.
Sub soil drainage is required due to the limited clearance to groundwater and to minimise fill. The CoG has suggested that amended soil is placed around the sub soil system to provide at source treatment of the groundwater rather than providing treatment at end of pipe.	Lab analysis of the existing soils on site will be completed to determine the soils current phosphorus retention index (PRI). This will form the basis for future recommendations regarding the use of soil amendment and groundwater quality treatment. The PRI soil analysis and treatment of groundwater collected in the subsoil drainage system will be detailed in the UWMP. RPS understands that the at source treatment of groundwater (through the use of soil amendment) minimises fill, maximises POS useability and improves groundwater quality. The use of soil amendment will be investigated further following the PRI analysis and detailed further in the UWMP.
The allowable discharge rate for this development is 0.13 m^3/s, not 0.48 m^3/s as is currently proposed in the LWMS addendum.	The Water Corporation has confirmed that it does not generally accept a higher discharge rate to Balannup Drain. Cossill & Webley engineers have prepared a revised drainage design concept that limits the peak discharge rate to Balannup Drain to approximately 0.17 m^3/s. Efforts to achieve the allowable Water Corporation discharge rate of 0.13 m^3/s will be achieved at detailed design by directing stormwater to the wetland where possible before discharging off site to Balannup Drain. Planted biofiltration areas will be provided to treat the first flush prior to the

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it snells ents	S es nses
	stormwater entering the main body of the wetland. This modified drainage concept will provide a clean water source to the wetland which will have a number of environmental benefits and will treat stormwater further before discharging off site to Ballanup Drain. The revised drainage concept is provided in Appendix 5.
The cross section given in Figure 19 is incorrect. Update Figure 19 to include the sub soil inverts. The CoG is looking for more details of the proposed subsoils and the drainage outlets at POS/Balanup Drain interface.	No longer applicable. Cossill & Webley and RPS will liaise with the CoG to confirm an appropriate subsoil outfall design. The detailed design will then be included in the UWMP.

In addition to the CoG comments detailed in Table 1, the DPaW has provided comments to the LWMS addendum in February 2016 and again in July 2016. A copy of the DPaW correspondence and LWMS addendum comments is provided in Appendix 6.

It is noted that a majority of the DPaW comments are consistent with the CoG comments detailed in Table 1. In responding to the DPaW comments, it is important to point out that LWP is liaising with the CoG in regards to the management of the wetland and the LSP design. The DPaW also notes that the remainder of their comments can be addressed in the UWMP, which will be produced at subdivision.

We hope the information contained herein adequately responds to the outstanding comments raised by the CoG and DPaW, and facilitates the City's endorsement of the LWMS. Please do not hesitate to contact the undersigned with any questions or to discuss this information further.

Yours sincerely
RPS



KELLY LAVELL
Principal Hydrologist

ATTACHMENTS

Appendix 1: LWMS Addendum (Cardno 2015)
Appendix 2: DoW Correspondence Regarding Approval of the LWMS
Appendix 3: LWMS Meeting Minutes and CoG LWMS Addendum Comments
Appendix 4: Landscape Plan
Appendix 5: Cossill & Webley Drainage Design
Appendix 6: DPaW Correspondence and LWMS Addendum Comments

cc: James Mackintosh, Department of Water

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References

Southern River Precinct 3E LWMS Addendum. Cardno October 2015.

Local Water Management Strategy (LWMS) for Lots 13, 14, 21 and 22 Southern River Road and Lots 18-20 Matison Street, Southern River. Bioscience December 2011.

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APPENDIX 1

LWMS Addendum (Cardno 2015)

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Southern River Precinct 3E LWMS Addendum

V14016



Prepared for
Department of Housing

13 October 2015

Cardno
Shaping the Future

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Document Information

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Date	6 October 2015
Effective Date	13/10/2015
Date Approved:	13/10/2015

Document History

Revision	Effective Date	Description of Revision	Prepared by:	Reviewed by:
A	08/09/2015	LWMS Addendum	RMG	JJ
B	07/10/2015	LWMS Addendum with client comments incorporated	SC	JJ
C	13/10/2015	Issued to DoW and CoG	SC	JJ

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2.6.2 Groundwater Monitoring

This section is to be added to Section 2.6.2 of the approved LWMS.

2.6.2.1 Additional Groundwater Monitoring

A short drill program was completed on 28 July 2014 comprising five monitoring boreholes. A plan of the site showing borehole locations is included as Figure AD 1.

The five groundwater level monitoring boreholes were constructed at least 1 m below the water table with 3 m of slotted PVC (50 mm nominal diameter) at the base of each borehole and plain casing to the surface. All boreholes were capped and set above ground in locked steel casing, cemented into the surface. Boreholes were surveyed by Land Surveys on 9 September 2014.

A summary of completed boreholes is included in Table 1 below:

Table 1 Borehole Details

Borehole	Easting	Northing	Top of casing (mAHD)	Ground Level (mAHD)	Casing Height (m)	Depth of Borehole (m)
GW01	401840.03	6447483.2	22.83	22.38	0.54	4
GW02	402224.21	6447792.2	21.93	21.32	0.78	4
GW03	402475.17	6447546.4	21.35	20.86	0.6	4
GW04	402213.83	6447598.4	23.36	22.75	0.68	4
GW05	402258.11	6447355.1	21.33	20.75	0.63	3.5

2.6.2.1.1 Groundwater and Surface Water Monitoring Completed

Pre-development groundwater monitoring and surface water monitoring was completed to establish baseline groundwater level and water quality data across the site. This included:

> groundwater level monitoring in five boreholes using down hole level loggers (piezometers) recording hourly;
> groundwater quality monitoring in five boreholes twice within the first four months and quarterly thereafter for 12 months, commencing in July 2014; and
> surface water monitoring completed monthly between August and October 2014.

2.6.2.1.2 Groundwater Level Data

Groundwater level data was obtained for an eleven month period from 29th July 2014 to 15th June 2015. Calibrated piezometer data is presented in Graph 1 and summarised in Table 2. Data was recorded hourly with downloads every three months, as part of the groundwater quality monitoring program.

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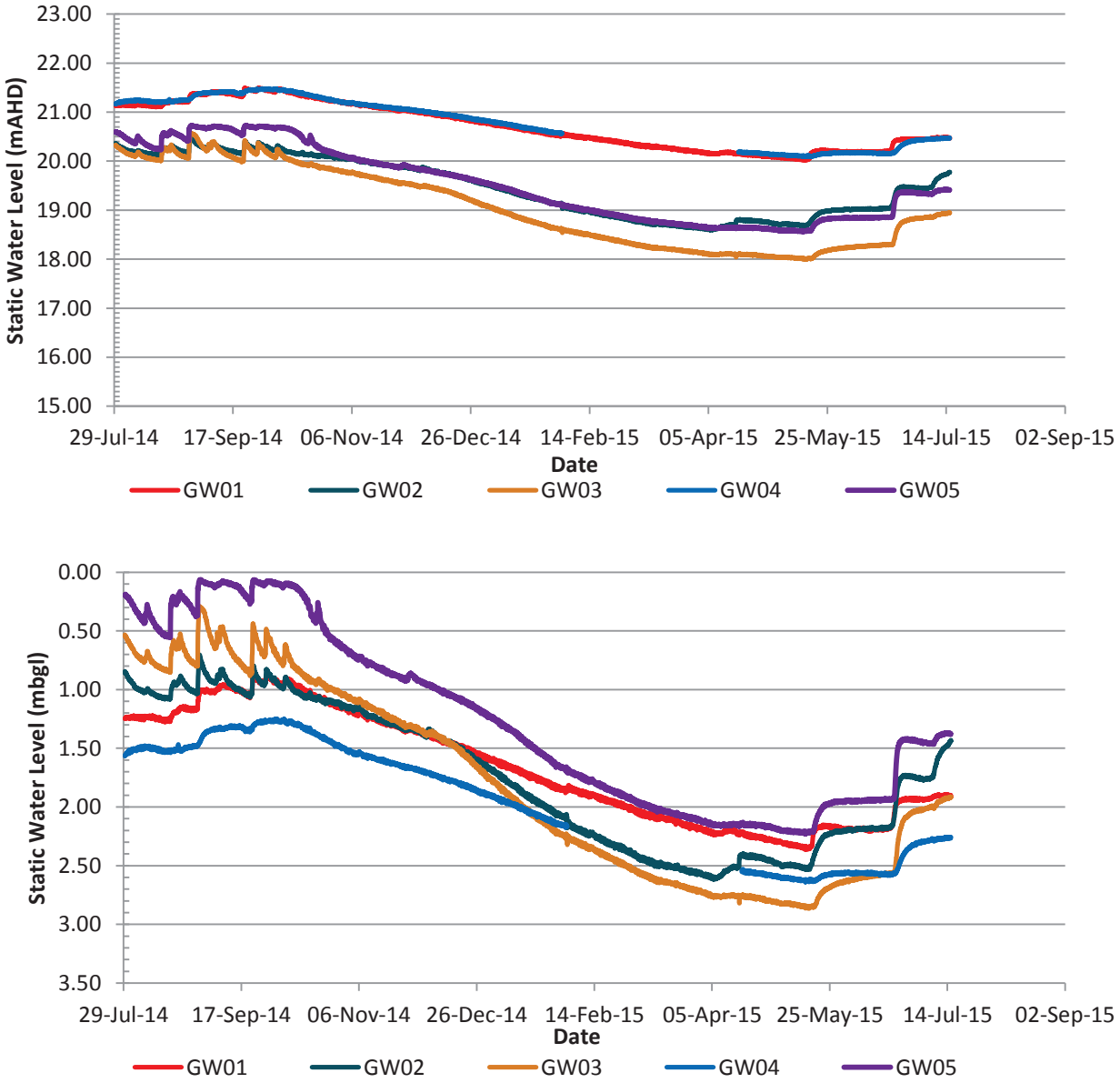

Graph 1 **Groundwater Level Data**

Table 2 **Groundwater Level Summary July 2014 to June 2015**

	Groundwater Level (mbgl)					Groundwater Level (mAHD)				
	GW1	GW2	GW3	GW4	GW5	GW1	GW2	GW3	GW4	GW5
Minimum	0.89	0.70	0.29	1.25	0.06	20.02	18.59	18.00	20.09	18.56
Maximum	2.36	2.62	2.86	2.64	2.23	21.49	20.51	20.57	21.48	20.73
Mean	1.67	1.74	1.81	1.90	1.27	20.71	19.47	19.05	20.83	19.52
Range	1.48	1.91	2.57	1.39	2.17	1.48	1.91	1.98	0.93	1.63

From the data outlined above the following conclusions can be drawn:

> groundwater levels peaked at over 20 mAHD in the winter months, from 20.5 mAHD in GW2 and GW3 to 21.5 in GW1 and GW4;
> this is equivalent to within 1 m of current ground levels in all boreholes, apart from GW4 which peaked at 1.25 mbgl;
> groundwater levels varied over the monitoring period by 1 m (GW1 and GW4) and 2 m (GW3); and

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> boreholes GW2, GW3 and GW5 were highly responsive to rain events. Boreholes GW2 and GW3 are adjacent to, and are in continuity with, the stream running along the north-eastern side of the site. GW5 is located next to an access track that was flooded for much of the winter.

2.6.3 Groundwater Quality

This section is to be added to groundwater data supplied in Section 2.6.3 of the approved LWMS.

Groundwater quality monitoring has been completed five times in August and September 2014, and February, April and June 2015. Each round of monitoring was completed in accordance with Australian Standard ASNZS 5667.11.1998 (Standards Australia 1998) with three well volumes of groundwater purged prior to sampling for field and laboratory analysis. A Hydrolab Quanta water quality meter was employed to collect field data. Groundwater parameters measured *in situ* were:

> pH;
> temperature;
> dissolved oxygen (DO);
> electrical conductivity (EC); and
> oxidation-reduction potential (Eh).

Once collected, groundwater samples were placed directly into laboratory prepared and supplied containers and put on ice. The samples were then transported to the laboratory under standard Chain of Custody (CoC) procedures. The parameters selected for groundwater analysis[1] were:

> nutrients: total nitrogen (TN), total phosphorous (TP), ortho-phosphate (Ortho P), oxides of nitrogen (NO_x), total kjeldahl nitrogen (TKN), and ammonia (NH_3).
> dissolved metals: arsenic (As), aluminium (Al), copper (Cu), cadmium (Cd), iron (Fe), lead (Pb), nickel (Ni), chromium (Cr), mercury (Hg) and zinc (Zn); and
> anions and cations: hydroxide carbonate bicarbonate, total alkalinity and acidity as $CaCO_3$, sulphate, chloride, calcium, magnesium, sodium and potassium.

Results of groundwater monitoring are outlined in Table 3 and summarised in Table 4.

[1] Monitoring parameters were agreed with SRT, DoW and CoG prior to monitoring commencing.

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Table 3 Groundwater Quality Results

Parameter	GW1					GW2					GW3					GW4					GW5				
	Aug-14	Sep-14	Feb-15	Apr-15	Jun-15	Aug-14	Sep-14	Feb-15	Apr-15	Jun-15	Jul-14	Sep-14	Feb-15	Apr-15	Jun-15	Aug-14	Sep-14	Feb-15	Apr-15	Jun-15	Aug-14	Sep-14	Feb-15	Apr-15	Jun-15
Water level from surface (m)	0.23	1.16	1.88	2.21	1.94	0.94	1.14	2.09	2.40	1.40	0.59	0.97	2.26	2.70	1.85	1.49	1.33	2.16	3.47	3.19	0.23	0.48	1.65	2.09	1.27
Watertable height (m AHD)	22.15	21.22	20.50	20.17	20.44	20.38	20.18	19.23	18.92	19.92	20.27	19.89	18.60	18.16	19.01	21.26	21.42	20.59	19.28	19.56	20.52	20.27	19.10	18.66	19.48
NH_4 (mg/L)	0.01	0.20	0.62	0.55	0.27	0.31	0.34	0.70	0.22	0.03	0.06	0.13	1.53	0.15	0.09	0.18	0.19	0.66	0.35	0.28	0.12	0.23	0.25	0.18	0.17
NOx (NO_3 + NO_2) (mg/L)	0.01	<0.02	<0.01	0.03	1.95	<0.01	<0.02	0.06	0.01	0.32	0.03	<0.01	<0.01	0.01	0.04	0.38	0.33	0.04	0.05	0.06	0.61	0.02	0.02	0.01	<0.01
TKN (mg/L)	1.4	1.7	3.8	2.9	2.3	5.0	1.7	2.4	1.2	4.6	2.3	1.4	5.7	1.7	2.1	4.7	3.4	6.2	4.9	3.7	19.2	11.8	18.3	2.9	10.7
TN (mg/L)	1.4	1.7	3.8	2.9	4.2	5.0	1.7	2.5	1.2	4.9	2.3	0.1	5.7	1.7	2.1	5.1	3.7	6.2	5.0	3.8	19.8	11.8	18.3	2.9	10.7
TP (mg/L)	<0.05	<0.05	<0.05	0.02	0.02	0.20	<0.05	0.12	0.06	0.36	0.14	0.11	0.29	0.06	0.09	0.19	0.19	<0.2	0.04	0.05	0.66	1.18	1.46	0.12	1.20
OrthoP (mg/L)	<0.01	<0.01	0.02	<0.05	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.03	<0.05	0.08	0.11	0.08	<0.05	<0.05	0.37	<0.01	<0.01	<0.05	<0.05
Temp (celcius)	18.57	19.56	22.14	23.30	20.69	16.53	18.49	21.35	22.48	18.29	17.14	17.74	21.66	21.60	18.82	18.03	18.72	21.25	21.85	19.31	16.37	18.17	21.84	21.58	18.15
Cond (mS/cm)	0.478	0.709	0.528	0.52	0.02	1.63	2.20	1.29	1.43	0.02	11.05	13.32	19.10	21.84	0.02	0.576	0.515	1.08	1.10	0.02	1.350	1.73	1.63	2.34	0.03
DO (mg/L)	2.91	2.37	3.26	1.20	1.35	4.89	4.76	3.04	2.56	5.05	5.04	2.94	2.11	3.26	3.40	3.84	6.43	6.69	3.05	2.20	3.85	9.45	5.29	2.90	1.90
pH	7.18	7.18	7.20	7.38	7.27	7.63	7.86	6.39	6.17	8.44	7.42	7.46	6.93	7.18	7.03	5.24	6.08	4.52	5.09	5.05	7.70	7.86	7.11	7.22	7.04
Salinity (TDS mg/L)	0.3	0.5	0.3	0.3	0.0	1.1	1.4	0.8	0.9	0.0	7.0	8.5	12.2	13.9	0.0	0.4	0.3	0.7	0.7	0.0	0.90	1.1	1.0	1.5	0.0
TSS (mg/L)	57.00	60	25.00	8.00	<5	2790	3090	5760	916	6300	1060	758	369	487	363	6010	776	68	49	46	18400	4090	5520	293	0
DO(%)	29.2	18.9	37.6	11.20	14.80	41.8	45	34.9	33.3	46.3	38.8	30.7	24.9	39.7	35.4	38.8	56.2	62.3	32.8	21.3	35.6	48.4	68.1	32.4	19.1
Redox (mV)	-119	-92	-133	-221.00	-158.00	-28	9	5	-84	6	81	-26	-87	-100	-88	81	210	89	-22	10	-29	20	-66	-138	-75
Dissolved Metals (mg/L):																									
Aluminium	0.22	0.24	0.44	0.48	0.2	0.06	0.08	1.26	0.08	0.84	0.01	<0.01	<0.01	<0.01	0.02	2.66	1.87	1.68	1.66	1.12	0.18	0.76	5.21	0.25	0.55
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.004	0.002	0.002	<0.001	0.002	0.004	0.003	0.004	0.011	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	0.002	0.002	0.005	0.002	0.002
Cadmium	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$
Chromium	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	0.001	0.002	0.002	0.001	0.001	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	<0.001	0.003	0.002	0.001	0.001	0.001	0.003	0.006	0.006	0.004	0.006
Copper	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	0.001	$<10^{-3}$	$<10^{-3}$	0.001	$<10^{-3}$	0.002	0.002	0.002	0.002	0.001	0.002	0.003	0.003	0.001	$<10^{-3}$	0.001	0.001	0.001	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$
Lead	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	0.002	$<10^{-3}$	0.001	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	0.001	0.002	0.001	0.001	0.001	0.002	0.011	0.002	0.002
Nickel	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$	0.002	0.002	0.003	0.002	0.005	0.003	0.003	0.002	0.003	0.006	0.003	0.001	0.001	<0.001	<0.001	<0.001	0.002	0.003	0.002	0.002
Zinc	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	0.007	0.007	<0.005	<0.005	<0.005	0.324	0.077	0.036	<0.005	<0.005
Iron	0.55	0.50	0.23	0.10	<0.05	1.92	4.6	0.35	2.93	0.34	0.32	0.19	0.17	0.1	0.13	4.49	1.84	0.74	0.76	0.43	1.06	1.11	1.3	1.22	0.66
Mercury	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	0.0001	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	$<10^{-4}$	0.0002	$<10^{-4}$	$<10^{-4}$
Anions Cations etc (mg/L)																									
Hydroxide Alkalinity as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$	217	278	177	151	249	61	52	84	54	42	333	411	470	497	306	<1	<1	<1	<1	<1	128	72	88	58	51
Total Alkalinity as $CaCO_3$	217	278	177	151	249	61	52	84	54	42	333	411	470	497	306	<1	<1	<1	<1	<1	128	72	88	58	51
Acidity as $CaCO_3$	18	35	13	58	12	32	35	16	32	35	25	24	15	68	23	113	91	96	125	90	69	56	34	35	41
Sulfate as SO_4 - Turbidimetric	<10	21	8	7	128	207	331	149	176	93	333	645	188	88	467	<10	<10	<80	14	<20	172	231	184	317	242
Chloride	35	79	61	75	124	431	470	278	310	113	4150	6090	5930	6850	4060	164	141	290	314	227	390	480	373	532	455
Calcium	74	106	59	54	144	14	20	8	12	6	63	103	96	102	31	6	5	10	13	7	8	9	8	10	9
Magnesium	8	10	9	9	13	41	60	24	33	14	198	340	327	342	96	12	10	18	21	15	30	41	32	44	38
Sodium	20	35	40	43	57	320	326	197	210	127	2260	3090	3040	3280	1080	76	70	136	154	116	278	331	260	396	316
Potassium	2	4	4	4	5	2	3	2	2	1	2	2	2	2	1	3	2	5	5	4	4	3	3	2	3

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Table 4 Summary of Groundwater Quality Results

Parameter	Minimum	Maximum	Mean	Range
NH_4 (mg/L)	0.01	1.53	0.31	1.52
NOx (NO^3 + NO^2) (mg/L)	0.01	1.95	0.22	1.94
TKN (mg/L)	1.2	19.2	5.0	18.0
TN (mg/L)	0.1	19.8	5.1	19.7
TP (mg/L)	0.02	1.46	0.33	1.44
OrthoP (mg/L)	0.01	0.37	0.09	0.36
Temp (celcius)	16.37	23.30	19.75	6.93
Cond (mS/cm)	0.02	21.84	3.38	21.82
DO (mg/L)	1.20	9.45	3.75	8.25
pH	4.52	8.44	6.87	3.92
Salinity (TDS mg/L)	0.00	13.90	2.15	13.90
TSS (mg/L)	0.00	18400	2387	18400
DO(%)	11.2	68.1	35.9	56.9
Redox (mV)	-221	210	-38	431
Dissolved Metals (mg/L):				
Aluminium	0.01	5.21	0.90	5.20
Arsenic	0.002	0.011	0.004	0.009
Cadmium	0	0	-	0
Chromium	0.001	0.006	0.003	0.005
Copper	0.001	0.003	0.002	0.002
Lead	0.001	0.011	0.002	0.010
Nickel	0.001	0.006	0.003	0.005
Zinc	0.005	0.324	0.058	0.319
Iron	0.10	4.60	1.09	4.50
Mercury	0	0	-	0
Anions Cations etc (mg/L)				
Hydroxide Alkalinity as $CaCO_3$	0	0	-	0
Carbonate Alkalinity as $CaCO_3$	0	0	-	0
Bicarbonate Alkalinity as $CaCO_3$	42	497	189	455
Total Alkalinity as $CaCO_3$	42	497	189	455
Acidity as $CaCO_3$	12	125	48	113
Sulfate as SO_4 - Turbidimetric	7	645	200	638
Chloride	35	6850	1297	6815
Calcium	5	144	39	139
Magnesium	8	342	71	334
Sodium	20	3280	650	3260
Potassium	1	5	3	4

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From this data the following conclusions can be drawn:

> electrical conductivity was below 2.35 mS/cm in all boreholes, averaging 0.96 mS/cm, except GW3 which averaged 13.06 mS/cm with a maximum reading of 19.1 mS/cm in February 2015. Overall a site-wide average of 3.81 mS/cm was returned;

> pH varied between 4.52 in GW4 in February 2015, to 8.44 in GW3 in June 2015, averaging 6.9 across the site. In general pH increased during the winter months with rainfall diluting the slightly acidic environment compared to the low rainfall months;

> total nitrogen comprised mainly organic nitrogen, with minor concentrations of ammonia, nitrate and nitrite, present;

> total nitrogen was significantly higher in GW5, compared to the other boreholes. GW5 returned the highest recorded value of 19.8 mg/L in August 2014. The site-wide average for total nitrogen was 6.0 mg/L.

> excluding data from GW5 total nitrogen averaged 3.4 mg/L across the site, with a maximum of 6.2 mg/L in GW4 in February 2015;

> ammonia ranged from 0.01 mg/L in August 2014 in GW1 to 1.53 mg/L in February 2015 in GW3;

> dissolved metals returned low or trace values with cadmium not identified in any borehole and mercury only occurring in GW5 in February 2015 at 0.0002 mg/L and GW3 in April 2015 at 0.0001 mg/L;

> aluminium was noted up to 5.21 mg/L in GW5 in February 2015 and the maximum zinc concentration of 0.324 mg/L was returned in August 2014 in the same bore;

> iron concentration varied from 0.10 mg/L in GW1 in April 2015 and 4.6 mg/L the following month, also in GW2. The site-wide average for iron concentration was 1.3 mg/L;

> alkalinity was only present in bicarbonate form across the site with the maximum concentration of 497 mg/L in April 2015 in GW3; and

> chloride and sodium were both uniformly high in GW3, up to 6,850 mg/L for chloride and 3,280 mg/L for sodium in April 2015. These high values are consistent with salinity readings obtained for this borehole.

2.7.4 Surface Water Quality Monitoring

Surface quality monitoring has been completed four times on a monthly basis from July 2014 to October 2014 over the winter of 2014. Only SW1 and SW4 consistently had water with SW2 and SW3 located in ephemeral streams that despite several rain events were dry, except for September 2014 when a sample was obtained at SW3. Surface water sampling was completed for the same parameters as groundwater. Sample locations are shown in Figure AD 1 with data presented in Table 5.

From the data presented the following observations can be made:

> electrical conductivity varied between 0.61 mS/cm in SW4 in September 2014 to 1.07 mS/cm in SW1 in August 2014. The site-wide average was 0.9 mS/cm:

> pH varied from 6.6 to 7.8, averaging 7.5, which is slightly higher than the groundwater average of 6.9. The 6.6 reading from SW1 in July 2014 is an outlier with all other readings 7.4 or above;

> total nitrogen had a site wide average of 3.2 mg/L ranging from 2.5 mg/L in July 2014 in SW4, to 3.9 mg/L in SW4 in October 2014. There was an increase in total nitrogen in October 2014 in both SW1 and SW4;

> variations in total nitrogen were mainly influenced by the concentration of the organically bonded form of nitrogen;

> nitrogen in ammonia, nitrate and nitrite forms contribute an average of 0.45 mg/L or around 14% of TN concentration. Variations in ammonia and nitrate + nitrite are not proportional to TN readings;

> dissolved metals returned low or trace values with cadmium and mercury not identified in surface water;

> iron concentration varied from 0.36 mg/L to 0.88 mg/L. The surface water average was 0.6 mg/L;

> aluminium was noted up to 0.7 mg/L in SW4 in July 2014, all other metals were occasionally noted, with all recorded concentrations below 0.01 mg/L at all monitoring locations;

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- as with groundwater monitored, alkalinity was only present in bicarbonate form across the site with the maximum concentration of 210 mg/L in September 2014 in SW3. Readings in SW1 and SW4 ranged from 113 mg/L to 157 mg/L; and
- chloride ranged from 116 mg/L to 300 mg/L, averaging 200 mg/L and sodium averaged 110 mg/L with trends across the winter months consistent between monitoring points.

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Table 5 Surface Water Quality Results

	SW1				SW3	SW4							
Parameter	**Jul-14**	**Aug-14**	**Sep-14**	**Oct-14**	**Sep-14**	**Jul-14**	**Aug-14**	**Sep-14**	**Oct-14**	**Minimum**	**Maximum**	**Mean**	**Range**
NH_4 (mg/L)	0.07	0.11	0.31	0.34	0.06	0.05	0.06	0.19	0.07	0.05	0.34	0.14	0.29
NOx (NO_3 + NO_2) (mg/L)	0.47	0.27	0.26	0.22	<0.01	0.22	0.41	0.29	0.32	0.22	0.47	0.31	0.25
TKN (mg/L)	2.6	2.6	2.4	3.6	3.7	2.3	2.8	2.3	3.6	2.30	3.70	2.88	1.40
TN (mg/L)	3.1	2.9	2.7	3.8	3.7	2.5	3.2	2.6	3.9	2.50	3.90	3.16	1.40
TP (mg/L)	0.51	0.48	0.61	0.42	0.21	0.49	0.56	0.61	0.42	0.21	0.61	0.48	0.40
OrthoP (mg/L)	0.46	0.42	0.50	0.16	0.13	0.33	0.59	0.49	0.15	0.13	0.59	0.36	0.46
Temp (celcius)	14.25	16.26	16.90	23.7	15.34	12.94	17.10	14.09	19.49	12.94	23.70	16.67	10.76
Cond (ms/cm)	1.046	1.067	0.752	0.873	0.747	0.851	1.027	0.613	0.870	0.61	1.07	0.87	0.45
DO (mg/L)	7.03	4.84	7.34	5.94	10.07	4.80	3.63	5.59	8.52	3.63	10.07	6.42	6.44
pH	6.59	7.61	7.69	7.61	7.39	7.72	7.65	7.42	7.82	6.59	7.82	7.50	1.23
Salinity (TDS mg/L)		0.70	0.50	0.6	0.50	0.50	0.70	0.40	0.50	0.40	0.70	0.55	0.30
TSS (mg/L)		<5		53	<5	<5	<5		15.00	15.00	53.00	34.00	38.00
DO(%)	67.8	44.8	68.7	62.3	81.5	40.6	36.2	50.1	59.6	36.20	81.50	56.84	45.30
Redox (mV)	41	186	198	101	235	185	-22	284	142	-22.00	284.00	150.00	306.00
Dissolved Metals (mg/L):													
Aluminium	0.6	0.32	0.5	0.24	0.2	0.73	0.37	0.54	0.26	0.20	0.73	0.42	0.53
Arsenic	0.003	0.002	0.002	0.004	0.002	0.002	0.003	0.003	0.003	0.00	0.00	0.00	0.00
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00	0.00	-	0.00
Chromium	0.002	<0.001	0.001	0.002	0.002	0.002	0.001	0.002	0.001	0.00	0.00	0.00	0.00
Copper	0.003	0.002	0.002	0.001	0.002	0.003	0.002	0.002	0.001	0.00	0.00	0.00	0.00
Lead	0.001	<0.001	<0.001	0.002	0.001	0.001	<0.001	<0.001	0.002	0.00	0.00	0.00	0.00
Nickel	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.00	0.00	0.00	0.00
Zinc	0.007	0.008	0.006	<0.005	0.006	0.008	0.006	0.006	<0.005	0.01	0.01	0.01	0.00
Iron	0.36	0.88	0.71	0.44	0.6	0.38	0.87	0.6	0.41	0.36	0.88	0.58	0.52
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0	0.00	-	0.00

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Table 6 Surface Water Quality results at Southern River (continued)

	SW1				SW3	SW4							
Parameter	**Jul-14**	**Aug-14**	**Sep-14**	**Oct-14**	**Sep-14**	**Jul-14**	**Aug-14**	**Sep-14**	**Oct-14**	**Min**	**Max**	**Ave**	**Range**
Anions Cations etc (mg/L)													
Hydroxide Alkalinity as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	0.00	-	0.00
Carbonate Alkalinity as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	0.00	-	0.00
Bicarbonate Alkalinity as $CaCO_3$	157	113	133	147	207	123	122	135	139	113.00	207.00	141.78	94.00
Total Alkalinity as $CaCO_3$	157	113	133	147	207	123	122	135	139	113.00	207.00	141.78	94.00
Acidity as $CaCO_3$	6	17	14	12	11	5	15	16	11	5.00	17.00	11.89	12.00
Sulfate as SO_4 - Turbidimetric	31	<10	20	45	<1	12	<10	1	44	1.00	45.00	25.50	44.00
Chloride	247	303	156	188	120	200	281	116	189	116.00	303.00	200.00	187.00
Calcium	54	45	53	43	64	43	48	51	36	36.00	64.00	48.56	28.00
Magnesium	25	20	15	19	18	20	20	13	18	13.00	25.00	18.67	12.00
Sodium	139	157	90	102	81	115	142	69	98	69.00	157.00	110.33	88.00
Potassium	13	10	12	7	12	10	10	11	7	7.00	13.00	10.22	6.00

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3 Proposed Development

This section will replace Section 3 of the approved LWMS.

The site is approximately 25 ha and zoned ‘Urban’ by the Metropolitan Region Scheme and ‘Residential Development’ under the local scheme. The site is bound by Southern River Road to the north, Balannup Lake Drain to the east, Matison Street to the south and Lander Street to the west.

The proposed development consists of residential lots zoned R25, R30, R40 and R60. It is proposed to have approximately 10 ha of lots zoned R25 and R40 with 0.8 ha set aside for R30 and R60 lots. A 4.2 ha POS area is proposed in the centre of the site. This area will be made up of 1.58 ha of conservation POS, 0.46 ha of traditional POS and 2.15 ha of drainage POS. There are also three further drainage areas proposed throughout the site; one area located in the northwest corner and two on the eastern boundary totalling approximately 0.92 ha. A 3.8 ha area has been reserved on the western boundary for future development with the local centre (0.26 ha) area located to the east of this.

The site will have six access points, one each on Southern River Road in the north and Holmes Street to the east and four along Matison Street to the south. There are approximately 6.8 ha of road reserve throughout the site interconnecting all the lots. The Outlined Development Plan is provided in Appendix 8.

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6.2 Post Development Modelling

This section will replace Section 6.2 of the approved LWMS.

Surface water runoff will be managed both on a development and a lot scale. The principle behind the stormwater management strategy is to ensure post development flows mimic pre-development conditions. The strategy also insures that stormwater flowing into the Balannup Lake Drain to the east of the site is of a suitable quality. The drainage system has been designed to achieve these objectives.

The overall drainage strategy for the site will be to retain and infiltrate to ground the 1yr 1hr Average Recurrence Interval (ARI) storm event within the site boundary and then detain the 5 yr and 100 yr ARI storm events to pre-development levels in the three drainage reserves (Figure 16). There will be three discharge locations into the Balannup Lake Drain from the site via three pipes.

There is some drainage in the south of the site which drains onto Matison Road. This is as per the approved LWMS with the total amount of runoff not changing.

6.2.1 Proposed Stormwater Management Strategy

The post development model incorporates seven catchments as shown in Figure 16 . Catchments 1, 2, 3 and 7 flow towards Detention Area 1 with Catchments 4 and 5 draining towards Detention Area 2 and Detention Area 3, respectively. Catchment 6 represents the internal POS in the center of the site.

Areas designated potential place of worship, subject to further planning and village hub have also been included in the modelling. As the land use for these areas have not been finalised it has been assumed that these areas will be 70% impervious and 30% pervious.

6.2.2 1yr 1hr ARI Storm Event

6.2.3.1 Lots

Runoff generated from the 1 yr 1 hr ARI storm event on lots has been modelled to be detained onsite through soakwells. Site investigation has identified that soakwells would be a viable option[2] for the infiltration of roof runoff, subject to further filling being placed on lots (where necessary) to establish adequate separation to groundwater. If this cannot be provided, it is proposed that rainwater tanks are installed in place of soakwells.

The modelled volume of each soakwell has been standardised for the site. It has been assumed that each lot will have a soakwell with the capacity to hold 2.54 m³. The total amount of storage required to retain the 1yr 1hr ARI events on lots is approximately 880 m³ or an average of 8.2 m³/1000m² across the site. Table 7 details the required storage per catchment. An infiltration rate of 1.7 m/day has been assumed for soakwells. This infiltration rate has been sourced from Section 2.5.4 of the approved LWMS which provides information on infiltration testing carried out onsite. The most conservative rate from the testing has been used.

Table 7 Soakwell Volumes

Catchment	Total Lot Area (m²)	Total Storage Required (m³)	Required Storage per 1000m² of lot (m³)	Infiltration Rate (m/day)
1	31,590	237	7.50	1.7
2	10,230	49	4.79	1.7
3	11,090	134	12.08	1.7
4	12,100	92	7.60	1.7
5	16,530	146	8.83	1.7
7	25,630	222	8.66	1.7

[2] Section 6.3 of the LWMS provides information on the use of soakwells.

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6.2.3.1 Roads

The retention of the 1yr 1hr ARI storm event from road reserves will be achieved through the use of detention areas located in the three drainage areas (Figure 17). Flows from the roads will be conveyed through a pit and pipe system.

It is proposed that Catchments 1, 2 and 3 flow to a vegetated swale system in the traditional POS. This will treat first flush road runoff before entering the conservation POS. Here it will flow south into Detention Area 1 located in the southern part of the POS. Further treatment will occur in Detention Area 1 via placement of appropriate soils and plantings in the Detention Area.

Catchment 7 runoff will flow into a vegetated swale system located on the southern extent of Detention Area 1. Treatment of Catchment 7 road runoff will occur in the vegetated swale system before entering the detention area.

Catchments 4 and 5 will flow into the vegetated core of Detention Area 2 and Detention Area 3, respectively. The volumes associated with each Detention Area are presented in Table 8. Flood inundation for the 1yr 1hr ARI event is presented in Figure 18a. Inundation is indicative but shows areas of low lying land.

Table 8 1yr 1hr ARI Event Stormwater Retention Volumes

ID	Catchment Runoff	Surface Area (m^2)	Depth (m)	Maximum Water Depth (m)	Volume (m^3)
Detention Area 1	Ct 1, 2, 3,7	9,950	1.00	0.05	347
Detention Area 2	Ct 4	800	0.80	0.07	40
Detention Area 3	Ct 5	490	0.80	0.17	57

6.2.3 5yr ARI Storm Event

The strategy for stormwater management is to convey the 5yr ARI rainfall event via the pit and pipe system and via a series of flush kerbing gaps directing stormwater to POS areas for detention.

Stormwater runoff generated by the critical duration (24 hour storm) 5yr ARI event will be stored in the three detention areas. As per Section 6.5 of the approved LWMS it is proposed that detention areas will be created by filling around the proposed development areas on either side of the POS corridor and by constructing a berm between the Detention Areas and the Balannup Lake Drain. It is proposed that the detention areas discharge through pipes into the Balannup Lake Drain to the east.

Table 9 5yr ARI Events Stormwater Retention Volumes

ID	Surface Area (m^2)	Depth (m)	5yr ARI Maximum Water Depth (m)	5yr ARI Volume (m^3)	Discharge Pipe (mm)	5yr ARI Discharge (m^3/s)
Detention Area 1	9,950	1.00	0.41	3,397	250	0.07
Detention Area 2	800	0.80	0.41	250	250	0.02
Detention Area 3	490	0.80	0.36	126	525	0.12

6.2.4 100yr ARI Storm Event

Runoff generated in the 100yr ARI storm event will be directed towards the pit and pipe system and roads where it will be conveyed overland to the POS areas. Runoff will be detained and discharged to pre-development flow rates. Table 10 presents required volumes and water depths for the 60 minute critical duration 100yr ARI storm event with flow paths illustrated in Figure 17. The 100yr flood inundation footprint is

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illustrated in Figure 18b. Cross sections through the detention areas (Figure 19) provide information on discharge into the Balannup Lake Drain.

Table 10 100yr ARI Events Stormwater Retention Volumes

ID	Surface Area (m^2)	Depth (m)	100yr ARI Maximum Water Depth (m)	100yr ARI Volume (m^3)	Discharge Pipe (mm)	100yr ARI Discharge (m^3 /s)
Detention Area 1	9,950	1.00	0.71	5,970	250	0.10
Detention Area 2	800	0.80	0.59	380	250	0.05
Detention Area 3	490	0.80	0.60	230	525	0.33

The stormwater strategy for the site was to mimic pre-development discharge from site in the post development scenario. From Section 6.1 of the approved LWMS the pre-development discharge during the 100yr ARI event from the site was 0.5 m³/s into the Balannup Lake Drain. The cumulative post development discharge from site is 0.48 m³/s, thus, complying with Better Urban Water Management and the site's previously approved drainage strategy.

6.2.4 Detention Area Drain Times

To ensure sufficient capacity within designed basins should rainfall events of magnitude occur back to back the Urban Water Resources Centre (2008) has produced a series of recommended emptying time criteria. These are:

> 0.5 days (12hrs) for 1yr ARI event.

> 1.5 days (36hrs) for 5yr ARI event.

> 3.5 days (84hrs) for a 100 year ARI event.

Table 11 displays the drain times for each basin. The detention areas will drain by a combination of infiltration and pipe discharge with the times for the basin to be free of water tabulated below. This table confirms the designed system complies with the recommended emptying times. This assumes infiltration is possible through both sides and the base of the drainage features.

Table 11 Basin Drain Times

Basin	1yr 1r ARI Basin Drain Time (hrs)	5yr ARI Basin Drain Time (hrs)	100yr ARI Basin Drain Time (hrs)
Detention Area 1	1.5	1.5	2
Detention Area 2	1.2	7	9
Detention Area 3	1.5	11	13

6.4 Stormwater and Subsoil Water Treatment

This section is to replace the third paragraph of Section 6.4 of the approved LWMS.

Groundwater across the site is typically quite shallow, with peak winter groundwater levels less than 1 mbgl in all groundwater monitoring boreholes, with the exception of one (Table 2). Consequently, it is proposed to use subsoil drainage and fill in order to ensure an adequate buffer between groundwater and the development is maintained across the site.

6.4.1 Fill

As demonstrated in Table 2 and Graph 1, the observed peak depth to groundwater across the site is within 1 mbgl. Fill will be required to be imported to the lots in order to provide sufficient separation between the

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finished lot levels and peak groundwater levels. Any imported fill will have to be certified by a geotechnical engineer as being structurally sound to support the proposed development.

6.4.2 Subsoil Drain Specifications

The preliminary design of the subsoil drainage system has consisted of the following criteria:

> Discharge inverts for subsoil pipes will be placed sufficiently above the invert levels of receiving bodies to permit free drainage; and

> Subsoil drainage pipes will have a minimum grade of 1:500.

Preliminary layout drawings are provided in Appendix 12.

6.4.3 Subsoil Drain Calculations

Mounding between the subsoils was calculated using Schilfgaarde's method as set out in Austroads Guide to Road Design 5A (2008). The soil parameters were estimated based on previous geotechnical investigations (Bioscience, 2010). Due to the lack of identification of an impermeable layer below the site, it was assumed that the loamy/clayey sands identified in previous geotechnical investigations were impermeable. Based on the maximum distance between roadways indicated by the structure plan, pipes were taken to have a spacing of 90 m.

Based on the assumptions above, it was determined that a maximum mound crest height of 0.65 m would be experienced for uniform infiltration between the subsoil drain and the crest mount, and a maximum crest height of 1.24 m would be achieved for the worst case infiltration scenario of having a soakwell placed directly over the mound.

6.4.4 Subsoil Operation

Subsoil drains are anticipated to be discharged into the onsite Detention Areas. Where this is not feasible, principally along the eastern site boundary, subsoils will be discharged to a treatment swale along the western edge of the Balannup Drain, before overtopping and flowing, via overland flow, into Balannup Drain, as outlined in Figure 19 of the original LWMS.

Finalisation of subsoil drainage design will be undertaken at the UWMP stage to confirm the interaction between the subsoil drainage network and associated drainage and treatment measures is sufficient.

6.5 Detention Areas

This section will replace the fourth paragraph of Section 6.5 of the approved LWMS.

These details are illustrated in Figure 18a, Figure 18b, Figure 19 and Appendix 12 which show the detention area with inundated areas, Balannup Lake Drain cross sections and subsoil drainage layout, respectively.

6.6 Proposed Finished Levels

This section will replace the third paragraph of Section 6.6 of the approved LWMS.

Achieving these finished levels will require the importation of fill. This fill material should comprise clean free-draining granular soil that has a permeability of at least 1m/day. Ideally, the fill material should also have a phosphorous retention index (PRI) that is better than a typical Bassendean sand.

The intended fill requirements will be investigated further at the UWMP stage. The use of clean fill at landscaped areas is recommended.

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7. Groundwater Management

This section is to replace Section 7 of the approved LWMS.

There are three primary objectives for groundwater protection and management for the proposed development, these include:

> Protection of infrastructure and assets from flooding and inundation which may be brought about by high groundwater levels.
> Protection of groundwater dependent ecosystems from modified runoff following development.
> Maintaining and managing groundwater levels and quality following development.

Subsoil drains are proposed to be constructed across the ODP area to ensure that groundwater levels do not rise above the estimated maximum levels as a result of urban development to the extent shown on the engineering drawings. This is necessary to ensure the ongoing performance of soakwells which will be used to infiltrate stormwater runoff from rooved areas on proposed lots.

7.4 Groundwater Quality

This section is to replace Section 7.4 of the approved LWMS.

The overall aim for groundwater is to ensure that the quality leaving the site is at least the same, or better, than the water entering the site. This will be achieved by the use of vegetated detention areas (when groundwater is below the CGC) throughout the site to treat the 1yr 1hr ARI event before infiltration. The use of vegetated detention areas will ensure groundwater is protected from pollutant transport such as hydrocarbons. Any pollutants or contaminants the new development may produce are not likely to infiltrate to the groundwater.

During wetter seasons when groundwater reaches the CGC the sub-soil drainage network (Appendix 12) will convey excess groundwater into the Ballanup Lake Drain.

Also at present land is undeveloped and as such there is a potential for significant nutrient load entering the groundwater system. Redeveloping the site will significantly reduce the amount of land available for landscaping. Therefore there is the potential that if the vegetated areas are managed appropriately, fewer nutrients will be introduced into the groundwater and the quality will improve. The further reduction of nutrient load to groundwater should be achieved in the development by:

> Minimising the use of fertilisers to establish and maintain vegetation within the landscaped area and street verges.
> Selection of drought tolerant turf species that require minimal water and nutrients.
> Use of roll-on turf within the landscaped area and street verges, to prevent the high nutrient input requirement during establishment.

Further detail on the measures and maintenance plan to be utilized within the development to reduce pollution to groundwater should be presented within the UWMP.

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10 Monitoring

This section is to replace Section 10 of the approved LWMS.

10.1 Pre-Development Monitoring

A pre-development groundwater monitoring programme commenced in July 2014. This monitoring schedule was undertaken in order to provide a good understanding of groundwater and surface water conditions on the site. This programme was supported by the CoG, DoW, DoP and SRT. The boreholes and surface water testing locations are illustrated in Figure AD 1. Groundwater level and surface water quality monitoring has been completed with the results presented in Section 2.6.2.

Groundwater quality monitoring undertaken up to June 2015 is also presented in Section 2.6.2.

10.2 Post Development Monitoring

It is proposed that the overall condition of POS areas and groundwater, subsoil and surface water monitoring be undertaken for two years, from completion of the civil and landscaping works. Reporting to the CoG will occur annually, detailing the monitoring performed to date. At the end of the two year monitoring and reporting period, the condition of the POS areas and groundwater and surface water condition will be assessed, and reported to the CoG within the final monitoring report.

A visual assessment will be undertaken on a bi-annual basis to monitor POS condition. If the results from the annual monitoring report indicate that action is required to address an issue, a number of contingency measures can be employed (Table 12).

Table 12 Visual Assessment and Contingency Action Plans

Aspect to monitor	Trigger for action	Contingency Action
Debris in drainage system	Visual assessment finds the condition of an aspect poor as compared to the initial visual assessment undertaken at completion of construction.	Remove debris
GP litter		Remove litter
Storm damage	Visual Assessment	Repair drainage system to original condition
Silt		Remove silt build up and restore to original condition
Weed infestation		Removal of weeds
Condition of garden beds and park trees		Restore to original condition through actions such as re-planting, pruning or application of fertilizer.
Turf conditions		Restore to original condition through actions such as re-planting or application of fertilizer.
Condition of paving		Restore paving to original condition
Condition of furniture/structures/fences		Repair and/or replace to original condition
Indicators of theft/vandalism		Restore to original condition by taking appropriate action on a case-by-case basis.
Litter		Remove litter.

10.3 Post Development Groundwater Monitoring

The post development groundwater level, quality and subsoil program is proposed to use the five pre-development boreholes for monitoring groundwater quality monitored at four locations. These are to be located as per Figure AD 2. These groundwater locations will be monitored quarterly for a period of two

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years to ensure that saline water is not utilized for irrigation of POS and also that the development is not negatively impacting groundwater quality downstream of the site. If the results from the annual monitoring report indicate that action is required to address an issue, a number of contingency measures can be employed.

To allow an assessment of the measured water quality parameters, a comparison will be made to trigger values. Trigger levels have been calculated by:

> Removing outlier monitoring results from pre-development record; and
> Averaging remaining pre-development results. This is the trigger value for all post development monitoring programme.

Trigger values are presented in Table 13.

Table 13 Trigger Values for Post Development Groundwater Monitoring

Element	Trigger Value (mg/L)
Ortho P	0.19
TN	2.60
TKN	2.70
NH_4	0.18
NO_X	0.15
TP	0.17

If the results from the post development monitoring indicate that action is required to address the issue, a number of contingency measures may be employed such as:

> Resampling will occur to omit laboratory error;
> Identify source if possible;
> Remove source if possible (e.g. fertiliser input, etc.); and
> Remove sediment-bound nutrients by removing Detention Area sediments.

10.4 Post Development Surface Water Monitoring

Surface water quality will be monitored as per pre-development monitoring locations (Figure AD 2). Surface water quality should be monitored opportunistically on five occasions annually following rainfall events. The post development monitoring should be conducted for three years and include at least one year of monitoring when 80% of the development is complete.

To allow an assessment of the measured water quality parameters, a comparison will be made to trigger values. Trigger values were calculated for pre-development monitoring and as per Section 10.3. Trigger values are presented in Table 14.

Table 14 Trigger Values for Post Development Surface Water Monitoring

Element	Trigger Value (mg/L)
Ortho P	0.35
TN	3.1
TKN	2.8
NH_4	0.14
NO_X	0.3
TP	0.47

If the results from the initial monitoring report (after one year of monitoring) indicate that action is required to address an issue, a number of contingency measures may be employed. In relation to nutrients, these include:

> Identify source if possible;

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> Remove source if possible (i.e. fertiliser input);
> Remove sediment-bound nutrients by removing detention area sediments; and
> Manual removal of plant material from POS and detention area to facilitate further nutrient uptake by growing vegetation.

A summary of the post development monitoring program is shown in Table 15.

Table 15 Monitoring Program Summary

Monitoring Type	Locations	Frequency	Parameters
Groundwater Levels	Five boreholes located as per Figure AD 2.	Monthly year round Frequency of monitoring should be reviewed after the first year results.	Groundwater levels
Groundwater Quality	Five boreholes locations as per Figure AD 2.	Quarterly	*In situ* pH, EC, dissolved oxygen, temperature. Sample pH, Total Suspended Solids, TN, TKN, NH_4, NO_X, TP, heavy metals and hydrocarbons.
Surface Water Quality	Four locations measuring the inflow and outflow from the development.	Five times per year corresponding to rainfall events typically between May and September	

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12 Future Work – Subdivision and UWMP

This section is to be replace Section 12 of the approved LWMS

The requirement to undertake preparation of more detailed water management plans is generally imposed as a condition of subdivision. The development of the UWMP should follow the guidance provided in the Urban Water management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions (DoW 2008).

While strategies have been provided within this LWMS that address planning for water management with the site, it is a logical progression that future subdivision designs and the supportive UWMP will clarify details not provided within the LWMS. The main areas that will require further clarification within future UWMPs are detailed in the following sections and include:

> Once sewer locations are known, appropriate soil investigations at these locations will be conducted. If investigations indicate that there is potential or actual ASS present then an ASS management plan will be required.
> Further detail regarding the post development water balance should be provided.
> Detailed landscaping plans need to be prepared for each of the detention areas, for consultation with the City of Gosnells.
> The City of Gosnells needs to be consulted on possible options for roadside treatment structures that will allow infiltration at source.
> The Water Corporation needs to be consulted as to its latest modelling of the performance of the Forrestdale Main Drain and in particular any impacts on the Balannup Lake Drain or recommendations in the Forrestdale Main Drain Arterial Drainage Strategy (Department of Water, 2009).
> Further detail on the measures and maintenance plan to be utilized within the development to reduce pollution to groundwater should be presented within the UWMP.
> The intended fill requirements will be investigated further at the UWMP stage.

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Appendix 6 – Post Development Stormwater Modelling

This section is to replace Appendix 6 of the approved LWMS

XPSWMM Modelling

Modelling was undertaken using XPSWMM, an industry standard hydrologic and hydraulic modelling software system. It routes flow from hydrological catchments through 1D connection, allowing an analysis of the hydraulics of the site drainage. All hydrological catchments modelled use the Laurenson Routing Method, with a value calculated by the XPSWMM software.

Rainfall Parameters

Design rainfall events for Southern River were determined following the procedure detailed in Australian Rainfall and Runoff (Engineers Australia, 1987). Catchment areas and slopes are determined from analysis of topographical data. The catchment roughness and percentage imperviousness are conservative and were determined from a combination of field experiments, review of AR&R and other technical documents.

Pre-development Modelling

No modelling of the pre-development conditions was undertaken. Pre-development flow rates were sourced from the Forrestdale Main Drain Arterial Drainage Strategy (Department of Water, 2009).

Post Development Modelling

The post development was modelled as seven catchments. Areas, slopes and runoff assumptions are provided in Table A 1.

A detailed earthworks plan covering the site was provided. This enabled the development of overland flow paths.

The aim of the post development modelling is to demonstrate the proposed drainage design is capable of detaining and infiltrating the first 1yr 1hr ARI event and to mimic the pre-development discharge from site in the post development scenario.

The model nodes and links for the post development are shown in Figure A 1. The peak flow rate of water leaving the site can be determined from the detention areas. The post development model has been designed to detain the 1yr 1hr ARI event on lots and to convey all runoff above this to the detention areas.

Delineation of contributing uses to lot areas for both R25, R30, R40 and R60 densities was based on the Western Australian Residential Design Codes (WAPC, 2013). Contributing uses for R-densities are provided in Table A2.

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Table A 1 Post Development Catchment Breakup

Catchment	Total Area (ha)	Slope	Total Road Reserve	Road	Verge	Developed Lot Areas (ha)					Future and Local	
						Total Number of Lots	Roof	Paved	Garden	POS	Impervious	Pervious
1	4.995	0.006	1.763	1.234	0.529	97	1.433	0.587	1.139	0.000	0	0
2	6.042	0.011	1.130	0.791	0.339	33	0.459	0.192	0.372	0.000	2.72181	1.16649
3	1.828	0.010	0.718	0.502	0.215	45	0.615	0.168	0.326	0.000	0	0
4	1.957	0.006	0.645	0.452	0.194	36	0.533	0.230	0.447	0.000	0	0
5	2.896	0.009	1.176	0.823	0.353	63	0.932	0.245	0.475	0.000	0	0
6	3.969	0.011	0.006	0.004	0.002	0	0.000	0.000	0.000	3.958	0	0
7	4.067	0.003	1.238	0.867	0.371	88	1.302	0.429	0.832	0.000	0.1836282	0.0786978

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Table A 2 Lot Breakup R Density

R-Density	Average Lot Area (m²)	Open Space (%)	Roof Area (m²)	Garden (%)	Paved (%)
R25	350	50%	175	66%	34%
R30	300	45%	135	66%	34%
R40	220	45%	121	66%	34%
R60	150	40%	112	66%	34%

The corresponding infiltration rates and roughness coefficient for each sub-class are shown in

Table A 3 Post-development Infiltration Rates

Land Type	Initial loss (mm)	Continuing Loss (mm/h)	Manning's n
POS	17.5	2.50	0.025
Road	1	0.10	0.013
Verge	9	1.50	0.02
Roof	1	0.10	0.013
Car Park	1	0.00	0.02
Garden	21.5	2.5	0.025



Figure A 1 XPSWMM Model Nodes and Links

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Appendix 8 – Outline Development Plan

This section is to replace Appendix 6 of the approved LWMS.

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KEY

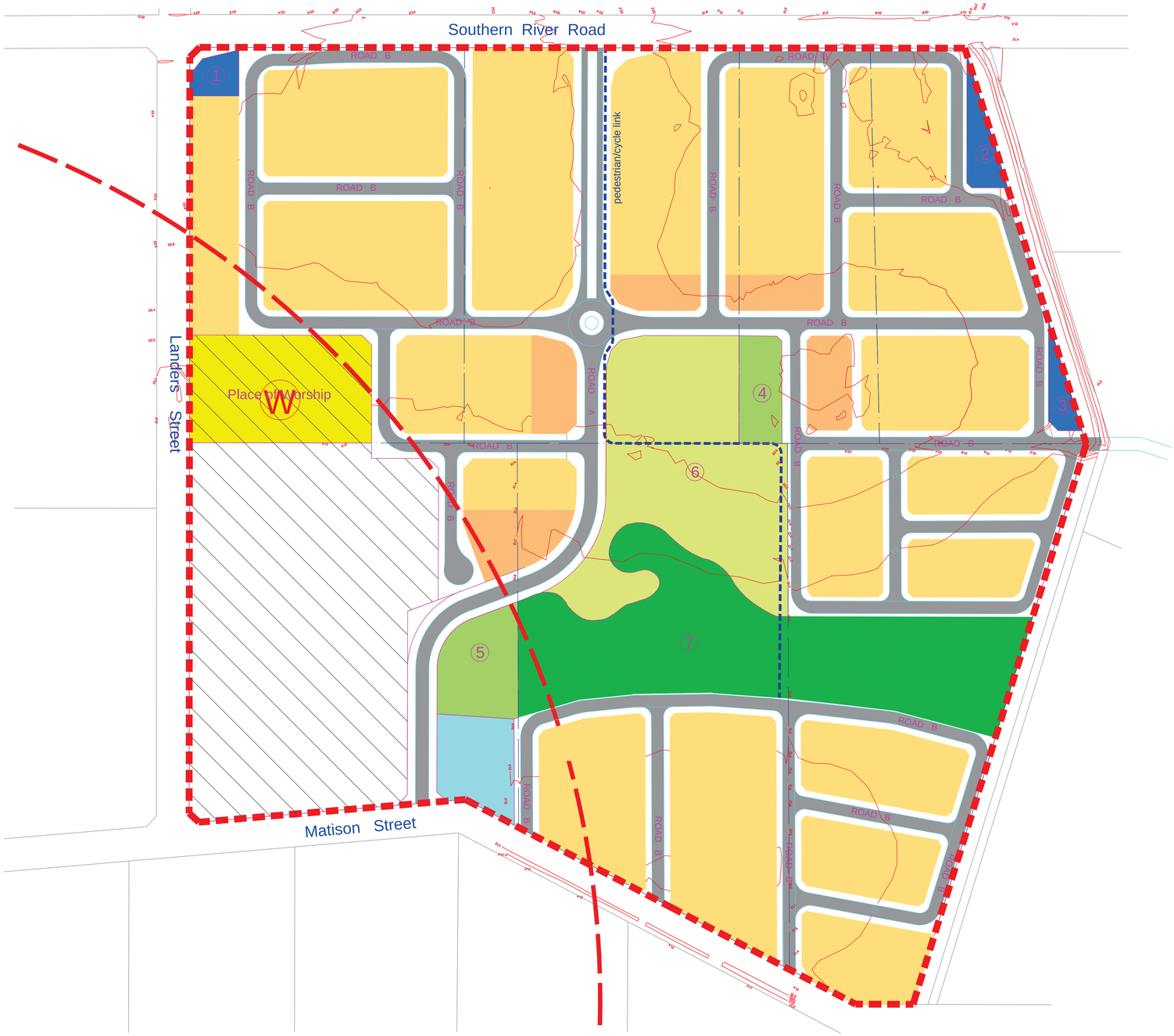
- Residential R25-R40
- Residental R30-R60
- Conservation POS
- Traditional POS
- Urban Water Management POS Swale Drainage
- Swale Drainage
- Subject to Further Planning
- Village hub. Maximum PLUC5 shop / retail floor space1200m² NLA
- Potential Place of Worship
- Road Reserve
- 500m Buffer to the outer boundary of all kennels zone properties

ROAD A = Access Street B
ROAD B = Access Street C

Outline Development Plan Extent

1. Endemic native vegetated Drainage Swales with engineered slopes of 1:6 (no irrigation) - 0.0703ha
2. Endemic native vegetated Drainage Swale with engineered slopes of 1:6 (no irrigation) - 0.1011ha
3. Endemic native vegetated Drainage Swale with engineered slopes of 1:6 (no irrigation) - 0.0672ha
4. Irrigated turf active space - 0.1717ha
5. Irrigated turf active space - 0.2924ha
6. Higher quaility conservation valua bushland with enclosed pedestrian path system - 1.4985ha
7. Multiple Use Wetland open space with no buffer requirements used as a drainage function (no irrigation) - 1.1613ha

Refer Part 1 of ODP report for applicable Statutory Provisions



PLAN 1

OUTLINE DEVELOPMENT PLAN *(indicative plan subject to change and detailed design)*

Lots 12, 14, 18, 19, 20, 21 and 22 Southern River and Matison Street
(in collaboration wirh owners of lot 18 and 20)

M G A
Town Planners
Scale 1:3000 at A3

June 2013 2676/Design23 revised ODP

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Appendix 12 – Engineering Drawings

This section is to be added to the approved LWMS.

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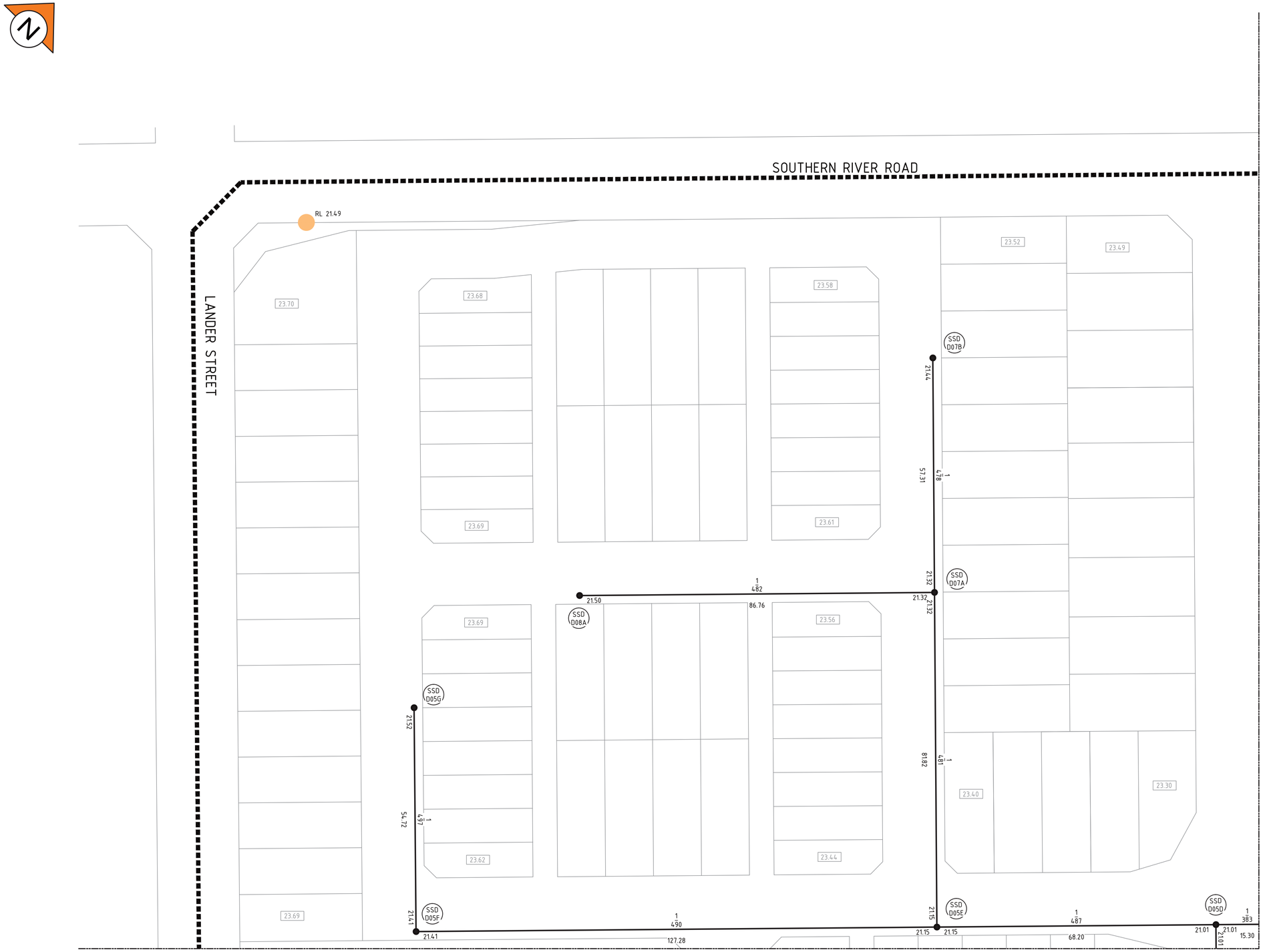
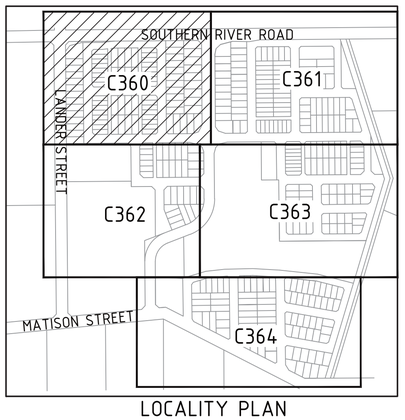
NOTES

1. SUBSOIL PIPES CROSSING PAVEMENT TO BE SOLID PIPE UNDER PAVEMENT (NOT SLOTTED).
2. SOLID PVC SUBSOIL TO BE EXTENDED MINIMUM 1m BEYOND PAVEMENT.
3. PIPE SIZES ARE IN MILLIMETRES. DISTANCES AND LEVELS ARE IN METRES.
4. ALL SUBSOIL PIPE SHALL BE CLASS 12 PVC SWJ (U.N.O)
5. MINIMUM COVER TO ANY PIPE TO BE 0.75m. MINIMUM CLEARANCE TO OTHER SERVICES TO BE 0.15m
6. CONTRACTOR TO LIAISE WITH RELEVANT AUTHORITIES WHEN NEAR EXISTING SERVICES.
7. ALL PIPE DISTANCES ARE MEASURED BETWEEN CENTRE OF MAINTENANCE SHAFTS..

LEGEND

- LIMIT OF WORKS BOUNDARY
- PROPOSED SUBSOIL DRAINAGE
- MGL CONTOURS (0.50m INTERVALS)
- PROPOSED MAINTENANCE SHAFT OR RISER
- U/S 25.00 / 1 / 500 / 16.5 / D/S 24.00 — UPSTREAM INVERT LEVEL / GRADE / LENGTH / DOWNSTREAM INVERT LEVEL
- MR 1A — MAINTENANCE RISER
- 22.68 — MINIMUM LOT LEVELS FOR GROUNDWATER SEPERATION
- SPOT GROUNDWATER LEVELS





LOCALITY PLAN

NOT TO SCALE

0 5 10 20 30m

SCALE 1:500 @ ORIGINAL SHEET SIZE A1

WARNING

BEWARE OF UNDERGROUND SERVICES

The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Worksafe Regulation 3.21.

DIAL1100 BEFORE YOU DIG

REV	DATE	DRAWN	CHECKED	APPROVED	
B	28.08.15	BL	JL	JL	ISSUED FOR LWMS APPROVAL
A	10.03.15	BL	MS	JL	ISSUED FOR INFORMATION

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CLIENT: DEPARTMENT OF HOUSING

PROJECT: LOTS 13, 14, 21, 22 SOUTHERN RIVER RD AND LOTS 18, 20 MATISON ST

DRAWING TITLE: SUBSOIL DRAINAGE AND MINIMUM LOT LEVELS FOR GROUNDWATER SEPARATION PLAN - SHEET 1 OF 5

DRAWN: B. LESLIE	WAPC No.
DESIGNED: M. SMITHERS	SCALE @ A1: 1:500
PROJECT MANAGER: J. LEE	DATUM: AHD; CO-ORDS: PCG-94
JDSi PROJECT No.: JDS11487	DRAWING No.: C360; REVISION: B

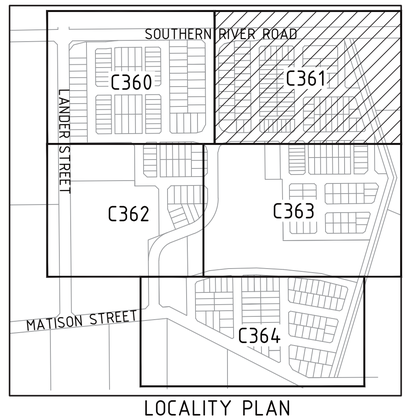
Plotted By: bleslie Plot Date: 28/08/15 - 14:31 Cad File: I:\JDS11487\Drawings\DWG\JDS11487_C360-C364.dwg

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

NOTES

1. REFER TO DRAWING C360 FOR NOTES AND LEGEND





LOCALITY PLAN
NOT TO SCALE

WARNING
BEWARE OF UNDERGROUND SERVICES
The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Worksafe Regulation 3.21.

DIAL1100 BEFORE YOU DIG

REV	DATE	DRAWN	CHECKED	APPROVED	
B	28.08.15	BL	JL	JL	ISSUED FOR LWMS APPROVAL
A	10.03.15	BL	MS	JL	ISSUED FOR INFORMATION

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JDSi CONSULTING ENGINEERS
Workzone, Level 6, 1 Nash Street, Perth WA 6000
P: (08) 9227 0595 F: (08) 9227 8617

CLIENT: DEPARTMENT OF HOUSING

PROJECT: LOTS 13, 14, 21, 22 SOUTHERN RIVER RD AND LOTS 18, 20 MATISON ST

DRAWING TITLE: SUBSOIL DRAINAGE AND MINIMUM LOT LEVELS FOR GROUNDWATER SEPARATION PLAN - SHEET 2 OF 5

DRAWN: B. LESLIE	WAPC No.
DESIGNED: M. SMITHERS	SCALE @ A1: 1:500
PROJECT MANAGER: J. LEE	DATUM: AHD; CO-ORDS: PCG-94
JDSI PROJECT No.: JDS11487	DRAWING No.: C361; REVISION: B

Plotted By: bleslie Plot Date: 28/08/15 - 14:31 Cad File: I:\JDS11487\Drawings\DWG\JDS11487_C360-C364.dwg

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

MATCHLINE - REFER DRG. C360

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23.68
23.28
23.36
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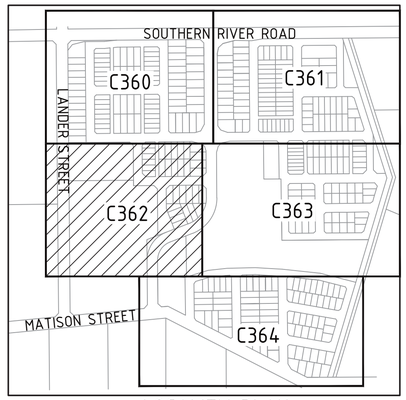
21.20
29.59
23.32
23.29
23.21
23.16
21.00
P.O.S.
RL 20.73

MATCHLINE - REFER DRG. C363

MATCHLINE - REFER DRG. C364

NOTES

1. REFER TO DRAWING C360 FOR NOTES AND LEGEND



LOCALITY PLAN
NOT TO SCALE

0 5 10 20 30m
SCALE 1:500 @ ORIGINAL SHEET SIZE A1

WARNING
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DIAL 1100 BEFORE YOU DIG

REV	DATE	DRAWN	CHECKED	APPROVED	
B	28.08.15	BL	JL	JL	ISSUED FOR LWMS APPROVAL
A	10.03.15	BL	MS	JL	ISSUED FOR INFORMATION

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PROJECT: LOTS 13, 14, 21, 22 SOUTHERN RIVER RD AND LOTS 18, 20 MATISON ST

DRAWING TITLE: SUBSOIL DRAINAGE AND MINIMUM LOT LEVELS FOR GROUNDWATER SEPARATION PLAN - SHEET 3 OF 5

DRAWN: B. LESLIE	WAPC No.
DESIGNED: M. SMITHERS	SCALE @ A1: 1:500
PROJECT MANAGER: J. LEE	DATUM: AHD / CO-ORDS: PCG-94
JDSi PROJECT No.: JDS11487	DRAWING No.: C362 / REVISION: B

Plotted By: bleslie Plot Date: 28/08/15 - 14:31 Cad File: I:\JDS11487\Drawings\DWG\JDS11487_C360-C364.dwg

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

NOTES

1. REFER TO DRAWING C360 FOR NOTES AND LEGEND

MATCHLINE - REFER DRG. C361

MATCHLINE - REFER DRG. C362

MATCHLINE - REFER DRG. C364

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21.00

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SSD D12D

SSD D12B

SSD D12A

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SSD D15A

SSD D13C

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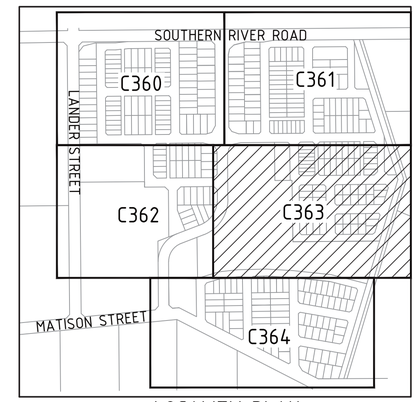

LOCALITY PLAN

NOT TO SCALE

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SCALE 1:500 @ ORIGINAL SHEET SIZE A1

WARNING

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PROJECT: LOTS 13, 14, 21, 22 SOUTHERN RIVER RD AND LOTS 18, 20 MATISON ST

DRAWING TITLE: SUBSOIL DRAINAGE AND MINIMUM LOT LEVELS FOR GROUNDWATER SEPARATION PLAN - SHEET 4 OF 5

DRAWN: B. LESLIE	WAPC No.
DESIGNED: M. SMITHERS	SCALE @ A1: 1:500
PROJECT MANAGER: J. LEE	DATUM: AHD; CO-ORDS: PCG-94
JDSi PROJECT No.: JDS11487	DRAWING No.: C363; REVISION: B

Plotted By: bleslie Plot Date: 28/08/15 - 14:31 Cad File: I:\JDS11487\Drawings\DWG\JDS11487_C360-C364.dwg

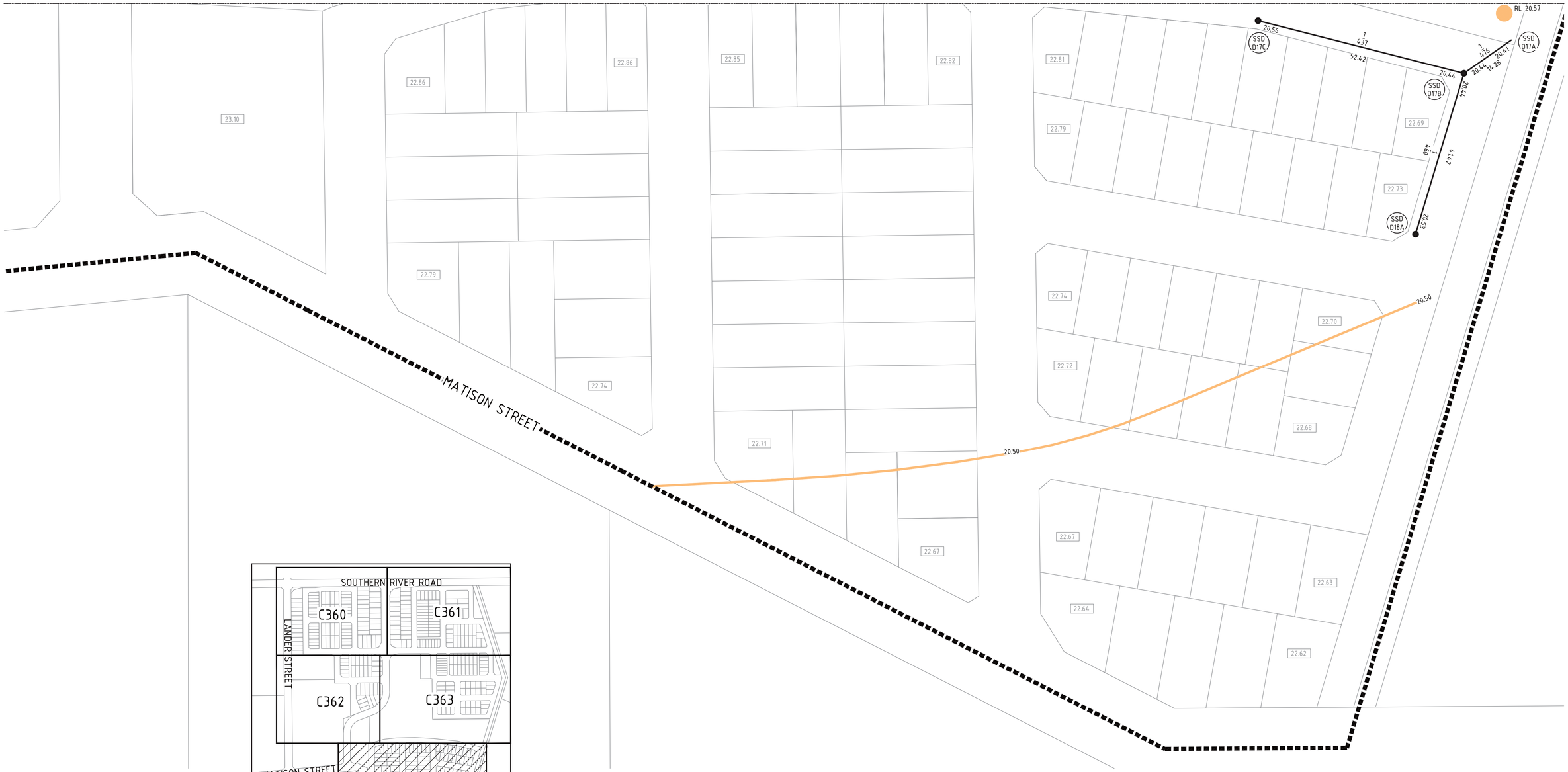
Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

NOTES

1. REFER TO DRAWING C360 FOR NOTES AND LEGEND

MATCHLINE – REFER DRG. C362

MATCHLINE – REFER DRG. C363



LOCALITY PLAN

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SCALE 1:500 @ ORIGINAL SHEET SIZE A1

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DIAL1100 BEFORE YOU DIG

REV	DATE	DRAWN	CHECKED	APPROVED	
B	28.08.15	BL	JL	JL	ISSUED FOR LWMS APPROVAL
A	10.03.15	BL	MS	JL	ISSUED FOR INFORMATION

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PROJECT: LOTS 13, 14, 21, 22 SOUTHERN RIVER RD AND LOTS 18, 20 MATISON ST

DRAWING TITLE: SUBSOIL DRAINAGE AND MINIMUM LOT LEVELS FOR GROUNDWATER SEPARATION PLAN – SHEET 5 OF 5

DRAWN: B. LESLIE	WAPC No.
DESIGNED: M. SMITHERS	SCALE @ A1: 1:500
PROJECT MANAGER: J. LEE	DATUM: AHD; CO-ORDS: PCG-94
JDSi PROJECT No.: JDS11487	DRAWING No.: C364; REVISION: B

Plotted By: bleslie Plot Date: 28/08/15 - 14:31 Cad File: I:\JDS11487\Drawings\DWG\JDS11487_C360-C364.dwg

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

References

Australian and New Zealand Environmental and Conservation Council (ANZECC), 1998, Water Quality - Sampling: Part 11: Guidance on Sampling of Groundwaters, Canberra.

Austroads, 2008, *Guide to Road Design Part 5A:Drainage – Road Surface, Networks, Basins and Subsurface*, Sydney

Department of Water (2009): Forrestdale Main Drain Arterial Drainage Strategy, Perth.

Engineers Australia, 1987, Australian Rainfall and Runoff, Canberra. Engineers Australia.

Urban Water Resources Centre, 2008, Water Sensitive Urban Design: Basic Procedures for 'Source Control' of Stormwater, University of South Australia.

Western Australian Planning Commission (WAPC), 2008, Better Urban Water Management, Perth.

Western Australian Planning Commission, 2013, State Planning Policy 3.1: Residential Design Codes, WAPC: Perth.

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Version: 1, Version Date: 24/07/2026

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

SW1

SW2

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Site Boundary

Groundwater Monitoring Locations

Surface Water Monitoring Locations

Government of Western Australia
Department of Housing

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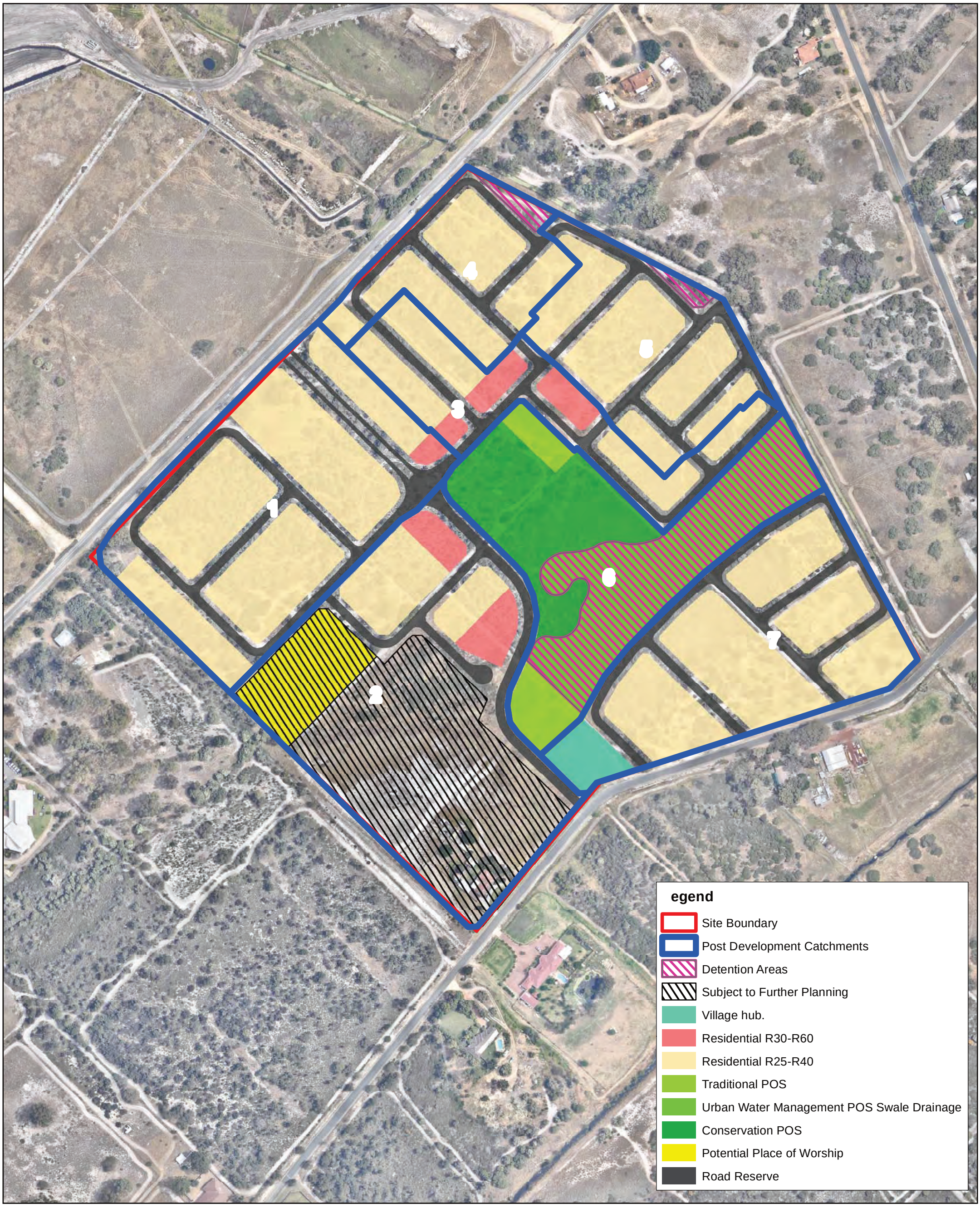
Map Produced by CARDNO
Date: 13-04-2015
Coordinate System: GDA 1994 MGA Zone 50
Project: V14016 Southern River LWMS
Map: V14016_FIG1_Monitoring_Locations.mxd 01

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026



Government of Western Australia
Department of Housing

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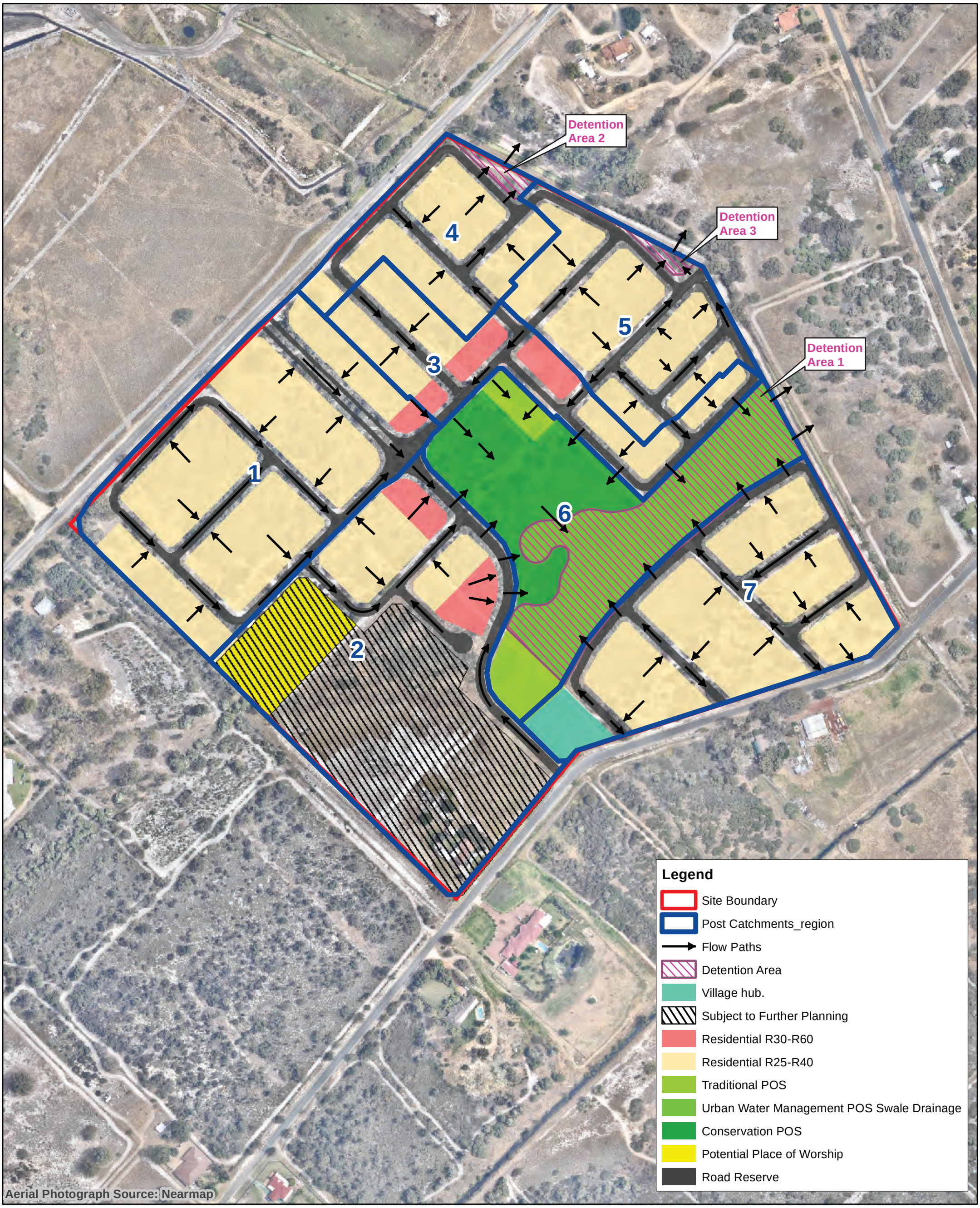
Cardno

Map Produced by CARDNO
Date: 10-04-2015
Coordinate System: GDA 1994 MGA Zone 50
Project: V14016 Southern River LWMS
Map: V14016_FIG2_Post_Catchments.mxd 01

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026



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Department of Housing

1:3,000 Scale at A3

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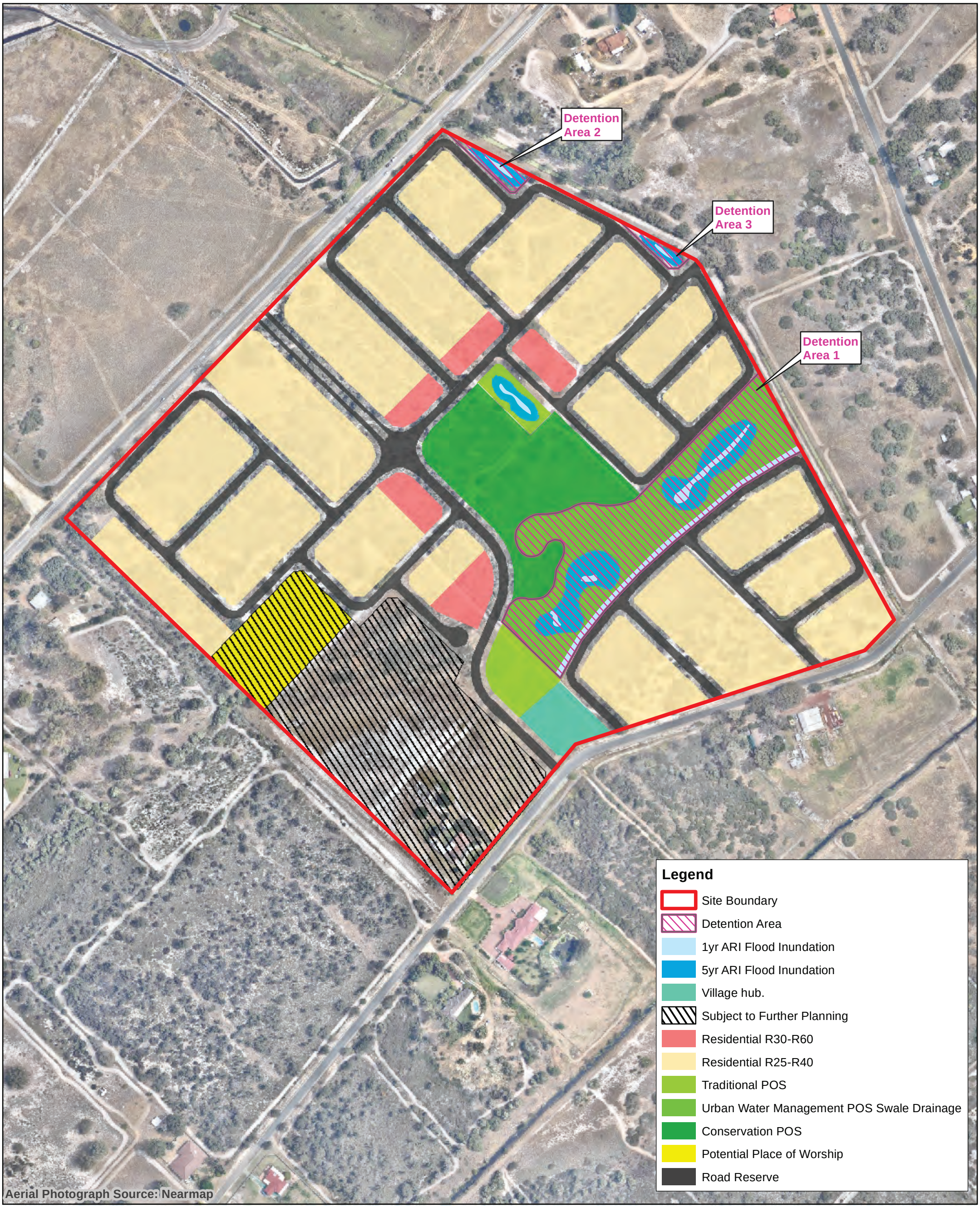
Flow Paths

Figure 17

Cardno

Map Produced by CARDNO
Date: 07-10-2015
Coordinate System: GDA 1994 MGA Zone 50
Project: V14016 Southern River LWMS
Map: V14016_Figure17_20151007.mxd 02

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026



Government of Western Australia
Department of Housing

1:3,000 Scale at A3

Metres

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1yr and 5yr ARI Flood Inundation

Figure 18a

Cardno

Map Produced by CARDNO
Date: 07-10-2015
Coordinate System: GDA 1994 MGA Zone 50
Project: V14016 Southern River LWMS
Map: V14016_Figure18a_1y_5yr_ARI_Flood_Inundation_20151007.mxd 01

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

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- Site Boundary
- 100yr ARI Flood Inundation
- Detention Area
- Subject to Further Planning
- Village hub.
- Residential R30-R60
- Residential R25-R40
- Traditional POS
- Urban Water Management POS Swale Drainage
- Conservation POS
- Potential Place of Worship
- Road Reserve

Government of Western Australia
Department of Housing

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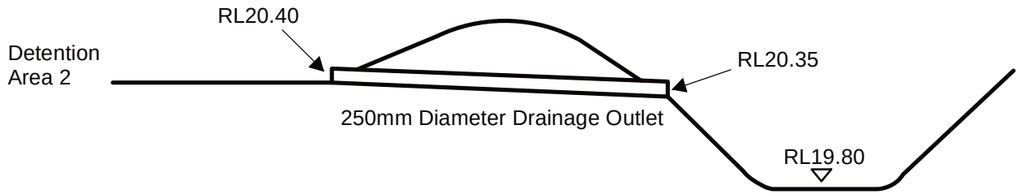
Map Produced by CARDNO
Date: 10-04-2015
Coordinate System: GDA 1994 MGA Zone 50
Project: V14016 Southern River LWMS
Map: V14016_FIG5_100yr_Flood_Inundation.mxd 01

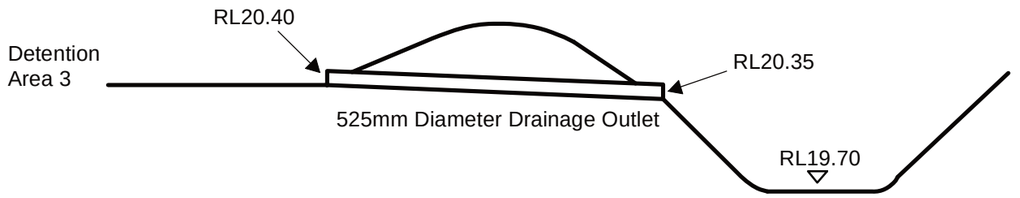
Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026



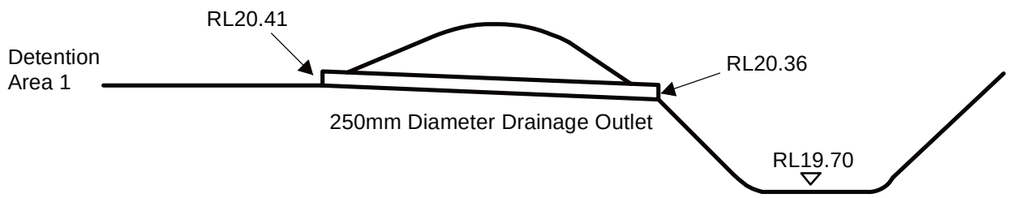
A - A



B - B



C - C



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Department of Housing

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FIGURE 19

Cardno

Map Produced by Cardno
Date: 13-04-2015
Coordinate System: GDA 1994 MGA Zone 50
Project: V14016
Map: V14016_FIG6_Cross_Sections.mxd 01

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026



Government of Western Australia
Department of Housing

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Cardno

Map Produced by CARDNO
Date: 08-09-2015
Coordinate System: GDA 1994 MGA Zone 50
Project: V14016 Southern River LWMS
Map: V14016_Post_Dev_Monitoring_Locations_SLC.mxd 01

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

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Cardno is an ASX200 professional infrastructure and environmental services company, with expertise in the development and improvement of physical and social infrastructure for communities around the world. Cardno's team includes leading professionals who plan, design, manage and deliver sustainable projects and community programs. Cardno is an international company listed on the Australian Securities Exchange [ASX:CDD].

Contact

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www.cardno.com

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Shaping the Future

Document Set ID: 9303595
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APPENDIX 2

DoW Correspondence Regarding Approval of the LWMS

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

ris lar e

r	MACKINTOSH James <James.MACKINTOSH@water.wa.gov.au>
Sent	Wednesday, 22 June 2016 11:46 AM
	Kelly Lavell
	SLODECKI Carlie
S e t	RE: Precinct 3E Southern River

The DoW will again defer assessment and approval to the City of Gosnells. Should the City specifically request the DoW's advice then we will provide comment direct to Gosnells. I would therefore suggest that a copy of the LWMS Addendum is sent to the DoW for our information only.

Regards

i Ma int s

e art ent ater

r gra Manager

and se lanning

S an A n egi n

08 6250 8043 |
james.mackintosh@water.wa.gov.au
Visit our website www.water.wa.gov.au

From: Kelly Lavell [mailto:Kelly.Lavell@rpsgroup.com.au]
Sent: Wednesday, 22 June 2016 11:26 AM
To: MACKINTOSH James
Subject: Re: Precinct 3E Southern River

Great thanks for getting back to me,
I'm preparing a further cover letter to the Cardno addendum which provides a slightly modified drainage design and landscape plan to address the last of the CoG comments.

Would DoW like to be involved in the review of this letter or are you ok to again defer to CoG for approval??

Regard
Kelly

Sent from my Samsung Galaxy A3 on the Telstra Mobile network

-------- Original message --------
From: MACKINTOSH James <James.MACKINTOSH@water.wa.gov.au>
Date: 22/06/2016 10:58 am (GMT+08:00)
To: Kelly Lavell <Kelly.Lavell@rpsgroup.com.au>
Cc: SLODECKI Carlie <Carlie.SLODECKI@water.wa.gov.au>
Subject: RE: Precinct 3E Southern River

Dear Kelly,

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

The Department of Water (DoW) deferred assessment and approval of the Southern River Precinct 3E LWMS Addendum to the City of Gosnells given the small nature of the Addendum.

Regards

i Ma int s

_____

e art ent ater

r gra Manager

and se lanning

S an A n egi n

08 6250 8043 |

james.mackintosh@water.wa.gov.au
Visit our website www.water.wa.gov.au

From: Kelly Lavell [mailto:Kelly.Lavell@rpsgroup.com.au]
Sent: Tuesday, 21 June 2016 12:33 PM
To: MACKINTOSH James
Subject: Precinct 3E Southern River

Hi Jim,

RPS is now working on the LWMS for the Southern River Precinct 3E site, which was previously being completed by Cardno.

LWP Property Group have purchased the land from the Department of Housing and are currently providing the City and WAPC with a range of information in order to get the revised ODP through the City and WAPC.

There has been two LWMS's written for this development as the ODP was revised, the second one written by Cardno has not been endorsed and i am now having to try and get it revised and endorsed through the City of Gosnells and DoW.

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I notice you attended a meeting with the City and the project consultant team back in February – see meeting minutes attached.

Can i confirm if you have provided any separate comments on the Cardno LWMS addendum to ensure i address them in this LWMS ‘cover letter’ that i’m preparing.

Regards

Kelly.

RPS

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Level 2, 27-31 Troode Street, West Perth, WA , Australia, 6005
PO Box 170, West Perth WA 6872.

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el +61 8 9211 1111
a +61 8 9211 1122
ail Kelly.Lavell@rpsgroup.com.au
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APPENDIX 3

LWMS Meeting Minutes and CoG LWMS Addendum Comments

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

Document Set ID: 9303595
Version: 1, Version Date: 24/07/2026

Southern River Precinct 3E LWMS Addendum Meeting Minutes

Date: 15 February 2016 **Time**: 2.00pm – 3.15pm **Location**: WAPC Offices, City of Perth

Attendees

Justine Jones (Cardno)
Paul Mathews (Maddestra Group)
James Mackintosh (Department of Water (DoW))
Alice Brown (DoP)
Jason Lee (JDSi)
Hannelie Evans (Housing Authority)
Jeff Glass (City of Gosnells (the City))
Jasmine Tothill (Department of Planning (DoP))
Jeff Malcolm (MGA Town Planners)

LWMS Addendum	Owner
The City has provided a series of queries relating to the submitted LWMS Addendum. These comments had been reviewed and a response provided to the City in relation to how the land owners propose to respond. The City identified that they objected to responses to five of the comments. These comments were discussed in detail at this meeting. Unfortunately Dumal Kannangara from the City who has been dealing with this application was unable to attend the meeting. As such resolutions to these matters were not able to be confirmed without further discussion internally within the City.	
City Comment 4: This section gives information on the POS - 4.2ha area consisting of 1.58ha conservation, 0.46ha traditional POS (is this the unrestricted, recreational POS?) and 2.15ha of drainage (what are the different storm events and how much is considered restricted and how much unrestricted?). There is no landscape concept plan provided for the POS showing these different areas and how they relate and will be developed. Discussion was centred around the information provided within the structure planning documents already approved by the City which may not have been available to the Parks and Environmental Operation's Team to review.	
MGA Town Planning to provide the City with the POS table included within the Planning documentation and a copy of the Landscape Plan.	JM
City to confirm that this information provides sufficient response to the City and that no further work is required.	City

The comment from Lesley Dunn from parks and environment is given below

My comments on the LWMS over the years related to a need for a landscape concept plan. I was provided with a plan for the POS from Jeff and Ashleigh recently (mid-February 2016) – Landscape Strategy Plan Rev A June 2013 Epcad. It seems this was submitted as part of the revised ODP documentation however I had not seen it previously. Regardless, a concept plan should have been included in the LWMS. While the concept plan is used in the ODP assessment in terms of the breakdown of POS areas (recreational, environmental and drainage) to give restricted and unrestricted POS, it is also used in the LWMS to provide details on the irrigation requirements of the recreational POS.

The Better Urban Water Management document states that the Landscape section / Landscape Plan in the LWMS needs to give information on:

- Proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas.

The plan provided, titled as a Landscape Strategy Plan, is a good overall plan however it needs to provide further details to adequately address what is required for the Landscape section in an LWMS.

Although some of this information may be included elsewhere in some documentation (if it is please advise – ODP / LWMS documentation) the plan itself should include a table / notations with the various areas. They have provided a LSP Description of Public Open

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Spaces on the Plan – which seems to be general design thoughts, so comment won't be provided at this stage on details such as whether a bbq should be provided or drinking facilities. However what should be provided is measurements for the different areas (and I guess I am mostly concerned about the recreational POS so Pocket Park 1 (Area B) and Pocket Park 2 (Area C)) and then to include notations on the plan showing the treatment of these areas (hardstand, irrigated turf, irrigated garden beds etc). Given the scale of the overall plan it may assist having additional drawings specifically showing Area B and Area C so it is clear what is proposed and the irrigation requirements.

I am also confused as Figure 18a in the LWMS Addendum (October 2015) shows drainage in Area B (which is meant to be Pocket Park 1). There seems to be 1 and 5 year events catered for in this area whereas the Landscape Strategy Plan shows a shelter and mentions "This small sheltered pocket park provides a children's playground, exercise equipment and BBQ area …). There is no mention of drainage being contained in this area. It is important that the small areas of recreational POS are not impacted further by drainage. The unrestricted POS must be unrestricted and available for recreational uses.

The Landscape Strategy Plan is a good guiding drawing however it requires additional information and is to include any changes (such as in regards to drainage requirements) since June 2013.

City Comment 5: The City of Gosnell's is currently working on design drawings for Southern River road widening project and looking for extra capacity of storage within the precinct 3E drainage system to manage the additional runoff that generated from a localize low point at the corner of Lander St and Southern River road. The total catchment area is about 11, 028 sq.m. with 80% impervious area. This needs to be considered at the detail design stage (UWMP). However the City would like to add this as a comment within the LWMS addendum as a record for future reference.

The City did not include a requirement to accept drainage from Southern River Road as part of the reworking required as part of the LWMS Addendum when this was discussed and the parameters of the reporting agreed.

Both Maddestra and the Housing Authority stated that they are not willing to accept any additional drainage from the development of Southern River Road onto their land.

The City agreed to review the design and to provide volumes of stormwater requested to be detained onsite. City

The City also agreed to review how drainage is being managed elsewhere along the road and to provide a summary of this. City

On receipt of this information from the City the land owners will review and further discussions will be held as necessary.

Any development located within an existing drainage catchment will need to take a catchment wide approach and consider the development impact on both upstream and downstream environments. In this instance, there is an existing road catchment of Southern River Road currently discharging runoff into the development site. As a minimum this status quo would need to be maintained and an allowance be made for the management of existing flows from this upstream catchment. With the duplication of Southern River Road, drainage is included as a scheme cost. If development is unwilling/unable to accommodate drainage from the additional road pavement, then the City would need to provide additional underground storage within the road reserve at a cost to the CIW scheme. In absence of this, it is expected that development on either side of the road corridor obtaining a benefit from the road upgrade can be reasonable expected to share the burden of accommodating drainage for this road. Inclusion of this impact into the CIW scheme could then be argued by the developers. There being no land set aside for

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the drainage of this road, these are the options available and would have an impact on the CIW scheme costs either way. For further discussion.

And also please find below the runoff volumes calculated for Southern River Road sub catchment near Lander Street

Storm Event ARI	Volume m3
1	138
2	175
5	213
10	238
20	274
50	328
100	371

City Comment 6: Treating subsoil at source is more practical and economical (save fill) with compare to the system where treatment at the end of pipe. With the City's last five years' experiences the proposed subsoil treatment of treating subsoil at the end of the system is not practical and cannot be achieved best treatment outcomes out of the system. Further the options available for correcting the faulty system are less and have to spend big money on it. (Example - Riverbank project - the solution was pumping back untreated water back to the upstream POS - spent more than $400,000). Due to this reason the City would like to propose amended soil around the subsoil as the best option for treating the subsoil discharge in a such shallower ground water environment.

It is understood that the City has undertaken trials of NUA which have been shown to be particularly successful at removing elevated nitrogen in groundwater. As the City are proposing a significant change to the approved LWMS method of treatment of subsoils it was agreed that the City would have to provide an explanation which stipulates why the City has changed it's mind, relating specifically to the particular treatment characteristics of the proposed NUA, for further discussion with the stakeholders.

City

DoW proposed this approach, stating that it was unfair to impose greater restrictions at this point after approval has been given and that the City should reconsider this approach.

Local government has legal responsibility for environmental health through various legislation, including planning, environmental and local government acts and associated regulations. Not only does Local Government have a civil liability, where a local government might be held liable in negligence for damages it has caused through its actions or as a result of a failure to act, but also there is a criminal liability for breach of legislation. Since the original LWMS approved some time ago, the City has gained knowledge of legacy nutrients based on evidence provided by various environmental consultants. Hence, the City is now concerned about pollution of the environment as a result of an accelerated discharge of nutrient enriched groundwater directly into the receiving environment via subsoil drainage. To this date, the only proven method of removal of the specific problem nutrients has been NUA soil amendment within the sand fill of the development area. End of pipe treatment has not been confirmed as a viable nutrient removal approach, due to the treatment efficiency of the material, need for residence/contact time and the risk of clogging if using the NUA material in higher concentration. It should be noted that it would need to be demonstrated that the material can be obtained to proceed with the development approach based on subsoil control. If this is not feasible, due to environmental obligations, the City would not be able to endorse a groundwater controlled development proposal that is reliant on NUA amendment and subsoil drainage to a downstream receiving environment. The drainage approach would then need be revised so that development does not interfere with nutrient laden groundwater. Otherwise the City

could be found in breach of statutory obligations, and failure to use Local Government powers to manage land development and to minimise pollution of the environment.

City Comment 9: The new modelling has come up with similar storage volumes with compare to the previous modelling done by Bioscience. However the new modelling shows that the site allows 0.48m3/s as cumulative post development discharge. With reference to the Forrestdale Main Drain Arterial Drainage Strategy (FDMDS), the allowable combine (including 0.4m3/s rate from Lander Street Compensating Basin) post development discharge rate should be 0.5m3/s. The approved LWMS for precinct 3F shows Lander Street compensating basin now discharges separately to FDMD further upstream. As a result the allowable peak discharge rate for this development is 0.1m3/s but not 0.48m3/s. With the previous modelling this rate was calculated as 0.135m3/s for 1 in 100 year event which is almost close to the allowable discharge rate of 0.1m3/s.	
The City stated that the Lander Street Compensation Basin discharges into the Balanup Drain via a discharge along Matison Street, i.e. downstream of Precinct 3E.	
Cardno proposed that as the 0.4m^3/s discharge would be downstream of Precinct 3E perhaps a more sustainable approach would be to manage the two discharges into Balanup Drain so that the peak flows do not happen at the same time instead of limiting the offsite discharge from Precinct 3E to 0.135m^3/s. DoW agreed that this approach was acceptable to them, however, identified that Water Corp would need to be included in the discussion, however, this could be undertaken as part of the UWMP.	
The City is to confirm this approach is an acceptable taking into account that restricting flows into the drain will require more attenuation space.	City

Provide a letter from Water Corporation which gives approval to discharge more than the allowable discharge which is given in Forrestdale Main Drain Arterial Drainage Strategy.

City Comment 10: The cross sections given in the Figure19 may not be correct as the cross section B-B contribute to a smaller catchment but it discharge through 525mm pipe. Update the figure 19 with the invert of proposed subsoil too. It seems the subsoils discharge at a higher levels with compare to the respective basins outlets. Show the proposed subsoil treatment swale details also in the same plan. The City is looking for more details of the proposed subsoils and the drainage outlets at POS/Balanup Lake Drain interface.	
Cardno provided an example of the cross sections proposed in response to this comment. The City are to agree these meet their requirements.	City

Our previous comment sits as it was and Cardno need to provide some clarification with some calculation.

The City agreed that Cardno's response to all other comments meets their requirements.

Waiting responses from other two officers from Parks and Env

DPaW has no provided a response to the LWMS Addendum. It was discussed that this should not hold up the approval of the LWMS Addendum.

DoW noted that the site is not within the jurisdiction of the Swan River Trust and as such they are not required to comment on the document.

As the proposed site deals with highly polluted ground water DPaW's comments are important and it cannot be neglected.

The City agreed to provide an idea of how long it will take them to respond to these comments to Justine Jones of Cardno.	City

Comments are provided in RED

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Structure Plan Approval	Owner
The City approval of the Structure Plan can be progressed, independently from the approval of the LWMS Addendum, however, there is a small risk that any approval may have to be altered if the LWMS Addendum approval changes requirements previously approved in the Structure Plan. JG to ensure that the City's Planning Department are aware of this. WAPC, however, can only approve the application when all sections have been approved by the City, therefore are reliant on the City approving the LWMS Addendum as well before a decision can be made.	City

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APPENDIX 4

Landscape Plan

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Landscape Masterplan

Legend

01 P.O.S. 1: Irrigated public open space with footpaths, turf, gardens, retained existing trees (where possible), picnic area and playground.

02 P.O.S. 2: Irrigated public open space with footpaths, turf, gardens, retained existing trees (where possible) and picnic area.

03 Conservation P.O.S.: Retained existing vegetation and informal footpath access utilising existing track locations (exact layout to be confirmed)

04 Drainage Detention Basin: Indicative location and layout of drainage basins. To be vegetated with a mix of biofiltration, embankment and wetland species.

05 Drainage Swale: Indicative location and layout of drainage swale. To be vegetated with a mix of biofiltration, embankment and wetland species.

06 Managed Landscape Buffer.

Note:
_ Refer Table 1. for Public Open Space area, irrigation method and water use.
_ Refer drainage drawings for details on basin sizes.
_ Road layout is indicative only, refer Engineer's Drawings for details.

	P.O.S. 1	P.O.S. 2
Proposed P.O.S area	1,794 sq/m	2,888 sq/m
Proposed water source	Bore	Bore
Turf irrigation areas	1,250 sq/m	1,900 sq/m
Garden irrigation areas	450 sq/m	850 sq/m
Estimated yearly water use	1,275 kl/yr	2,062 kl/yr

Table 1: Public Open Space area, irrigation method and water use.



RPS

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APPENDIX 5

Cossill & Webley Drainage Design

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Precinct 3E Stormwater Calculations – Cossil and Webley

Catchment	1:1 yr ARI Volume (m3)	1:1 yr ARI Area (m2)	1:5 yr ARI Volume (m3)	1:5 yr ARI Area (m2)	1:100 yr ARI Volume (m3)	1:100 yr ARI Area (m2)
Catchment 1-2	296	750 (50m by 15m, 0.36m deep)				
Catchment 3	81	150 (15m by 10m, 0.44m deep)	135	200 (20m by 10m, 0.53m deep)	372	200 (20m by 10m, 1.16m deep)
Catchment 4	79	150 (15m by 10m, 0.43m deep)	130	200 (20m by 10m, 0.52m deep)	360	200 (20m by 10m, 1.13m deep)
Catchment 5	110	200 (40m by 5m, 0.42m deep)				
Catchment 6	54	100 (20m by 5m, 0.41m deep)				
Catchment 7	67	150 (30m by 5m, 0.36m deep)				
POS	55	100 (20m by 5m, 0.42m deep)				
Combined in Swale (all except 3 and 4)			2,105	2255 (451m by 5m, 0.55m deep)	7,888	7500 (250m by 30m, 0.88m deep)
tal						

Catchment	1:1 yr ARI basin invert	Groundwater Level 1:1 yr ARI basin	1:5 yr ARI basin invert	1:100 yr ARI basin invert	Groundwater Level 1:5 yr ARI and 1:100 yr ARI
Catchment 1/2	22.00	21.00	20.50	21.00	20.00
Catchment 3	20.70	20.40	20.40	20.40	20.40
Catchment 4	20.70	20.40	20.40	20.40	20.40
Catchment 5	22.50	21.50	20.50	21.00	20.00
Catchment 6	21.00	20.00	20.50	21.00	20.00
Catchment 7	21.00	20.00	20.50	21.00	20.00

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Precinct 3E Area = 25.8 ha
Note the stormwater basin for Catchments 1, 2, 5-7 over a 1:1yr event are all the same.

Run off Coefficients

and r	**n e**	
	r A	**r A**
POS	0.05	0.05
Lots	0.2	0.45
Roads	0.8	0.8

The 1:5 yr storage is within the 1:100yr ARI storage basin/swale.
Max Outflow (1:100yr storm)
Catchment 3 = approx. 0.06m3/sec
Catchment 4 = approx. = 0.06m3/sec
Remaining Catchment = approx. 28m3 in 15min = 0.05m3/sec.
Total Flow = 0.17m3/sec - within acceptable Water Corporation tolerance.

Precinct 3E Stormwater Calculations – Cardno

Cardno has three detention areas for the management of stormwater.

Detention Area ID	1:1 yr ARI Volume (m3)	1:1 yr ARI Area (m2)	1:5 yr ARI Volume (m3)	1:5 yr ARI Area	1:100 yr ARI Volume (m3)	1 :100 yr ARI Area
1	347	9950 (0.05m depth)	3397	9,950 (0.41 m depth)	5,970	9950 (0.71 m depth)
2	40	800 (0.07m depth)	250	800 (0.41 m depth)	380	800 (0.59 m depth)
3	57	490 (0.17m depth)	126	490 (0.36 m depth)	230	490 (0.60 m depth)
tal						

Max Outflow (1:100yr storm)
Detention Area 1 = 0.10 m3/s
Detention Area 2 = 0.05 m3/s
Detention Area 3 = 0.33 m3/s



Preliminary Concept Plan

LOTS 13, 14, 21 & 22 SOUTHERN RIVER ROAD AND LOTS 19 & 20 MATISON STREET, SOUTHERN RIVER

DRAFT

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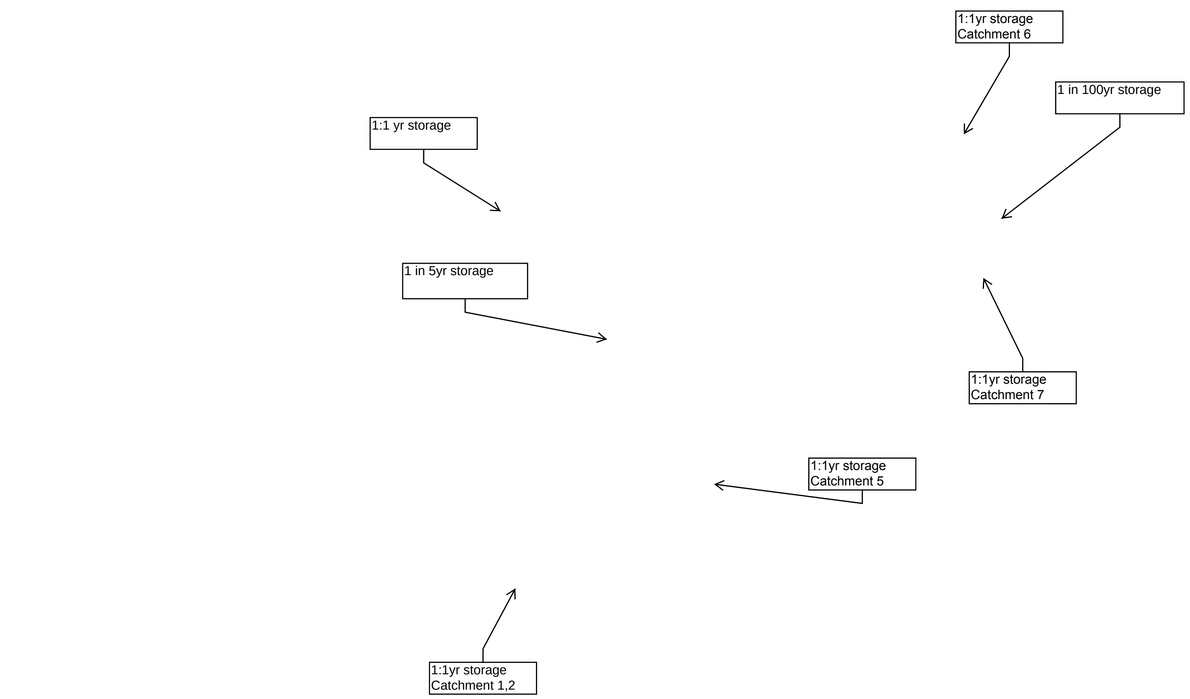

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APPENDIX 6

DPaW Correspondence and LWMS Addendum Comments

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Our Ref V14016-WA-L005-A-DPaWComments

Contact Justine Jones

30 May 2016

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Department of Parks and Wildlife
Rivers and Estuaries Division
Locked Bag 104
Bentley Delivery Centre
WA 6983

Attention: Suzanna Chan

Dear Suzanna

SUBJECT: LOCAL WATER MANAGEMENT STRATEGY ADDENDUM - SOUTHERN RIVER PRECINCT 3E - LOTS 13, 14 21 & 22 SOUTHERN RIVER ROAD AND LOTS 18, 19 & 20 MATISON STREET

The Department of Parks and Wildlife (DPaW), provided the City of Gosnells Engineering Department with comments on the Southern River Precinct 3E addendum on the 8 February 2016. The City passed these comments to Cardno 17 March 2016. In the intervening time the WAPC, City of Gosnells and Department of Water have held a number of meetings to agree a streamlined approach to gaining approval for the site's local structure plan.

Cardno has reviewed DPaW's comments in light of the outcomes of these meetings and propose the following response to the comments (see Table 1 overleaf). I would be grateful if DPaW could agree to the proposed approach, prior to update of the report is undertaken.

I trust the enclosed is self-explanatory, however, please do not hesitate to contact Justine Jones on 08 9273 3888 or justine.jones@cardno.com.au should you wish any further clarification.

Yours sincerely,

Justine Jones
Section Leader: Environment Services and Water
for Cardno

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Table 1 Stakeholder Comments

DPaW Comment Number	DPaW comment	Report Update
a	It is noted in the meeting minutes provided by Cardno for the meeting held on 19 June 2014 states that an update letter (previously issued on the 16 June 2016 to address SRT comments) will be provided to confirm the following: a) the historical land use of the site do not include liquid waste facility; and b) the status of the wetland Please note, the updated letter has not been provided to Parks and Wildlife to date.	The wetland is currently classified as Resource Enhancement. Discussions have historically agreed the development of parts of the wetland. A search of the Contaminated Sites Database did not identify any registered contaminated sites across the site. No further work is proposed to be submitted to address this issue.
b	It is noted in Table 11 that the proposed detention area drainage times for 1 year ARI events will be within 1.5 hrs. It is unclear if this detention times will allow for sufficient water quality treatment. As stated in the LWMS Addendum, the· Urban Water Resources Centre (2008) recommends an emptying time of 12 hours for 1 year ARI events. Please confirm that adequate detention times will be achieved to provide sufficient water quality treatment.	Urban Water Resources Centre recommends a drain time of up to 12 hours for a 1 year storm event. This drain time has not been set based on water quality parameters but to ensure that sufficient capacity is available on site to manage stormwater runoff generated by the development should two storm events occur consecutively. The methods of treatment of stormwater have not changed from the previously approved LWMS. As such it had been assumed that all stakeholders had previously agreed that sufficient water quality treatment had been provided in the approved proposed system. No further work is proposed to be submitted to address this issue.
c	The potential for nutrients and contaminants to be mobilised from groundwater on the site to the river is a key issue in the local region. The pre-development groundwater data identified that nutrients levels, in particularly GW5, exceeded the long term targets for nutrient concentrations in the Southern River (Healthy Rivers Action Plan 2009, TN 1mg/L and TP 0.1 mg/L), with some metals (e.g. aluminium and zinc) and salinity levels above the ANZECC (2000) guidelines trigger values. The controlled groundwater level and subsoil treatment should be designed to minimise nutrient mobilisation - it is unclear whether this has been considered. The LWMS Addendum states that intercepted groundwater from the site will be discharged into the Detention Area for treatment, or into a treatment swale via the subsoil drainage network, prior to overtopping and flowing into the Balannup drain. Please confirm that the detention areas have the capacity to treat both stormwater and groundwater discharge and provide indicative drawings of the proposed treatment swale. It is understood that a post development water balance will be completed at the UWMP stage, and that further details regarding the controlled groundwater level and fill requirements will provided then.	The treatment of subsoils is proposed to be undertaken as outlined in the approved LWMS, in particular Figure 19 of the Bioscience Report. It has been agreed with the City that the addendum will provide an updated plan of this swale (see attached). No further work is proposed to be submitted to address this issue.
d	A conceptual landscaping and design plan should be provided for the detention areas within the public open space, in accordance with Better Urban Water Management (2006), particularly given that the water quality outcomes are reliant on these structures. Please also include the details of the proposed vegetated swales.	An agreement between the WAPC and City has agreed that a landscape plan is not required at this stage. No further work is proposed to be submitted to address this issue.

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DPaW Comment Number	DPaW comment	Report Update
e	It is noted that one of the primary objectives for groundwater management includes the protection of groundwater dependent ecosystems from modified runoff following development; further discussion is needed to outline how this will be achieved.	The agreed scope of the LWMS Addendum was to update section 7.2 of the Approved LWMS if the results of chapter 6 updates required this. As chapter 6 updates did not amend the proposed management of stormwater from the approved system section 7.2 (Protection of Groundwater-Dependent Ecosystems) was not updated. No further work is proposed to be submitted to address this issue.
f	It is noted that stormwater runoff generated from 1 year ARI events on lots will be detained on site either through soakwells or rainwater tanks. It is presumed that stormwater will be infiltrated onsite. Please confirm whether soakwells within lots will be used to retain runoff from both the roof and paved areas.	Yes that is the method proposed.
g	If dewatering is required, the resulting tailwater should be managed on-site unless it can be demonstrated that the quality of water is suitable for discharge to the local drainage system, which ultimately flows to the river.	Noted.
h	The post-development monitoring schedule is not consistent with the requirements of the SRILWMP and should be revised accordingly. Additional monitoring within the subsoil treatment and discharge/detention areas should also be included.	The monitoring schedule will be updated.

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From:	Chan, Suzanna
To:	justine.jones@cardno.com.au
Cc:	"DKannangara@gosnells.wa.gov.au"; wvanlieven@gosnells.wa.gov.au; Jasmine.Tothill@planning.wa.gov.au; Kelly Lavell
Subject:	Southern River Precinct 3E - LWMS Addendum
Date:	Monday, 4 July 2016 3:05:59 PM

Hi Justine,

Thank you for providing proposed responses to the Department of Parks and Wildlife's letter dated 8 February 2016 regarding the Local Water Management Strategy Addendum for the Southern River Precinct 3E. The following matters remain outstanding and should be addressed.

Responses to DPaW comment number (a)

- It is noted that the wetland is classified as a 'Resource Enhancement Wetland'. Has the Department's Wetland/Land Use Planning branch provided formal comments on the ODP and LWMS given that portions of the REW will be used for residential development and stormwater drainage? Please note, I have requested its advice on this matter.
- It is noted that the site is not registered as a contaminated site, however the original LWMS identified that a former liquid waste disposal site operated in the vicinity. It is recommended that a desktop historical land assessment be completed (prior to the preparation of the UWMP) to confirm the location of significant previous land uses or confirm that the historical land use of the site did not include a liquid waste facility.

Responses to DPaW comment number (b)

- Whilst it is acknowledged that the recommended 12 hour drain time has not been based on water quality parameters, the Department still requires further details to ensure that the proposed detention area design is sufficient for water quality treatment. 1.5 hours drain time is unlikely to provide adequate retention for nitrogen attenuation. This will need to be addressed either in the LWMS addendum or at the UWMP stage.

Responses to DPaW comment number (c)

- The original LWMS states that subsoil drains do not require treatment and will discharged directly into the Balannup Lake Drain. However it is noted that the addendum states that intercepted groundwater from the site will be discharged into the detention basins or a subsoil treatment swale prior to flowing into the Balannup Drain. Figure 19 indicate that intercepted groundwater from the subsoil drains can potentially bypass the detention basins for flows above the 20.4 RL (i.e. discharged without treatment/infiltration). The monitoring results indicate that the groundwater is nutrient rich (particularly organic nitrogen), and thus, all subsoil drainage water must be treated accordingly before it gets discharged to the Balannup Lake Drain.
- It is further noted that the proposed subsoil treatment swales are located within the proposed detention basins. As requested, please confirm that the detention areas have the capacity treat both stormwater and groundwater discharge.

Responses to DPaW comment number (d)

- It is noted that vegetated swales are proposed to treat first flush road runoff prior to infiltration within the wetland core/detention area – whilst this approach is supported, the flow path diagram (Figure 17) appears to indicate that stormwater runoff will enter the detention areas at multiple points across the catchments. It is understood that

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detailed landscaping plans will be provided at the UWMP stage, however it is still recommended that a conceptual landscaping and design plan be provided with the LWMS addendum and an updated flow path diagram to demonstrate that the approach outlined above can be achievable.

Responses to DPaW comment number (e)

- Further details will need to be provided at the UWMP stage to demonstrate that modified runoff from the development (and the installation of subsoil drains) will not have an adverse impact on the REW.

Responses to DPaW comments number (f) to (h)

- Noted. No further comments required at this stage.

Please don't hesistate to contact me if you have any queries.

Regards

Suzanna Chan | Environmental Officer
Rivers and Estuaries Division
Department of Parks and Wildlife
08 9278 0935 | Locked Bag 104, Bentley Delivery Centre WA 6983
www.swanrivertrust.wa.gov.au or www.dpaw.wa.gov.au

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